NFPA® 301

Code for Safety to Life from Fire on Merchant Vessels

2008 Edition

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An International Codes and Standards Organization

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NFPA® 301

Code for

Safety to Life from Fire on Merchant Vessels

2008 Edition

This edition of NFPA 301, *Code for Safety to Life from Fire on Merchant Vessels*, was prepared by the Technical Committee on Merchant Vessels and acted on by NFPA at its June Association Technical Meeting held June 3–7, 2007, in Boston, MA. It was issued by the Standards Council on July 26, 2007, with an effective date of August 15, 2007, and supersedes all previous editions.

This edition of NFPA 301 was approved as an American National Standard on August 15, 2007.

Origin and Development of NFPA 301

In 1993, the Coast Guard approached the NFPA Standards Council with a request to form a new committee that would develop a consensus standard on fire protection of merchant vessels, similar in format to the *Life Safety Code*®. The basis for this request was a Coast Guard initiative known as Maritime Regulatory Reform. One aspect of maritime regulatory reform involves greater use of industry standards in lieu of detailed design requirements contained in the Code of Federal Regulations.

The initial approach advocated by the Coast Guard was to develop a standard that was applicable to passenger vessels only and to add requirements for different vessel types in future editions. However, the committee agreed that it would not take much more effort to draft a standard that was applicable to passenger vessels, cargo vessels, and tank vessels. Towing vessels were added to this list in anticipation of a federal law mandating fire protection upgrades. Other vessel types might be added in future editions.

By shifting development and maintenance of regulations to standards-making organizations, the regulators (in this case the Coast Guard) are assured of dynamic standards that are regularly updated. The marine industry benefits through increased input into the rules it would subsequently be required to follow. Similar efforts either have been completed or are in progress to add marine-specific criteria to existing fire protection system standards, such as automatic sprinklers, water mist extinguishing systems, foam, carbon dioxide, and clean agent alternatives to halons.

NFPA 301 provides minimum requirements for the design, operation, and maintenance of merchant vessels for safety to life from fire and similar emergencies. The document establishes occupancy classifications and then provides requirements for design and construction, access and egress, and fire protection. The document applies to passenger vessels, towing vessels, and cargo vessels.

The code underwent a complete revision in 2001 to implement *Manual of Style for NFPA Technical Committee Documents* changes, which reorganized the document and stressed the use of enforceable language. This revision incorporated changes to the testing requirements for interior finishes, deck coverings, mattresses and bedding, and electrical cable. The code expanded the vessels covered to include ocean-going towing vessels as part of the cargo vessel requirements in Chapter 18. In the passenger vessel chapter, the code redefined the classification criteria for vessel categories. One outcome of this change was an attempt to modify the requirements for sprinkler protection on certain classes of passenger vessels so that the requirements more closely matched existing Coast Guard requirements, in order to encourage use of the code as an alternative to Coast Guard prescriptive regulations.

The code has undergone another substantial change in the 2008 edition. A new chapter has been added to allow vessel designers and other users the ability to incorporate equivalencies and alternative design considerations in vessel construction that satisfy the fundamentals of fire prevention, fire protection, and means of egress. The chapter on towing vessels has been completely revised to update requirements for all new-construction towing vessels regardless of length and horsepower in accordance with current U.S. Coast Guard regulations and industry best practices.

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Committee Scope: This Committee shall have primary responsibility for documents on the protection of human life, property, and the marine environment from fires aboard merchant vessels.

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Code for

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Information on referenced publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1 Scope.

1.1.1 Title. NFPA 301, *Code for Safety to Life from Fire on Merchant Vessels*, shall be known as the *Merchant Vessel Code* and is referred to herein as "this code" or "the code."

1.1.2 The code addresses construction, arrangement, protection, and space utilization factors that are necessary to minimize danger to life from fire, smoke, fumes, or panic. It also provides for reasonable protection against property damage and avoidance of environmental damage consistent with the normal operation of vessels. Fundamental requirements applicable to all vessels are found in Chapters 1 through 9. These fundamental requirements are modified in Chapters 10 through 18 as applicable for any type of space. The requirements in Chapters 1 through 18 are modified in Chapters 19 through 21 as applicable for any given vessel type. For example, a passenger vessel would follow the requirements of Chapters 1 through 18 and Chapter 21.

1.1.3 The code identifies the minimum criteria for the design of egress facilities so as to permit prompt escape of passengers and crew to safe areas aboard vessels and, where necessary, to survival craft embarkation stations.

1.1.4 The code recognizes that life safety is more than a matter of egress and, accordingly, deals with other considerations that are essential to life safety. It also recognizes the unique operating environment of merchant vessels and the relationships among life safety, property protection, and environmental protection and deals with these criteria accordingly.

1.1.5* Where permanently moored and occupied as buildings, merchant vessels shall be permitted to be treated as buildings and shall be permitted to be subject to the provisions of appropriate building codes and standards as specified by the local authority having jurisdiction.

1.2 Purpose.

1.2.1 The purpose of this code is to provide minimum requirements, with due regard to function, for the design, operation, and maintenance of merchant vessels for safety to life from fire and similar emergencies.

1.2.2 As related to fire safety, the objective of this code is to protect the passengers and crew from loss of life. It is also intended that the code will provide for minimum loss of property and minimum impact on the environment.

1.2.3* The level of safety is achieved by the combination of design, prevention, protection, egress, and other features enumerated in the individual vessel occupancy classification with due regard to the capabilities and reliability of the features involved. Recognition is given to human factors and to the need for crew training and passenger instruction.

1.2.4 The code endeavors to avoid requirements that could involve unreasonable hardships or unnecessary inconvenience or interference with the normal use of a vessel, but it provides minimum requirements for fire safety consistent with the public interest.

1.3 Application.

1.3.1* This code shall apply to new construction merchant vessels to the extent described in Chapters 19 through 21. This code does not apply to pleasure craft or commercial craft covered by NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, or to warships.

1.3.2 Existing vessels undergoing major modification or conversion shall comply with all requirements of this code within the areas being modified and ancillary support systems.

1.3.3 Any alteration or any installation of new equipment, joinery, or furnishings shall comply with the requirements for new construction.

1.3.4 Where specific requirements contained in Chapters 10 through 18 differ from general requirements contained in Chapters 1 through 9, the requirements of Chapters 10 through 18 shall govern. Where the requirements in Chapters 19 through 21 differ from the requirements in Chapters 1 through 18, the requirements in Chapters 19 through 21 shall govern.

1.3.5 Provisions in Excess of Code Requirements. Nothing in this code shall be construed to prohibit additional means of egress, or otherwise safer means of egress than those specified by the minimum requirements of this code.

1.3.6* This code is not intended for application in addition to Safety of Life at Sea (SOLAS) requirements to vessels in international trade.

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1.4 Equivalency Concepts.

1.4.1 Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, durability, and safety as alternatives to those prescribed in this code.

1.4.2 The specific requirements of this code shall be permitted to be modified by the authority having jurisdiction to allow alternative arrangements that will ensure, as much as practicable, an equivalent level of safety to life from fire, but in no case shall the modification afford less safety to life than that which, in the judgment of the authority having jurisdiction, would be provided by compliance with the corresponding provisions contained in this code.

1.4.3 Vessels with alternative fire protection features accepted by the authority having jurisdiction shall be considered as conforming with the code.

1.5 Units.

1.5.1 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.5.2 If a value for measurement as provided in this code is followed by an equivalent value in other units, the first stated value is to be regarded as the requirement. A given equivalent value might be an approximation.

1.6 Vessel Construction, Repair, and Alteration.

1.6.1* Vessels built or converted to meet this code shall comply with all of the provisions of the code.

1.6.2 Changes in Service. In any vessel, whether necessitating a physical alteration or not, a change in service from one use to another shall be permitted only if such vessel, or portion thereof, conforms with the requirements of this code that apply to new construction for the proposed new use.

1.6.3* Vessels or portions of vessels shall be permitted to be occupied during conversion, repair, alterations, or additions only if all means of egress and all fire protection features are in place and continuously maintained for the occupied portion. Temporarily installed fire protection features shall comply with Section 1.4 of this code.

1.7 Maintenance.

1.7.1 Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance with the provisions of this code, such device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be permanently maintained unless the code exempts such maintenance.

1.7.2 Additional approved life safety features such as, but not limited to, automatic sprinklers, fire alarm systems, standpipes, and horizontal exits, if not required by the code, shall be permanently maintained or removed.

1.8 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. *(See Annex C for sample wording for enabling legislation.)*

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2007 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2005 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2007 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2002 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2002 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 2003 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2008 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2008 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products,* 2007 edition.

NFPA 70, *National Electrical Code®,* 2008 edition.

NFPA 72®, National Fire Alarm Code®, 2007 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2007 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2002 edition.

NFPA 99, *Standard for Health Care Facilities,* 2005 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source,* 2006 edition.

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials,* 2006 edition.

NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces,* 2007 edition.

NFPA 270, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber,* 2008 edition.

NFPA 271, *Standard Method of Test for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter,* 2004 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2006 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 2004 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2004 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2006 edition.

NFPA 1964, *Standard for Spray Nozzles,* 2003 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2007 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services,* 2007 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2008 edition.

2.3 Other Publications.

2.3.1 ABS Publications. American Bureau of Shipping, ABS Plaza, 16855 Northchase Drive, Houston, TX 77060.

Rules for Building and Classing Steel Vessels Under 90 Meters in Length, 2006.

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2.3.2 ABYC Publications. American Boat & Yacht Council, Inc., 613 Third Street, Suite 10, Annapolis, MD 21403.

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ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture Items,* 2002.

ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses,* 2007.

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ASTM E 2257, *Standard Test Method Room Fire Test of Wall and Ceiling Materials and Assemblies,* 2003.

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ASTM F 1384, *Standard Test Method for Fire Tests of Marine Joiner Doors,* 1993.

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2.3.5 CGA Publications. Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2933.

Commodity Specifications for Air, G-7.1, 2004.

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CSA C 22.2, No. 0.3-01 (R), *Test Methods for Electrical Wires and Cables,* Revised edition, 2005.

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IEEE 1202, *Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies,* 2000.

IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms,* 2001.

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Maritime Safety Committee Circular (MSC/Circ.) 732, *Interim Guidelines on the Test Procedure for Demonstrating the Equivalence of Composite Materials to Steel Under the Provisions of the 1974 SOLAS Convention,* 2000.

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ISO 9705, *Room Fire Test in Full Scale for Surface Products*, 1993.

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2.3.10 NVIC Publications. Coast Guard Headquarters, 2100 2nd Street, SW, Washington, DC 20593-0001.

NVIC 9-97, *Guide to Structural Fire Protection Aboard Merchant Vessels*, 1997.

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ANSI/UL 13, *Standard for Power-Limited Circuit Cables,* 1996.

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ANSI/UL 1581, *Reference Standard for Electrical Wires, Cables and Flexible Cords,* 2001.

ANSI/UL 1666, *Standard for Test for Flame Propagation Height of Electrical and Optical Fiber Cable Installed Vertically in Shafts,* 2007.

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Title 46, Code of Federal Regulations, "Shipping," Parts 1–199.

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NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves,* 2006 edition.

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NFPA 1405, *Guide for Land-Based Fire Fighters Who Respond to Marine Vessel Fires,* 2006 edition.

NFPA 5000®, Building Construction and Safety Code®, 2006 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. 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* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

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.

3.3 General Definitions.

3.3.1 Accommodation Area. A group of accommodation spaces and interconnecting corridors or spaces.

3.3.2* Area of Refuge. In merchant vessels, an area of refuge means an area that is separated from the effects of fire and flooding where passengers and crew can gather to await disembarking in the event of fire or flooding. To qualify as an area of refuge, the area must provide separation from the effect of fire and flooding for the maximum amount of time required to complete disembarking of the vessel, or 1 hour, whichever is less.

3.3.3 Atrium. A continuous series of deck openings connecting three or more deck levels within an accommodation space that is covered at the top of the series of openings and is used for purposes other than an enclosed stairway, elevator hoistway, escalator opening, or a utility trunk for pipe, cable, or ductwork.

3.3.4 Balcony. Deck area that projects from a bulkhead.

3.3.5 Bulkhead. A vertical structure constructed between the deck and overhead that divides the vessel interior into spaces.

3.3.6* Bulkhead Panel. A component of a division or bulkhead.

3.3.7 Cargo. Commodities in transit. [**307,** 2006]

3.3.8 Cargo Hold. Cargo spaces containing other than bulk liquid cargo.

3.3.9* Ceiling. In merchant vessels, a ceiling is a horizontal division within a space for the purpose of decoration, acoustics, or fire protection.

3.3.9.1 *Continuous B-Class Ceiling.* A B-Class ceiling that terminates only in an A- or B-Class bulkhead.

3.3.10 Central Control Station. A control station in which fire and safety control and indicator functions are centralized.

3.3.11* Common Path of Travel. The portion of exit access that must be traversed before two separate and distinct paths of travel to two exits are available.

3.3.12 Damper.

3.3.12.1* *Fire Damper.* In merchant vessels, a duct-closure device intended to restrict the passage of flame that is operated automatically or manually, including manual remote.

3.3.12.2 *Smoke Damper.* In merchant vessels, a duct-closure device intended to restrict the passage of smoke that is operated automatically or manually, including manual remote.

3.3.13 Dead-End Corridor. A passageway, or portion thereof, from which there is only one means of egress.

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3.3.14 Deck. In merchant vessels, a horizontal division in a vessel's structure.

3.3.15* Deck Covering. A material applied to a deck for purposes of increasing the fire or thermal endurance of the deck.

3.3.16* Deck Finish. The final exposed surface of the deck.

3.3.17 Deck Overlay. A material used for leveling purposes or for creating a suitable surface for application of deck finish.

3.3.18 Division.

3.3.18.1 ***A-Class Division.*** A fire barrier system consisting of bulkheads or decks and including all penetrations for piping and cables, doors, windows, and ductwork, providing 60 minutes of fire resistance when tested in accordance with established test methods.

3.3.18.2 ***B-Class Division.*** A fire barrier system consisting of bulkheads or decks and including all penetrations for piping and cables, doors, windows, and ductwork, providing 30 minutes of fire resistance when tested in accordance with established test methods.

3.3.19 Door.

3.3.19.1 ***C-Class Door.*** A door constructed of noncombustible material that does not have A- or B-class fire endurance.

3.3.19.2 ***Horizontal Sliding Door.*** A door installed in the vertical plane that slides in a direction that is perpendicular to the direction of egress travel.

3.3.19.3 ***Weathertight Door.*** Door that prevents the penetration of rain, snow, wind-driven spray, and water on deck into the interior spaces.

3.3.20* Draft Stop. A continuous membrane used to subdivide a concealed space to resist the passage of smoke and heat. [***5000,*** 2006]

3.3.21 Embarkation Area. The area from which a person exits the vessel in an emergency.

3.3.22* Exit. That portion of a means of egress that is separated from all other spaces of the vessel by construction or equipment to provide a protected way of travel to the exit discharge.

3.3.22.1* ***Horizontal Exit.*** An exit between adjacent areas on the same deck that passes through an A-60 Class boundary that is contiguous from side shell to side shell or to other A-60 Class boundaries.

3.3.23 Exit Access. That portion of a means of egress that leads to an exit.

3.3.24 Exit Discharge. That portion of a means of egress between the termination of an exit and an embarkation area or area of refuge.

3.3.25 Exit Enclosure. The bulkheads and decks around an exit.

3.3.26 Fire Hydrant. In merchant vessels, a connection to the fire main for the purpose of supplying water to fire hose or other fire protection apparatus.

3.3.27 Fire Performance. Reaction to fire exposure of materials, such as finishes, furnishings, fabrics, padding, draperies, and other combustible materials.

3.3.28 Fire Protection Suppression System. A fixed system designed to extinguish a fire or substantially reduce the heat release rate of the fire.

3.3.29 Fire Pump Controller. A group of devices that serves to govern, in some predetermined manner, the starting and stopping of the fire pump driver as well as monitoring and signaling the status and condition of the fire pump unit.

3.3.30* Fire-Rated Glazing. Glazing systems installed in fire-rated bulkhead or overhead assemblies that have been tested to achieve specified fire resistance ratings.

3.3.31 Flame Spread. The propagation of flame over a surface.

3.3.32 Food Preparation Area. An area that has no cooking equipment with surface temperatures greater than 120°C (248°F).

3.3.33 Fuel.

3.3.33.1 ***High-Risk Fuel.*** Class-IA, -IB, -IC, or -II liquids or Class-IIIA or -IIIB liquids heated to within 10°C (50°F) of their flash point, or pressurized to 174.4 kPa (25.3 psi) or more.

3.3.33.2 ***Low-Risk Fuel.*** All other fuels that are not high risk.

3.3.34 Furnishings. The contents of spaces such as desks, chairs, tables, sofas, draperies, and rugs.

3.3.35 Gallery. An intermediate level between deck and overhead of any area or space that exceeds 25 percent of the space below.

3.3.36 High-Speed Vessels. A craft capable of a maximum speed, in meters per second (knots) equal to or exceeding the following: (1) $m/sec \geq 3.7 \times displacement^{(.1667)}$ [$knots \geq 7.4 \times displacement^{(.1667)}$], (2) displacement in m^3 or long tons.

3.3.37 Hospital. A vessel or part of a vessel used on a 24-hour basis for the medical, obstetrical, or surgical care of four or more inpatients.

3.3.38 Joiner Construction. Nonstructural partitions used to subdivide compartments, such as bulkhead panels, doors, windows, insulation, ceilings, connectors, and interior finishes.

3.3.39 Lining. Structural components, such as suspended ceilings or curtain bulkheads, which are non–load bearing or used for aesthetic purposes.

3.3.40 Low-Location Lighting. Electrically powered lighting or photoluminescent indicators placed at points of the escape route to readily identify all routes of escape.

3.3.41* Major Modification. A conversion of a vessel that substantially changes the dimensions or carrying capability of the vessel, changes the type of the vessel, substantially prolongs the life of the vessel, or otherwise changes the vessel such that it is essentially a new vessel.

3.3.42 Material.

3.3.42.1 ***Combustible Material.*** Any material that will burn regardless of its autoignition temperature.

3.3.42.2 ***Noncombustible Material.*** A substance that will not ignite and burn when subjected to a fire. [**220,** 2006]

3.3.42.3 ***Steel or Other Equivalent Material.*** Any noncombustible construction that has structural and thermal integrity properties equivalent to steel at the end of the applicable exposure to the standard fire test.

3.3.43* Means of Egress. A continuous and unobstructed way of exit travel from any point in the vessel to an area of refuge or embarkation area consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge.

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3.3.44 Mezzanine. An intermediate level between deck and overhead of any area or space that does not exceed 25 percent of the space below.

3.3.45 Ocean-Going Towing Vessel. A towing vessel intended to operate at a distance greater than 20 miles offshore.

3.3.46 Overlays. Decorative materials applied to decks for finishing purposes.

3.3.47 Overnight Accommodations. Accommodation space that has one or more berths, including beds or bunks, for use by passengers.

3.3.48 Passageway. A corridor or hallway. [**1405,** 2006]

3.3.49 Passenger. An individual carried on a vessel who is not one of the following: (1) an owner, a representative of the owner, a charterer, or a representative of a charterer; (2) the vessel's master; or (3) a member of the vessel's crew who is paid for onboard services.

3.3.50* Photoluminescent. Having the ability to store incident electromagnetic radiation typically from ambient light sources, and release it in the form of visible light.

3.3.51 Signaling Line Circuit. A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both, are carried.

3.3.52 Stairtower. A stairway enclosed in a continuous vertical shaft.

3.3.53 Stairway. A vertical means of egress between decks.

3.3.54* Structural Fire Protection. Fire protection that is intended to limit the spread of fire and smoke to as small an area as reasonable, by specifying fire endurance capabilities of structural elements.

3.3.55* Survival Craft. Craft capable of sustaining the lives of persons in distress after abandoning the vessel on which they were originally carried.

3.3.56 Tank Ship. A vessel that carries flammable or combustible liquids in bulk.

3.3.57* Trunk. A vertical shaft or duct used for the passage of pipes, wires, ladders, and other devices.

3.3.58 Underlayment. A layer of materials installed between a deck finish and the deck below.

3.3.59 Voids. Cofferdams and spaces not normally accessible or used for storage.

3.4 Space Definitions.

3.4.1* Electrical and Control Space. Electrical and control spaces are those used for the control and management of routine and emergency vessel operations.

3.4.2* Engineering and Machinery Space. Engineering and machinery spaces, including trunks and ducts, are those containing machinery used to support propulsion, power generation, heating and ventilation, and other auxiliary systems.

3.4.3* Manned Space. A space that is normally occupied.

3.4.4 Public Space. Any space that is dedicated for use by and accessible to the public.

3.4.5* Restricted Access Space. Spaces that are not normally occupied by the crew during the course of normal working or watchstanding but that can be periodically checked during the course of their rounds.

3.4.6 Security Space. A space dedicated to an activity that requires the limitation or control of access by persons to certain given times, such as counting rooms, vaults, monitor stations, or areas of physical restraint.

3.4.7* Unmanned Space. A space that is occasionally occupied.

3.4.8* Vehicle Space. Those spaces used for the carriage of vehicles with fuel in their tanks.

3.5 Special Definitions. Terms used in Chapter 5.

3.5.1 Alternative Calculation Procedure. A calculation procedure that differs from the procedure originally employed by the design team but that provides predictions for the same variables of interest.

3.5.2 Data Conversion. The process of developing the input data set for the assessment method of choice.

3.5.3 Design Fire Scenario. A fire scenario selected for evaluation of a proposed design. [**914**, 2007]

3.5.4* Design Specification. A building characteristic and other conditions that are under the control of the design team. [***5000,*** 2006]

3.5.5 Design Team. A group of stakeholders including, but not limited to, representatives of the architect, client, and any pertinent engineers and other designers.

3.5.6* Exposure Fire. A fire that starts at a location that is remote from the area being protected and grows to expose that which is being protected.

3.5.7* Fire Model. A structured approach to predicting one or more effects of a fire.

3.5.8* Fire Scenario. A set of conditions that defines the development of fire, the spread of combustion products throughout a building or portion of a building, the reactions of people to fire, and the effects of combustion products.

3.5.9* Fuel Load. The total quantity of combustible contents of a building, space, or fire area. [***5000,*** 2006]

3.5.10 Incapacitation. A condition under which humans do not function adequately and become unable to escape untenable conditions.

3.5.11 Input Data Specification. Information required by the verification method.

3.5.12 Occupant Characteristics. The abilities or behaviors of people before and during a fire.

3.5.13* Performance Criteria. Threshold values on measurement scales that are based on quantified performance objectives.

3.5.14* Proposed Design. A design developed by a design team and submitted to the authority having jurisdiction for approval.

3.5.15 Safe Location. A location remote or separated from the effects of a fire so that such effects no longer pose a threat.

3.5.16 Safety Factor. A factor applied to a predicted value to ensure that a sufficient safety margin is maintained.

3.5.17 Safety Margin. The difference between a predicted value and the actual value where a fault condition is expected.

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3.5.18 Sensitivity Analysis. An analysis performed to determine the degree to which a predicted output will vary given a specified change in an input parameter, usually in relation to models. [***5000,*** 2006]

3.5.19 Stakeholder. An individual, or representative of same, having an interest in the successful completion of a project.

3.5.20 Uncertainty Analysis. An analysis performed to determine the degree to which a predicted value will vary. [***5000,*** 2006]

3.5.21 Verification Method. A procedure or process used to demonstrate or confirm that the proposed design meets the specified criteria.

Chapter 4 Fundamental Requirements

4.1* Fundamentals. The following requirements shall be used in applying this code:

(1) Limit fire to the space and deck of origin.
(2) Provide for 100 percent self-sufficiency in extinguishing or controlling fires, protecting lives, and protecting property.
(3) Provide protected escape routes for egress.
(4) Provide areas of refuge.
(5) Provide for rapid improvement of requirements as marine and fire protection technology advances.
(6) Recognize the role of fire-fighting training of crew.
(7) Provide adequate inspection, maintenance, and housekeeping requirements.

4.2 Fundamentals of Means of Egress.

4.2.1 Every vessel shall be provided with means of egress and other safeguards sufficient to provide a reasonable degree of safety for passengers and crew. The design of means of egress and other safeguards shall be such that reliance for safety to life will not depend solely on any single safeguard. Additional safeguards shall be provided for life safety in case any single safeguard is ineffective due to human or mechanical failure.

4.2.2 Every vessel shall be provided with means of egress and other safeguards of kinds, numbers, locations, and capacities appropriate to the individual vessel with due regard to the vessel service, the capabilities of the passengers and crew, the number of persons exposed, the fire protection available, the type of construction of the vessel, and other factors necessary to provide all passengers and crew with a reasonable degree of safety.

4.2.3 In every vessel, means of egress shall be arranged and maintained to provide free and unobstructed egress from all parts of the vessel at all times when it is occupied. No lock or fastening shall be installed to prevent free escape from any space on the vessel, other than from security spaces intended for physical restraint.

4.2.4 Every exit shall be clearly visible, or the route to reach every exit shall be conspicuously indicated in such a manner that every occupant of each vessel will know the direction of escape from any point. Each means of egress, in its entirety, shall be arranged or marked so that the way to a place of safety is indicated in a clear manner. Any doorway or passageway that is not an exit or a way to reach an exit, but is capable of being confused with an exit, shall be arranged or marked to prevent confusion with exits. Every effort shall be taken to avoid occupants mistakenly traveling into dead-end spaces in a fire emergency.

4.2.5 A minimum of two means of egress shall be provided in every area where size, occupancy, and arrangement endanger passengers and crew attempting to use a single means of egress that is blocked by fire or smoke. The two means of egress shall be arranged to minimize the possibility that both might be rendered impassable by the same emergency condition.

4.2.6 Every designated vertical egress opening between decks of a vessel shall be enclosed or protected to afford safety to passengers and crew while using that means of egress and to prevent spread of fire, smoke, or fumes through vertical openings from deck to deck before occupants have entered exits.

4.3 Fundamentals of Construction. Every vessel shall be constructed, arranged, equipped, maintained, and operated to avoid undue danger to the lives and safety of its passengers and crew from fire, smoke, fumes, or resulting panic during the period of time necessary to defend in place or for that period of time needed to abandon ship.

4.4 Fundamentals of Illumination. Where artificial illumination is required, egress facilities shall be included in the lighting design to ensure that the egress paths are illuminated.

4.5 Fundamentals of Alarms. In every vessel of such size, arrangement, or service such that a fire itself does not provide adequate occupant warning, alarm facilities shall be provided where necessary to warn of the existence of fire and smoke.

4.6 Life Safety Compliance Options.

4.6.1 Options. Life safety meeting the fundamental requirements of Sections 4.1 and 4.2 shall be provided in accordance with either of the following:

(1) Prescriptive-based provisions per 4.6.2
(2) Performance-based provisions per 4.6.3

4.6.2 Prescriptive-Based Option.

4.6.2.1 A prescriptive-based life safety design shall be in accordance with Chapters 1 through 4, Chapters 6 through 8, and the applicable occupancy chapter, Chapters 9 through 21.

4.6.2.2 Prescriptive-based designs meeting the requirements of Chapters 1 through 3, Sections 4.3 through 4.5, and Chapters 6 through 21 of this code shall be deemed to satisfy the provisions of Sections 4.1 and 4.2.

4.6.2.3 Where specific requirements contained in Chapters 9 through 21 differ from the general requirements contained in Chapters 1 through 4, and Chapters 6 through 8, the requirements of Chapters 9 through 21 shall govern.

4.6.3 Performance-Based Option. A performance-based life safety design shall be in accordance with Chapters 1 through 5.

Chapter 5 Performance-Based Option

5.1 General Requirements.

5.1.1* Application. The requirements of this chapter shall apply to life safety systems designed to the performance-based option permitted by 4.6.1 and 4.6.3.

5.1.2 Goals and Objectives. The performance-based design shall meet the fundamental requirements of this code in accordance with Sections 4.1 and 4.2.

5.1.3 Qualifications. The performance-based design shall be prepared by a registered design professional.

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5.1.4* Independent Review. The authority having jurisdiction shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the authority having jurisdiction.

5.1.5 Sources of Data. Data sources shall be identified and documented for each input data requirement that must be met using a source other than a design fire scenario, an assumption, or a design specification. The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

5.1.6* Final Determination. The authority having jurisdiction shall make the final determination as to whether the performance objectives have been met.

5.1.7* Maintenance of Design Features. The design features necessary for the vessel to continue to meet the fundamental requirement of this code shall be maintained for the life of the vessel. Such fundamental requirements shall include complying with all documented assumptions and design specifications. Any variations shall require the approval of the authority having jurisdiction prior to the actual change.

5.1.8 Special Definitions. A list of special terms used in this chapter follows:

(1) Alternative calculation procedure. See 3.5.1.
(2) Data conversion. See 3.5.2.
(3) Design fire scenario. See 3.5.3.
(4) Design specification. See 3.5.4.
(5) Design team. See 3.5.5.
(6) Exposure fire. See 3.5.6.
(7) Fire model. See 3.5.7.
(8) Fire scenario. See 3.5.8.
(9) Fuel load. See 3.5.9.
(10) Incapacitation. See 3.5.10.
(11) Input data specification. See 3.5.11.
(12) Occupant characteristics. See 3.5.12.
(13) Performance criteria. See 3.5.13.
(14) Proposed design. See 3.5.14.
(15) Safe location. See 3.5.15.
(16) Safety factor. See 3.5.16.
(17) Safety margin. See 3.5.17.
(18) Sensitivity analysis. See 3.5.18.
(19) Stakeholder. See 3.5.19.
(20) Uncertainty analysis. See 3.5.20.
(21) Verification method. See 3.5.21.

5.2 Performance Criteria.

5.2.1 General. A design shall meet the objectives specified in Sections 4.1 and 4.2 if, for each design fire scenario, assumption, and design specification, the performance criterion in 5.2.2 is met.

5.2.2* Performance Criterion. Any occupant who is not knowledgeable about ignition shall not be exposed to instantaneous or cumulative untenable conditions.

5.3 Retained Prescriptive Requirements.

5.3.1* Systems and Features. All fire protection systems and features of the vessel shall comply with applicable NFPA standards for those systems and features.

5.3.2 Means of Egress. In addition to the performance criteria of Section 5.2 and the methods of Section 5.4 through Section 5.8, the design shall comply with the following requirements:

(1) Changes in level in means of egress — 7.1.6
(2) Guards — 7.2.2.4.1
(3) Doors — 7.2.1
(4) Stairs — 7.2.2, excluding the provisions of 7.2.2.6.1 and 7.2.2.6.2
(5) Ramps — 7.2.5
(6) Alternating tread devices — 7.2.9
(7) Capacity of means of egress — Section 7.3, excluding the provisions of 7.3.3 and 7.3.4
(8) Impediments to egress — 7.5.2
(9) Illumination of means of egress — Section 7.8
(10) Emergency lighting — Section 7.9
(11) Marking of means of egress — Section 7.10

5.3.3 Equivalency. Equivalent designs for the features covered in the retained prescriptive requirements mandated by 5.3.2 shall be addressed in accordance with the equivalency provisions of Section 1.4.

5.4 Design Specifications and Other Conditions.

5.4.1* Clear Statement. Design specifications and other conditions used in the performance-based design shall be clearly stated and shown to be realistic and sustainable.

5.4.2 Assumptions and Design Specifications Data.

5.4.2.1 Each assumption and design specification used in the design shall be accurately translated into input data specifications, as appropriate for the calculation method or model.

5.4.2.2 Any assumption and design specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.4.2.3 Any assumption and design specifications modified in the input data specifications, because of limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.4.3 Vessel Characteristics. Characteristics of the vessel or its contents, equipment, or operations that are not inherent in the design specifications, but that affect occupant behavior or the rate of hazard development, shall be explicitly identified.

5.4.4* Operational Status and Effectiveness of Vessel Features and Systems. The performance of fire protection systems and vessel features shall reflect the documented performance and reliability of the components of those systems or features, unless design specifications are incorporated to modify the expected performance.

5.4.5 Occupant Characteristics.

5.4.5.1* General. The selection of occupant characteristics to be used in the design calculations shall be approved by the authority having jurisdiction and shall provide an accurate reflection of the expected population of vessel users. Occupant characteristics shall represent the normal occupant profile, unless design specifications are used to modify the expected occupant features. Occupant characteristics shall not vary across fire scenarios except as authorized by the authority having jurisdiction.

5.4.5.2* Response Characteristics. The basic response characteristics of sensibility, reactivity, mobility, and susceptibility shall be evaluated. Such evaluation shall include the expected distribution of characteristics of a population appropriate to the use of the vessel. The source of data for these characteristics shall be documented.

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5.4.5.3 Location. It shall be assumed that, in every normally occupied room or area, at least one person shall be located at the most remote point from the exits.

5.4.5.4* Number of Occupants. The design shall be based on the maximum number of people that every occupied room or area is expected to contain. Where the success or failure of the design is contingent on the number of occupants not exceeding a specified maximum, operational controls shall be used to ensure that the maximum number of occupants is not exceeded.

5.4.5.5* Crew Assistance. The inclusion of trained crew members as part of the fire safety system shall be identified and documented.

5.4.6 Outside Assistance. Design characteristics or other conditions related to the availability, speed of response, effectiveness, roles, and other characteristics of shoreside emergency response personnel shall be specified, estimated, or characterized sufficiently for evaluation of the design. Alternative safety assessments complying with 46 CFR 199.630(f), "Lifesaving for Certain Inspected Vessels, Alternatives for Passenger Vessels in a Specified Space," if applicable, shall be considered in this evaluation.

5.4.7* Post-Construction Conditions. Design characteristics or other conditions related to activities during the life of a vessel that affect the ability of the vessel to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.8 Vessel Route. Design characteristics or other conditions related to resources or conditions along the vessel's normal area of operation that affect the ability of the vessel to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.9* Consistency of Assumptions. The design shall not include mutually inconsistent assumptions, specifications, or statements of conditions.

5.4.10* Special Provisions. Additional provisions that are not covered by the design specifications, conditions, estimations, and assumptions provided in Section 5.4, but that are required for the design to comply with the performance objectives, shall be documented.

5.5* Design Fire Scenarios.

5.5.1 Approval of Parameters. The authority having jurisdiction shall approve the parameters involved in design fire scenarios. The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design fire scenario. *(See 5.5.3.)*

5.5.2* Evaluation. Design fire scenarios shall be evaluated using a method acceptable to the authority having jurisdiction and appropriate for the conditions. Each design fire scenario shall be as challenging as any that could occur in the vessel, but shall be realistic, with respect to at least one of the following scenario specifications:

(1) Initial fire location
(2) Early rate of growth in fire severity
(3) Smoke generation

5.5.3* Required Design Fire Scenarios. Design fire scenarios shall comply with the following requirements:

(1) Scenarios selected as design fire scenarios shall include, but shall not be limited to, those specified in 5.5.3.1 through 5.5.3.8.
(2) Design fire scenarios demonstrated by the design team to the satisfaction of the authority having jurisdiction as inappropriate for the vessel use and conditions shall not be required to be evaluated fully.

5.5.3.1* Design Fire Scenario 1. Design fire scenario 1 shall be as follows:

(1) It is an occupancy-specific fire representative of a typical fire for the occupancy.
(2) It explicitly accounts for the following:
  (a) Occupant activities
  (b) Number and location
  (c) Room size
  (d) Furnishings and contents
  (e) Fuel properties and ignition sources
  (f) Ventilation conditions
  (g) Identification of the first item ignited and its location

5.5.3.2* Design Fire Scenario 2. Design fire scenario 2 shall be as follows:

(1) It is an ultrafast-developing fire (i.e., flammable liquid fire) in the primary means of egress, with interior doors open at the start of the fire.
(2) It addresses the concern regarding a reduction in the number of available means of egress.

5.5.3.3* Design Fire Scenario 3. Design fire scenario 3 shall be as follows:

(1) It is a fire that starts in a normally unoccupied room, potentially endangering a large number of occupants in a large room or other area.
(2) It addresses the concern regarding a fire starting in a normally unoccupied room and migrating into a space that can, potentially, hold the greatest number of occupants.

5.5.3.4* Design Fire Scenario 4. Design fire scenario 4 shall be as follows:

(1) It is a fire that originates in a concealed bulkhead or ceiling space adjacent to a large occupied room.
(2) It addresses the concern regarding a fire originating in a concealed space that does not have either a detection system or a suppression system and then spreading into the room within the vessel that can, potentially, hold the greatest number of occupants.

5.5.3.5* Design Fire Scenario 5. Design fire scenario 5 shall be as follows:

(1) It is a slowly developing fire, shielded from fire protection systems, in close proximity to a high-occupancy area.
(2) It addresses the concern regarding a relatively small ignition source causing a significant fire.

5.5.3.6* Design Fire Scenario 6. Design fire scenario 6 shall be as follows:

(1) It is an ultrafast-developing fire resulting from the largest possible fuel load characteristic of the normal operation of the vessel.
(2) It addresses the concern regarding a rapidly developing fire with occupants present.

5.5.3.7* Design Fire Scenario 7. Design fire scenario 7 shall be as follows:

(1) It is an outside exposure fire.

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(2) It addresses the concern regarding a fire starting at a location remote from the area of concern and either spreading into the area, blocking escape from the area, or developing untenable conditions within the area.

5.5.3.8* Design Fire Scenario 8. Design fire scenario 8 shall be as follows:

(1) It is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system independently rendered ineffective.
(2) It addresses concerns regarding the unreliability or unavailability of each fire protection system or fire protection feature, considered individually.
(3)*It is not required to be applied to fire protection systems for which the level of reliability in conjunction with the design performance in the absence of the system are acceptable to the authority having jurisdiction.

5.5.4 Design Fire Scenarios Data.

5.5.4.1 Each design fire scenario used in the performance-based design proposal shall be translated into input data specifications, as appropriate for the calculation method or model.

5.5.4.2 Any design fire scenario specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.5.4.3 Any design fire scenario specifications modified in input data specifications, because of limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.6* Evaluation of Proposed Designs.

5.6.1 General. A proposed design's performance shall be assessed relative to each fundamental requirement in Section 4.1 and Section 4.2 and each applicable scenario in 5.5.3, with the assessment conducted through the use of appropriate calculation methods. The authority having jurisdiction shall approve the choice of assessment methods.

5.6.2 Use. The design professional shall use the assessment methods to demonstrate that the proposed design will achieve the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, for each scenario, given the assumptions.

5.6.3 Input Data.

5.6.3.1 Data. Input data for computer fire models shall be obtained in accordance with ASTM E 1591, *Standard Guide for Obtaining Data for Deterministic Fire Models.* Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

5.6.3.2 Data Requirements. A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

5.6.3.3* Uncertainty and Conservatism of Data. Uncertainty in input data shall be analyzed and, as determined appropriate by the authority having jurisdiction, addressed through the use of conservative values.

5.6.4* Output Data. The assessment methods used shall accurately and appropriately produce the required output data from input data based on the design specifications, assumptions, and scenarios.

5.6.5 Validity. Evidence shall be provided to confirm that the assessment methods are valid and appropriate for the proposed vessel, use, and conditions.

5.7* Safety Factors. Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

5.8 Documentation Requirements.

5.8.1* General. All aspects of the design, including those described in 5.8.2 through 5.8.14, shall be documented. The format and content of the documentation shall be acceptable to the authority having jurisdiction.

5.8.2* Technical References and Resources. The authority having jurisdiction shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods. The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

5.8.3 Vessel Design Specifications. All details of the proposed design that affect the ability of the vessel to meet the stated goals and objectives shall be documented.

5.8.4 Performance Criteria. Performance criteria, with sources, shall be documented.

5.8.5 Occupant Characteristics. Assumptions about occupant characteristics shall be documented.

5.8.6 Design Fire Scenarios. Descriptions of design fire scenarios shall be documented.

5.8.7 Input Data. Input data to models and assessment methods, including sensitivity analyses, shall be documented.

5.8.8 Output Data. Output data from models and assessment methods, including sensitivity analyses, shall be documented.

5.8.9 Safety Factors. The safety factors utilized shall be documented.

5.8.10 Prescriptive Requirements. Retained prescriptive requirements shall be documented.

5.8.11* Modeling Features.

5.8.11.1 Assumptions made by the model user and descriptions of models and methods used, including known limitations, shall be documented.

5.8.11.2 Documentation shall be provided to verify that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios.

5.8.12 Evidence of Modeler Capability. The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

5.8.13 Performance Evaluation. The performance evaluation summary shall be documented.

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5.8.14 Use of Performance-Based Design Option. Design proposals shall include documentation that provides anyone involved in the ownership or management of the vessel with notification of the following:

(1) Approval of the vessel as a performance-based design with certain specified design criteria and assumptions
(2) Need for required re-evaluation and re-approval in cases of remodeling, modification, renovation, change in use, or change in established assumptions

Chapter 6 Classification of Occupancy and Hazard of Contents

6.1 Classification of Occupancy.

6.1.1 General. All vessel occupancies shall be classified according to this chapter. Occupancies shall conform to the requirements of the specific occupancy Chapters 10 through 18.

6.1.2 Accommodation Spaces. Accommodation spaces shall include, but are not limited to, all portions of a vessel used for such purposes as overnight residence, deliberation, worship, entertainment, dining, or amusement. *(For requirements, see Chapter 10.)*

6.1.2.1 Accommodation spaces shall include the following:

(1) Passenger or crew cabins
(2) Lounge areas
(3) Athletic facilities
(4) Gaming areas
(5) Office spaces
(6) Spaces for religious worship
(7) Theaters
(8) Restaurants and messing areas
(9) Public toilets and washrooms
(10) Public sales and shops

6.1.3 Medical, Health Care, and Child Care Spaces. Medical and health care spaces shall include those spaces used for purposes such as medical or other treatment or care of persons suffering from physical illness, disease, or infirmity; child care spaces shall include those spaces used for the care of infants and children. *(For requirements, see Chapter 11.)*

6.1.3.1* Medical, health care, and child care spaces shall include the following:

(1) Hospital and intensive care facilities
(2) Limited-care facilities
(3) Child care facilities

6.1.4 Service Spaces. Service spaces shall include galleys, laundries, or other spaces used for the purposes of providing support services to passengers and crew. *(For requirements, see Chapter 12.)*

6.1.4.1 Service spaces shall include the following:

(1) Galleys
(2) Film development and processing facilities
(3) Sculleries
(4) Food preparation areas [no cooking facilities, i.e., no equipment capable of generating temperatures in excess of 120°C (248°F)]
(5) Laboratory facilities
(6) Laundries

6.1.5 Electrical and Control Spaces. Electrical and control spaces shall include those spaces used for the control and management of routine and emergency operations. *(For requirements, see Chapter 13.)*

6.1.5.1 Electrical and control spaces shall include the following:

(1) Radio and communications areas
(2) Engineering enclosed operating station (not in the machinery space)
(3) Electrical power, control, and switchboard spaces
(4) Navigation and bridge area
(5) Central damage control, fire-protection systems control, or both

6.1.6 Engineering and Machinery Spaces. Engineering and machinery spaces shall include those spaces containing machinery used to support propulsion, power generation, heating and ventilation, and other auxiliary systems. *(For requirements, see Chapter 14.)*

6.1.6.1* Engineering and machinery spaces shall include the following:

(1) Main and auxiliary propulsion plants
(2) Power-generating plants, including emergency generator rooms
(3) Steering gear rooms
(4) Machine shops
(5) Marine sanitation devices
(6) Pump rooms and bunkering stations
(7) Stabilizer rooms
(8) Heating, ventilation, and air-conditioning plants, including fan rooms
(9) Refrigeration machinery plants
(10) Anchor windlass rooms
(11) Miscellaneous industrial facilities
(12) Sewage treatment spaces
(13) Incinerator rooms

6.1.7 Storage Spaces. Storage spaces shall include all spaces of the vessel utilized primarily for the storage of goods, merchandise, food products, and other items necessary to support the daily routine operation of the vessel. Minor storage incidental to another occupancy shall be treated as part of the predominant occupancy. *(For requirements, see Chapter 15.)*

6.1.7.1 Storage spaces shall include the following:

(1) General storage spaces
(2) Pyrotechnics lockers
(3) General storage lockers (no flammable materials)
(4) Cleaning gear lockers
(5) Flammable materials storage
(6) Flammable materials lockers
(7) Walk-in refrigeration spaces
(8) Bosun's lockers
(9) Garbage and trash holding and processing other than incineration

6.1.8 Cargo Spaces and Fuel Tanks. Cargo spaces shall include those spaces utilized for the carriage or storage of items or products that are being transported by the vessel. *(For requirements, see Chapter 16.)*

6.1.8.1 Cargo spaces shall include the following:

(1) Enclosed dry cargo storage
(2) Liquid fuel tanks
(3) Open vehicle decks

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(4) Chemical tanks
(5) Open cargo storage
(6) Liquefied and compressed gas storage
(7) Enclosed vehicle decks

6.1.9 Open Deck.

6.1.9.1 Spaces permanently open to weather on one or more sides shall be considered open decks. For covered open deck spaces, all portions of the overhead shall be less than 5 m (16.4 ft) from the nearest opening to the weather.

6.1.9.2 Open-ended or open-sided covered spaces, regardless of size, shall be considered to be equivalent to open deck spaces, provided that such structures are not permanently enclosed on more than one side.

6.1.10 Helicopter Deck. Areas on a weather deck of a vessel dedicated to accommodating the landing of helicopters for routine or emergency uses shall be considered to be helicopter decks. The helicopter deck is an area on a weather deck of the vessel dedicated to accommodating the landing of helicopters for routine or emergency uses. Hangar spaces shall also be covered by Section 6.1 if the helicopter is to be routinely embarked on the vessel during voyages. *(For requirements, see Chapter 18.)*

6.1.11 Voids. Spaces that do not contain any equipment or room dedicated for storage shall be considered to be voids.

6.1.12 Mixed Occupancies. Where two or more classes of occupancy are contained in the same space on a vessel, and are intermingled so that separate safeguards are impracticable, means of egress facilities, construction, protection, and other safeguards shall comply with the life safety requirements of the highest hazard occupancy involved. Minor equipment that is incidental to the space, such as HVAC or bar equipment, shall be considered as part of that space.

6.1.13* Multiple-Purpose Vessels. For vessels that serve multiple purposes, the requirements of Chapters 19 through 21 shall apply to their corresponding portions of the vessel. Where conflicts arise, the most stringent requirement shall apply.

Chapter 7 Means of Egress

7.1 General.

7.1.1 Application. Means of egress for vessels shall comply with this chapter. *(Also see Chapter 1.)*

7.1.2 Special Terms.

7.1.2.1 Area of Refuge. See 3.3.2.

7.1.2.2 Common Path of Travel. See 3.3.11.

7.1.2.3 Embarkation Area. See 3.3.21.

7.1.2.4 Exit. See 3.3.22.

7.1.2.5 Exit Access. See 3.3.23.

7.1.2.6 Exit Discharge. See 3.3.24.

7.1.2.7 Exit Enclosure. See 3.3.25.

7.1.2.8 Horizontal Exit. See 3.3.22.1.

7.1.2.9 Means of Egress. See 3.3.43.

7.1.3 Separation of Means of Egress. See also Section 8.2.

7.1.3.1 Where an exit is required by this code to be protected by separation from other parts of the vessel, the separating construction shall meet the requirements in 7.1.3.1.1 through 7.1.3.1.4.

7.1.3.1.1 The separation shall be a minimum of A-0 Class divisions where the exit connects two or more decks. This shall apply whether the decks counted are above or below the deck where exit discharge begins. Where an exit bounds a high-risk accommodation space, high-risk service space, high-risk machinery space, or a cargo space, the separation shall be an A-60 class division.

7.1.3.1.2 Openings in exit enclosures shall be limited to those necessary for access to the enclosure from normally occupied spaces and corridors and for egress from the enclosure, and shall be protected by an A-Class door in accordance with 8.2.4.3.1.

7.1.3.1.3 Penetrations through an exit enclosure for electrical systems, ducts, and pipes serving the enclosure shall be permitted only if constructed in accordance with 8.2.4.9.

7.1.3.1.4 Penetrations between adjacent exit enclosures for electrical systems, ducts, and pipes shall be permitted only if constructed in accordance with 8.2.4.9, and the penetrating item passes completely through the enclosure.

7.1.3.1.5 There shall be no penetrations or communicating openings between adjacent exit enclosures.

7.1.3.2 An exit enclosure that only connects two decks shall be required to be enclosed only at one deck, provided the enclosure meets the requirements of 8.2.5.1 for deck construction.

7.1.3.3 Exit enclosures shall be designed to provide a continuous protected path of travel, including landings and passageways, to an exit discharge.

7.1.3.4 No exit enclosure shall be used for any purpose that could interfere with its use as an exit and, if so designated, as an area of refuge. *(See also 7.2.2.6.4.)*

7.1.3.5 Exit Access Passageways. Passageways used as exit access shall be constructed as a minimum B-15 Class division in accordance with 8.2.4.3.2. Where exit access bounds a high-risk service space, or high-risk machinery space, the separating division shall be minimum A-60 Class. Where exit access bounds a cargo space or open deck, the separating division shall be minimum A-0 Class. Alternative fire protection provisions for exit access passageways contained in Chapters 10 through 21 shall be permitted.

7.1.4 Interior Finish and Furnishings in Exits and Exit Accesses.

7.1.4.1 Interior finish in exits and exit accesses shall meet the requirements of Section 8.3.

7.1.4.2 Furnishings in exits shall meet the requirements of Section 8.4.

7.1.5* Headroom. Means of egress shall be designed and maintained to provide the required headroom as required in 7.2.2.2.1.

7.1.5.1 Means of egress shall have a ceiling height at least 2.15 m (7 ft).

7.1.5.2 Any projection from the overhead in a means of egress shall not be less than 2.0 m (6 ft 8 in.) nominal height from the deck.

7.1.6 Changes in Level in Means of Egress.

7.1.6.1 Changes in level in means of egress shall be by a ramp or a stair where the elevation difference is more than 50 cm (19.7 in.).

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7.1.6.2 Changes in level in means of egress not more than 50 cm (19.7 in.) shall be either by a ramp or a stair complying with the requirements of 7.2.2 and 21.2.3.

7.1.6.2.1 The minimum tread depth of such stair in a means of egress shall be 30 cm (11.8 in.).

7.1.6.2.2 The location of each step in a means of egress shall be apparent by a change in color pattern, texture, or lighting.

7.1.7 Impediments to Egress. Any device or alarm installed to restrict the improper use of a means of egress shall be designed and installed so that it cannot, even in case of failure, impede or prevent emergency use of such means of egress. Alternative provisions contained in Chapters 10 through 21 shall be permitted.

7.2 Means of Egress Components.

7.2.1 Doors.

7.2.1.1 General.

7.2.1.1.1 A door assembly (i.e., the door opening, frame, door, and necessary hardware) used as a component in a means of egress shall conform to the general requirements of Section 7.1 and to the special requirements of this subsection. Such an assembly shall be designated as a door.

7.2.1.1.2 Every door that is required to serve as an exit shall be designed and constructed so that the way of exit travel is obvious and direct. Windows that could be mistaken for doors, because of their physical configuration or design and the materials used in their construction, shall be made inaccessible to the occupants by barriers or railings.

7.2.1.2* When determining the width for a door opening for purposes of calculating egress capacity, only the clear width of the door opening when the door is in the fully open position shall be measured. Clear width shall be the net, unobstructed width of the door opening without projections into such width.

7.2.1.3 No door opening in the means of egress shall be less than 80 cm (31.5 in.) in clear width. Where a pair of doors is provided, at least one of the doors shall provide a minimum 80 cm (31.5 in.) clear width opening. Alternative provisions contained in Chapters 10 through 21 shall be permitted.

7.2.1.4 Swing and Force to Open.

7.2.1.4.1 Any door in a means of egress shall be of the side-hinged or pivoted-swinging type, except for the following:

(1) Horizontal doors complying with 7.2.1.10
(2) Revolving doors complying with 21.2.2.1

7.2.1.4.2 Each door within the path of egress shall be designed and installed so that it is capable of swinging to the full use of the opening in which it is installed.

7.2.1.4.2.1 Doors shall swing in the direction of egress travel.

7.2.1.4.2.2 Stateroom doors shall be permitted to swing into those spaces.

7.2.1.4.2.3 Doors for spaces not designated for passenger occupancy, such as office or service spaces, shall be permitted to swing into those spaces.

7.2.1.4.3* During its swing, any door that opens into a means of egress shall leave unobstructed at least one-half of the required width of an aisle, passageway, or landing.

7.2.1.4.3.1 When fully open, a door shall not project more than 15 cm (5.9 in.) into the required width of an aisle, passageway, or landing.

7.2.1.4.3.2 Doors shall not open immediately onto a stair without a landing.

7.2.1.4.3.3 The landing shall have a width at least equal to the width of the door. *(See 7.2.2.3.)*

7.2.1.4.4 The forces required to fully open any door manually in a means of egress shall not exceed 65 N (14.8 lbf) to release the latch, 130 N (29.6 lbf) to set the door in motion, and 65 N (14.8 lbf) to open the door to the minimum required width. Opening forces for interior side-hinged or pivoted-swinging doors without closers shall not exceed 20 N (4.9 lbf). These forces shall be applied at the latch stile when the vessel is on an even keel. These provisions shall not apply to power-operated doors, which shall comply with 7.2.1.8.

7.2.1.5 Locks, Latches, and Alarm Devices.

7.2.1.5.1 Doors shall be arranged to be opened from the normal egress side whenever the space is occupied. Locks, if provided, shall not require the use of a key, tool, special knowledge, or effort for operation from the inside of the space. These provisions shall not apply to the doors described in 7.2.1.5.2 or the barriers described in 7.2.1.5.3.

7.2.1.5.2 Doors shall be permitted to have key-operated locks from the egress side, provided the requirements in 7.2.1.5.2.1 through 7.2.1.5.2.4 are met.

7.2.1.5.2.1 Key-operated locks shall be specifically permitted by Chapters 10 through 21.

7.2.1.5.2.2 On the egress side, on or adjacent to the door, there shall be a readily visible, durable sign that reads in letters not less than 2.5 cm (1 in.) high on a contrasting background:

THIS DOOR TO REMAIN UNLOCKED
WHEN THE SPACE IS OCCUPIED.

7.2.1.5.2.3 The locking device shall be of a type that is readily distinguishable as locked.

7.2.1.5.2.4 A key shall be available to any occupant inside the space.

7.2.1.5.3 Access barriers that are intended to protect the space or activities therein shall have closure operable from inside the space. Barriers intended to restrain persons within the space shall be continuously monitored by persons capable of opening the barrier.

7.2.1.5.4 Every stair enclosure door shall allow re-entry from the stair enclosure to the interior of the vessel.

7.2.1.5.5 A latch or other fastening device on a door shall be provided with a lever, handle, panic bar, or other simple type of releasing device having an obvious method of operation (under all lighting conditions). The releasing mechanism for any latch shall be located not more than 120 cm (47.2 in.) above the finished floor. Doors shall be capable of being opened with no more than one releasing operation, except as provided in 7.2.1.5.6.

7.2.1.5.6 Egress doors from individual staterooms shall be permitted to be provided with devices that require not more than one additional releasing operation, such as a night latch, dead bolt, or security chain, provided such device is operable from the inside without the use of a key or tool and is mounted at a height not to exceed 120 cm (47.2 in.) above the finished floor.

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7.2.1.6 Exit Door Hardware.

7.2.1.6.1 Exit door hardware shall consist of a door-latching assembly that incorporates a device that releases the latch upon the application of a force in the direction of egress travel.

7.2.1.6.2 A door in the means of egress shall be equipped with exit door hardware that meets the following requirements:

(1) Consists of bars or panels, the actuating portion of which shall extend across not less than one-half of the width of the door leaf, not less than 75 cm (29.5 in.) nor more than 110 cm (43.3 in.) above the floor
(2) Causes the door latch to release when a force that shall not be required to exceed 65 N (14.8 lbf) is applied

7.2.1.6.3 Required exit door hardware shall not be equipped with any locking device, set screw, or other arrangement that can be used to prevent the release of the latch when pressure is applied to the releasing device. Devices that hold the latch in the retracted position shall be prohibited on exit door hardware unless listed and approved for such use.

7.2.1.7 Self-Closing Devices. A door designed to be kept normally closed in a means of egress shall be a self-closing door and shall not be secured in the open position at any time.

7.2.1.7.1 Doors in a means of egress shall be permitted to be held open where the requirements of 7.2.1.7.2 through 7.2.1.7.6 are met.

7.2.1.7.2 The hold-open mechanism shall be so designed that the door will automatically close upon release of the hold-open mechanism.

7.2.1.7.3 The release device shall be designed so that the door can be released instantly and, upon release, become self-closing manually (locally) and remotely from a continuously manned control station, or the automatic releasing mechanism or medium is activated by one of the following:

(1) The operation of a listed, automatic smoke detection system installed to protect the entire vessel and, further, designed and installed to provide for actuation of the system in time to preclude the generation of heat or smoke sufficient to interfere with egress
(2) The operation of approved smoke detectors installed in such a way as to detect smoke on either side of the door opening
(3) Operation of an automatic sprinkler system

7.2.1.7.3.1 These systems shall be permitted to be zoned as approved by the authority having jurisdiction.

7.2.1.7.4 Any fire detection system or smoke detector shall be so designed that it is provided with supervision and safeguards as are necessary to ensure reliability of operation in case of fire *(see also Section 9.1)*.

7.2.1.7.5 Upon loss of power to the hold-open device, the hold-open mechanism shall be released and the door shall become self-closing.

7.2.1.7.6 The automatic release of one door in a stair enclosure shall result in the closing of all doors serving that stair.

7.2.1.8 Power-Operated Doors. Where required doors are operated by power, such as doors actuated by sensing devices upon the approach of a person or doors with power-assisted manual operation, the design shall be such that, in the event of power failure, the door can be opened manually to permit egress travel or closed where necessary to safeguard the means of egress. The forces required to open these doors manually shall not exceed those specified in 7.2.1.4.4 except that the force required to set the door in motion shall not exceed 220 N (50.1 lbf). The door shall be designed and installed so that, when a force is applied to the door on the side from which egress is made, it shall be capable of swinging from any position to the full use of the required width of the opening in which it is installed. *(See 7.2.1.4.)* These provisions shall not apply to the power-operated doors in 7.2.1.8.1 through 7.2.1.8.5.

7.2.1.8.1 Sliding, power-operated doors in exit access that can be manually opened in the direction of door travel with forces not exceeding those specified in 7.2.1.4.3 shall not be required to have a swing-out feature.

7.2.1.8.2 In the emergency break-out mode, a door leaf located within a two-leaf opening shall be exempted from the minimum 80 cm (31.5 in.) single-leaf requirement of 7.2.1.3, if a minimum of 75 cm (29.5 in.) clear width is provided by the single leaf.

7.2.1.8.3 Doors complying with 7.2.1.9 shall not be required to comply with 7.2.1.8.

7.2.1.8.4 Doors fitted with an independent, local power source capable of operation a minimum of 10 times subsequent to loss of primary power shall not be required to comply with 7.2.1.8.

7.2.1.8.5 Power-operated watertight doors shall not be required to comply with 7.2.1.8.

7.2.1.9 Balanced Doors.

7.2.1.9.1 Where panic hardware is installed on balanced doors, the panic hardware shall be of the push-pad type.

7.2.1.9.2 The pad shall not extend more than approximately one-half the width of the door measured from the latch side.

7.2.1.10 Horizontal Sliding Doors. Horizontal sliding doors used in a means of egress shall comply with 7.2.1.10.1 through 7.2.1.10.6.

7.2.1.10.1 The door shall be operable by a simple method from either side without special knowledge or effort.

7.2.1.10.2 The force applied to the device that is required to operate the door shall not exceed 65 N (14.8 lbf) when the vessel is on an even keel.

7.2.1.10.3 The force required to operate the door shall not exceed 130 N (29.6 lbf) to set the door in motion and 65 N (14.8 lbf) to close the door or open it to the minimum required width when the vessel is on an even keel.

7.2.1.10.4 The door shall be operable with a force not to exceed 220 N (50.1 lbf) when a force of 1110 N (252.9 lbf) is applied perpendicularly to the door adjacent to the operating device when the vessel is on an even keel.

7.2.1.10.5 The door assembly shall comply with the applicable fire protection rating and, where rated, shall be self-closing or automatic-closing by smoke detection in accordance with 7.2.1.7.

7.2.1.10.6 The door assembly shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

7.2.1.11 Watertight Doors. Watertight doors in a means of egress shall be the quick-acting or power-operated type.

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7.2.2 Stairs.

7.2.2.1 General. Stairs, either interior or exterior, used as a component in the means of egress shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.2, unless they are aisle steps in accommodation occupancies as provided in 21.2.10.2.

7.2.2.2 Types of Stairs.

7.2.2.2.1* Dimensional Criteria. Stairs shall be in accordance with Table 7.2.2.2.1.

Table 7.2.2.2.1 Stairs

Stair Requirements	Dimensions	
	cm	in.
Minimum width clear of all obstructions, except projections not exceeding 10 cm (3.9 in.) at or below handrail height on each side	90	35.4
Maximum height of risers	20	7.9
Minimum height of risers	10	3.9
Minimum net tread depth	24	9.4
Minimum headroom	205	80.7
Maximum height between landings	350	137.8
Landing	*(See 7.2.2.3 and 7.2.1.4.3.)*	

7.2.2.2.2 Tread Slope. Tread slope shall not exceed 2.0 cm/m (0.24 in./ft) (a slope of 1 in 50).

7.2.2.2.3* Riser Height and Net Tread Depth.

7.2.2.2.3.1 Riser height shall be measured as the vertical distance between tread nosings.

7.2.2.2.3.2 Tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge, but shall not include beveled or rounded tread surfaces that slope more than 20 degrees (a slope of 1 in 2.75).

7.2.2.2.3.3 At tread nosings, such beveling or rounding shall not exceed 1.5 cm (0.6 in.) in horizontal dimension.

7.2.2.2.3.4 The total tread shall not be less than 25 cm (9.8 in.).

7.2.2.2.4 There shall be no variation exceeding 0.5 cm (0.2 in.) in the depth of adjacent treads or in the height of adjacent risers, and the tolerance between the largest and smallest riser or between the largest and smallest tread shall not exceed 1.0 cm (0.4 in.) in any flight.

7.2.2.3 Stair Details.

7.2.2.3.1 All stairs serving as required means of egress shall be of permanent, fixed construction.

7.2.2.3.2 Stairs, platforms, and landings used to connect more than three decks shall be of noncombustible material throughout. Handrails shall not be required to be of noncombustible material.

7.2.2.3.3 Stairs and intermediate landings shall continue with no decrease in width along the direction of egress travel.

7.2.2.3.3.1 Every landing shall have a dimension measured in the direction of travel equal to the width of the stair.

7.2.2.3.3.2 The dimensions of a landing shall not be required to exceed 120 cm (47.2 in.) where the stair has a straight run.

7.2.2.3.4 Stair treads shall be uniformly slip resistant and shall be free of projections or lips that could trip stair users.

7.2.2.3.5 Treads of stairs and landing floors shall be solid, unless they are noncombustible or grated stair treads and landings, in which case they shall be permitted to follow the provisions in Chapters 10 through 21.

7.2.2.3.6 Stairs shall be arranged so as to make clear the direction of egress to an area of refuge or an embarkation area. Stairs that continue beyond a level of exit discharge that is not obvious shall be interrupted at the level of exit discharge by partitions, doors, or other effective means.

7.2.2.3.7 Spiral Stairs. Where specifically permitted for individual occupancies by Chapters 10 through 21, spiral stairs used as a means of egress shall comply with 7.2.2.3.7.1 through 7.2.2.3.7.6.

7.2.2.3.7.1 The occupant load served shall not exceed five.

7.2.2.3.7.2 The clear width of the stairs shall be not less than 65 cm (25.6 in.).

7.2.2.3.7.3 The height of risers shall not exceed 24 cm (9.4 in.).

7.2.2.3.7.4 Headroom shall be not less than 200 cm (78.7 in.).

7.2.2.3.7.5 Treads shall have a minimum depth of 20 cm (7.9 in.) at a point 30 cm (11.8 in.) from the narrower edge.

7.2.2.3.7.6 All treads shall be identical.

7.2.2.3.8 Turnstiles. No turnstiles or other devices to restrict the movement of persons shall be installed in such a manner as to interfere in any way with required means of egress facilities.

7.2.2.4 Guards and Handrails.

7.2.2.4.1 Guards. Means of egress such as stairs, landings, passageways, deck openings, ramps, aisles, galleries, or mezzanines that are more than 75 cm (29.5 in.) above the deck below shall be provided with guards to prevent falls over the open side.

7.2.2.4.2 Handrails. Each stair or ramp with a slope exceeding 1 in 12 shall have handrails on both sides.

7.2.2.4.2.1 Handrails shall be provided within 75 cm (29.5 in.) of all portions of the required egress width of stairs.

7.2.2.4.2.2 The required egress width shall be along the natural path of travel. *(See also 7.2.2.4.5.)*

7.2.2.4.3 Required guards and handrails shall continue for the full length of each flight of stairs. At turns of stairs, inside handrails shall be continuous between flights at landings.

7.2.2.4.4 The design of guards and handrails and the hardware for attaching handrails to guards, balusters, or bulkheads shall be such that there are no projections that could engage loose clothing.

7.2.2.4.5* Handrail Details.

7.2.2.4.5.1 Handrails on stairs shall be not less than 85 cm (33.5 in.) nor more than 95 cm (37.4 in.) above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread, unless the required handrails form part of a guard, in which case they shall be permitted to have a maximum height of 105 cm (41.5 in.) measured vertically to the top of the rail from the leading edge of the tread.

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7.2.2.4.5.2 Additional rails that are lower or higher than the main handrail shall be permitted.

7.2.2.4.5.3 Handrails shall provide a clearance of at least 4 cm (1.6 in.) between the handrail and the bulkhead to which it is fastened.

7.2.2.4.5.4 Handrails shall be designed so they can be grasped firmly with a comfortable grip and so the hand can be slid along the rail without encountering obstructions.

7.2.2.4.5.5 Handrail ends shall be returned to the bulkhead or deck or shall terminate at newel posts.

7.2.2.4.5.6 Handrails that are not continuous between flights shall extend horizontally, at the required height, at least 30 cm (12 in.) beyond the top riser, and continue to slope for a depth of one tread beyond the bottom riser where a guard or bulkhead exists.

7.2.2.4.5.7 Handrails on open sides of stairs shall have intermediate rails or an ornamental pattern such that a sphere 10 cm (3.9 in.) in diameter cannot pass through any openings in such handrail, except that the triangular openings formed by the riser, tread, and bottom element of a guardrail at the open side of a stair shall be of such size that a sphere 15 cm (5.9 in.) in diameter cannot pass through the triangular opening.

7.2.2.4.5.8 Handrails shall be capable of withstanding a distributed horizontal load of 750 N/m (170.8 lbf/ft) applied in the direction normal to the bulkhead and a distributed load of 750 N/m (170.8 lbf/ft) applied in the downward direction.

7.2.2.4.6 Guard Details.

7.2.2.4.6.1 The height of guards required by 7.2.2.4.1 shall be measured vertically to the top of the guard from the top of the surface below.

7.2.2.4.6.2 Guards shall be not less than 100 cm (39.4 in.) high, except that guards in accommodation occupancies shall comply with the provisions of Chapter 10.

7.2.2.4.6.3 Open guards, in spaces other than engineering and machinery space occupancies and in storage occupancies, shall have intermediate rails or an ornamental pattern such that a sphere 10 cm (3.9 in.) in diameter cannot pass through any opening, except that the triangular openings formed by the riser, tread, and bottom element of a guardrail at the open side of a stair shall be of such size that a sphere 15 cm (5.9 in.) in diameter cannot pass through the triangular opening.

7.2.2.5 Special Provisions for Exterior Stairs.

7.2.2.5.1 Landings. Landings to which egress doors lead shall be approximately level [within 1 cm (⅜ in.)] with the adjoining deck.

7.2.2.5.2 Exterior stairs shall be permitted to be used as a component of egress where there is an obvious route or egress direction signage leading to an area of safe refuge or an embarkation area.

7.2.2.5.3 Exterior stairs shall be constructed of noncombustible material.

7.2.2.5.4 Exterior stairs, serving spaces with 10 or more persons, shall not be permitted to constitute more than 50 percent of the required egress capacity.

7.2.2.5.5 Exterior stairs shall comply with the requirements of Table 7.2.2.5.5 and subsequent sections.

7.2.2.6 Enclosure and Protection of Stairs.

7.2.2.6.1 Enclosures. All interior stairs serving as an exit or exit component shall be enclosed in accordance with 7.1.3.1. All other interior stairs shall be protected in accordance with 7.2.5.

7.2.2.6.2* Separation and Protection of Outside Stairs. Outside stairs that are part of a required means of egress shall be protected in accordance with 7.2.2.6.2.1 through 7.2.2.6.2.3.

7.2.2.6.2.1 Outside stairs shall be separated from the interior of the vessel by bulkheads with the fire resistance rating required for enclosed stairs with fixed or self-closing opening protectives.

7.2.2.6.2.2 The separation shall extend vertically from the freeboard deck to a point 3 m (10 ft) above the topmost landing of the stairs or to the deck, whichever is lower, and at least 3 m (10 ft) horizontally.

7.2.2.6.2.3 Outside stairs shall be protected from adjacent interior spaces as follows:

(1) Low-risk spaces shall not require protection.
(2) Medium- and high-risk spaces that are not protected by sprinklers require A-0 protection.
(3) Medium- and high-risk spaces that are protected by sprinklers require either A-0 protection or window sprinkler protection.

7.2.2.6.3 There shall be no enclosed, usable space within an exit enclosure, including under stairs, nor shall any open space within the enclosure, including stairs and landings, be used for any purpose, such as storage or similar use, that could interfere with egress, unless the enclosed usable space meets the requirements of 7.2.2.6.4.

7.2.2.6.4 Enclosed usable space under stairs shall be permitted, provided the bulkheads and soffits of the enclosed space are protected in the same manner as the stair enclosure. Entrance to such enclosed usable space under stairs shall not be from within the stair enclosure.

7.2.2.7 Signs. Stairs shall be provided with signage within the enclosure at each deck landing.

7.2.2.7.1 The signage shall be inside the enclosure located approximately 1.5 m (5 ft) above the floor landing in a position that is visible when the door is in either the open or closed position.

7.2.2.7.2 The signage shall indicate the deck level, the terminus of the top and bottom of the stair enclosure, and the identification of the stair.

7.2.2.7.3 The signage also shall state the deck level of, and the direction to, the exit discharge.

7.2.3 Smokeproof Enclosures.

7.2.3.1 Where smokeproof enclosures are required by other sections of this code, they shall comply with 7.2.3.

7.2.3.2 A smokeproof enclosure shall be an enclosure designed so that the movement of products of combustion produced by a fire occurring in any part of the vessel into the smokeproof enclosure shall be limited.

7.2.3.3 The appropriate design method shall be any system that meets the performance level stipulated in 7.2.3.2. The smokeproof enclosure shall be permitted to be created by using natural ventilation, by using mechanical ventilation incorporating a vestibule, or by pressurizing the enclosure.

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Table 7.2.2.5.5 Exterior Stairs

Stair Requirements	Dimensions for Stairs Serving More than 10 Persons		Dimensions for Stairs Serving 10 or Fewer Persons	
	cm	in.	cm	in.
Minimum widths	75 clear between rails	29.5 clear between rails	70 clear between rails	27.5 clear between rails
Minimum horizontal dimension of any landing or platform	75 clear	29.5 clear	70 clear	27.5 clear
Maximum riser height	22	8.7	30	11.8
Minimum tread, exclusive of nosing	22	8.7	15	5.9
Minimum nosing or projection	2.5	1	No requirement	
Spiral stairs	As permitted by 7.2.2.3.7		As permitted by 7.2.2.3.7	
Minimum headroom	200	80.4	200	80.4
Handrail height	85 to 95	32 to 37	85 to 95	32 to 37

7.2.3.4 Enclosure. Where a vestibule is used, it shall be within the enclosure and shall be considered part of the smokeproof enclosure. Vestibules shall have a minimum dimension of 110 cm (43.5 in.) in width and 185 cm (72.8 in.) in the direction of travel.

7.2.3.5 Discharge. Every smokeproof enclosure shall open to an adjacent smokeproof enclosure, to an open deck having direct access to an embarkation area, or into an exit access or exit.

7.2.3.5.1 The exit passageway shall be separated from the remainder of the vessel by A-0 Class divisions.

7.2.3.5.2 The exit passageways shall be without openings other than the entrance from the smokeproof enclosure and the door to the open deck or to the embarkation area.

7.2.3.6 Access. Access to spaces other than smokeproof enclosures consisting of a pressurized stair enclosure shall be by way of a vestibule, an exit, an exit access, a stair enclosure, or by way of an open deck.

7.2.3.7 Natural Ventilation. Doors to smokeproof enclosures using natural ventilation shall either be normally closed, self-closing, or shall be automatic-closing by actuation of a smoke detector within 3 m (9.8 ft) of the vestibule door.

7.2.3.8 Mechanical Ventilation. Smokeproof enclosures by mechanical ventilation shall comply with 7.2.3.8.1 through 7.2.3.8.4.

7.2.3.8.1 The door assembly from the vessel into the vestibule shall be normally closed, self-closing, or automatic-closing by actuation of a smoke detector located within 3 m (9.8 ft) of the vestibule door and remotely from the bridge or a central control station.

7.2.3.8.2 In the smoke control mode, the vestibule shall be provided with not less than one air change per minute, and the exhaust shall be 150 percent of the supply.

7.2.3.8.2.1 Supply air shall enter and exhaust air shall discharge from the vestibule through separate, tightly constructed ducts used only for those purposes.

7.2.3.8.2.2 Supply air shall enter the vestibule within 15 cm (5.9 in.) of the deck level.

7.2.3.8.2.3 The top of the exhaust register shall be located not more than 15 cm (5.9 in.) down from the top of the trap and shall be entirely within the smoke trap area.

7.2.3.8.2.4 Doors, when in the open position, shall not obstruct duct openings.

7.2.3.8.2.5 Controlling dampers shall be permitted in duct openings if needed to meet the design requirements, but are not otherwise required.

7.2.3.8.3 To serve as a smoke and heat trap and to provide an upward-moving air column, the vestibule ceiling shall be at least 50 cm (19.7 in.) higher than the door opening into the vestibule. The height shall be permitted to be decreased where justified by engineering design and field testing.

7.2.3.8.4 The smokeproof enclosure shall be provided with a dampered relief opening at the top and supplied mechanically with sufficient air to discharge a minimum of 1200 L/sec (2543 ft^3/min) through the relief opening while maintaining a minimum positive pressure of 25 Pa (0.10 in. water column) in the enclosure relative to the vestibule with all doors closed.

7.2.3.9 Activation of Mechanical Ventilation Systems. The activation of the systems shall be initiated by a smoke detector installed in an approved location within 3 m (9.8 ft) of the entrance to the smokeproof enclosure; or by an automatic sprinkler system; by remote manual operation from the bridge, a central control station, or other location that is continuously manned.

7.2.3.10 Door Closers. The activation of an automatic-closing device on any door in the smokeproof enclosure shall activate all other automatic-closing devices on doors in the smokeproof enclosure.

7.2.3.11 Standby Power. Standby power for mechanical ventilation equipment shall be provided by an emergency source of power.

7.2.3.12 Testing. Before the mechanical equipment is accepted by the authority having jurisdiction, it shall be tested to confirm that the mechanical equipment is operating in compliance with these requirements.

7.2.3.13 Emergency Lighting. All smokeproof enclosures and vestibules shall be provided with emergency lighting powered by the standby power system *(see 7.2.3.11)*.

7.2.4 Horizontal Exits.

7.2.4.1 Application. Horizontal exits shall be permitted to be substituted for other exits to the extent that the total egress capacity of the other exits (e.g., stairs, ramps, doors leading outside the vessel) will not be reduced below half that required for the entire deck area of the occupancy if no horizontal exit existed.

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7.2.4.2 Horizontal Exit Division.

7.2.4.2.1 Every area for which credit is allowed in connection with a horizontal exit shall have at least one exit that is not a horizontal exit in addition to the horizontal exit or exits.

7.2.4.2.2 Every horizontal exit for which credit is given shall be arranged so that there is at least one exit leading from each side of the horizontal exit to stairways or other means of egress leading to an area of refuge or embarkation area.

7.2.4.3 Egress from Horizontal Exits. Where the horizontal exit is intended to be used for egress from both sides of a horizontal exit, the deck area on either side of a horizontal exit shall be sufficient to hold the occupants of both floor areas, allowing not less than 0.30 m^2 (3.2 ft^2) clear floor area per person.

7.2.4.4 Doors in Horizontal Exits.

7.2.4.4.1 Doors in horizontal exits shall comply with 7.2.1.4.

7.2.4.4.2 Swinging fire doors used in horizontal exits shall comply with 7.2.4.4.2.1 through 7.2.4.4.2.3.

7.2.4.4.2.1 These fire doors shall swing in the direction of egress travel.

7.2.4.4.2.2 Where a horizontal exit serves areas on both sides of a fire barrier, there shall be adjacent openings with swinging doors, opening in opposite directions, with signs on each side of the fire barrier indicating the door that swings with the travel from that side.

7.2.4.4.2.3 Horizontal exits shall be of any other approved arrangement, provided that doors always swing with any possible egress travel.

7.2.4.4.3 Doors in horizontal exits shall be designed and installed to minimize air leakage.

7.2.4.4.4 All fire doors in horizontal exits shall be self-closing or automatic-closing in accordance with 7.2.1.7.

7.2.4.4.5 Horizontal exit doors located across a corridor shall be automatic-closing in accordance with 7.2.1.7.

7.2.4.5 Boundaries for Horizontal Exits. Boundaries separating areas between which there are horizontal exits shall be A-60 Class divisions, unless they meet the requirements provided in 7.2.4.6 or 7.2.4.7. They shall provide a separation continuous from sideshell to sideshell and from deck to deck.

7.2.4.6 Where an A-60 Class division is used to provide a horizontal exit in any deck of a vessel, it shall not be required on other decks if the decks on which the boundary is omitted are separated from the deck with the horizontal exit by an A-60 Class division.

7.2.4.7 Alternative provisions for boundaries in Chapters 19 through 21 shall supersede the requirements of 7.2.4.5.

7.2.5 Ramps.

7.2.5.1 General. Every ramp used as a component in a means of egress shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.5.

7.2.5.2 Dimensional Criteria. Ramps shall be in accordance with Table 7.2.5.2, except for aisle ramps as permitted for accommodation occupancies in Chapter 21.

7.2.5.3 Ramp Details.

7.2.5.3.1 Landings. Ramps shall have landings at the top, at the bottom, and at doors opening onto the ramp.

Table 7.2.5.2 Ramps

Ramp Details	Requirements
Minimum width clear of all obstructions, except projections not exceeding 9 cm (3.5 in.) at or below handrail height on each side	115 cm (45 in.)
Maximum slope	For rise ≥15 cm (6 in.): 1 in 12 For rise >7.5 cm (3 in.) and <15 cm (6 in.): 1 in 10 For rise ≤7.5 cm (3 in.): 1 in 8
Maximum cross-slope	1 in 48
Maximum rise for single ramp run	75 cm (30 in.)

7.2.5.3.1.1 The slope of the landing shall not be steeper than 1 in 50.

7.2.5.3.1.2 Every landing shall have a dimension measured in the direction of travel not less than the width of the ramp.

7.2.5.3.1.3 Ramp dimensions shall not be required to exceed 120 cm (47.2 in.) where the ramp has a straight run.

7.2.5.3.2 Slip Resistance. A ramp shall have a slip-resistant surface.

7.2.5.3.3 Changes in Direction of Travel. Changes in direction of travel, if any, shall be made only at landings. Ramps and intermediate landings shall continue with no decrease in width along the direction of egress travel.

7.2.5.3.4 Drop-Offs. Ramps and landings with drop-offs shall have curbs, walls, railings, or projecting surfaces that prevent people from traveling off the edge of the ramp. Curbs or barriers shall be a minimum of 10 cm (3.9 in.) in height.

7.2.5.3.5 Ramps Serving as Required Means of Egress.

7.2.5.3.5.1 All ramps serving as required means of egress shall be of permanent, fixed construction.

7.2.5.3.5.2 A ramp used as a means of egress shall be constructed of noncombustible material. Deck coverings on ramps shall comply with 8.3.4. The ramp floor and landings shall be solid and without perforations.

7.2.5.4 Guards and Handrails. Guards complying with 7.2.2.4 shall be provided for ramps. Handrails complying with 7.2.2.4 shall be provided along both sides of a ramp segment steeper than 1 in 20. The height of handrails and guards shall be measured vertically to the top of the guard or rail from the walking surface adjacent thereto, except for guards and handrails provided for ramped aisles in accommodation occupancies in accordance with Chapter 21.

7.2.5.5 Special Provisions for Outside Ramps. Balconies or landings to which doors lead shall be approximately level [within 1 cm (⅜ in.)] with the deck of the vessel.

7.2.5.6 Water Accumulation. Outside ramps and landings shall be designed to prevent water from accumulating on their surfaces.

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7.2.5.7 Enclosure and Protection of Ramps. Ramps in a required means of egress shall be enclosed or protected as a stair in accordance with 7.2.2.6.

7.2.6* Exit Passageways.

7.2.6.1 General. Exit passageways shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.6.

7.2.6.2 Enclosure. An exit passageway shall be separated from other parts of the vessel as specified in 7.1.3.1.

7.2.6.3 Stair Discharge. An exit passageway that serves as a discharge from a stair enclosure shall have the same fire resistance rating and opening-protective fire protection rating as that required for the stair enclosure.

7.2.6.4 Width. The width of an exit passageway serving a single deck shall be adequate to accommodate the aggregate required capacity of all exits discharging through it. The width of an exit passageway serving more than one deck shall comply with 7.3.1.4.

7.2.6.5 Deck. The deck shall be solid and without perforations.

7.2.7 Service Stairs and Ladders.

7.2.7.1 General. Service stairs and ladders shall be designed to be used for egress from areas accessible only to able-bodied crew.

7.2.7.2 Dimensional Criteria. Service stairs and ladders shall comply with the requirements of Table 7.2.7.2.

Table 7.2.7.2 Service Stairs and Ladders

Stair Requirements	Dimensions	
	cm	in.
Minimum width	70	27.5
Minimum horizontal dimension of landing or platform	70	27.5
Maximum riser height	30	11.8
Minimum net tread depth	17	6.7
Minimum total tread depth	25	9.8
Hand rail height	85 to 95	33.5 to 37.5
Minimum headroom	200	79
Spiral stairs	As permitted by 7.2.2.3.7	

7.2.7.3 Construction Materials. Service stairs and ladders shall be constructed of steel or equivalent materials, unless otherwise permitted in Chapters 10 through 21.

7.2.7.4 Construction and Installation.

7.2.7.4.1 Service ladders shall comply with the requirements of ASTM F 840, *Standard Specification for Ladders, Fixed, Vertical, Steel, Ship's.*

7.2.7.4.2 Ladders installed with a pitch less than 75 degrees shall not be permitted.

7.2.8 Vertical Ladders.

7.2.8.1 General. Vertical ladders shall be permitted to be used for egress from areas accessible only to able-bodied crew.

7.2.8.2 Construction and Installation. Vertical ladders shall be constructed of steel unless otherwise permitted in Chapters 19 through 21.

7.2.8.2.1 Each ladder used as a means of escape shall be mounted at least 18 cm (7 in.) from the nearest permanent object in back of the ladder measured to the closest portion of the ladder.

7.2.8.2.2 Rungs shall be constructed as follows:

(1) At least 40.5 cm (16 in.) in width
(2) Not more than 30.5 cm (12 in.) apart, and uniformly spaced for length of the ladder with at least 11 cm (4.5 in.) clearance above each rung

7.2.8.2.3 When a deck scuttle serves as a means of escape, it shall not be less than 45.5 cm (18 in.) in diameter and shall be fitted with a quick-acting release and a holdback device to hold the scuttle in an open position.

7.2.8.3 The lowest rung of any ladder shall be not more than 30 cm (11.8 in.) above the level of the surface beneath it.

7.2.9* Alternating Tread Devices.

7.2.9.1 Alternating tread devices that comply with 7.2.9.2 shall be permitted to be used only as follows:

(1) To provide access to unoccupied upper deck areas
(2) To provide a second means of egress from spaces subject to occupancy only by able-bodied crew

7.2.9.2 Alternating tread devices shall comply with 7.2.9.2.1 through 7.2.9.2.10.

7.2.9.2.1 Handrails shall be provided on both sides of alternating tread devices in accordance with 7.2.2.4.5.

7.2.9.2.2 The clear width between handrails shall be a minimum of 45 cm (17.7 in.) and shall not exceed 60 cm (23.6 in.).

7.2.9.2.3 Headroom shall not be less than 2 m (6.6 ft).

7.2.9.2.4 The angle of the device shall be between 50 and 68 degrees to horizontal.

7.2.9.2.5 The height of the riser shall not exceed 25 cm (9.8 in.).

7.2.9.2.6 Treads shall have a minimum projected tread depth of 15 cm (5.9 in.) measured in accordance with 7.2.2.2.3, with each tread providing 25 cm (9.8 in.) of depth, including tread overlap.

7.2.9.2.7 A minimum distance of 15 cm (5.9 in.) shall be provided between the stair handrail and any other object.

7.2.9.2.8 The initial tread of the stair shall begin at the same elevation as the platform, landing, or deck surface.

7.2.9.2.9 The alternating treads shall not be laterally separated by more than 5 cm (2 in.).

7.2.9.2.10 The occupant load served shall be three or fewer.

7.2.10 Areas of Refuge.

7.2.10.1 Area of Refuge Details.

7.2.10.1.1 An area of refuge, other than weather deck areas of refuge, shall comply with the requirements in 7.2.10.1.1.1 through 7.2.10.1.1.3.

7.2.10.1.1.1 An area of refuge shall be bounded by A-60 Class divisions, unless otherwise provided in Chapters 19 through 21.

7.2.10.1.1.2 An area of refuge shall be located above the waterline.

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7.2.10.1.1.3 An area of refuge shall be a smokeproof enclosure in accordance with 7.2.3, unless the vessel is protected throughout by an approved, supervised automatic sprinkler system.

7.2.10.1.2 Ducts shall be permitted to penetrate A-60 Class divisions, unless prohibited by other provisions of this code, and shall be provided with smoke-actuated dampers meeting the requirements of Type I-250 or Type II-250 as defined in ANSI/UL 555S, *Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems*, or other approved means to resist the transfer of smoke into the area of refuge.

7.2.10.2 An area of refuge shall have access to an embarkation area by means protected as required for an exit.

7.2.10.3 Where the exit used to provide egress from an area of refuge to an embarkation area (as required by 7.2.10.2) includes stairs, the stairs shall comply with 7.2.2.

7.2.10.4* The area of refuge shall be provided with a two-way communication system for communication between the area of refuge and a central control point.

7.2.10.5 Instructions for summoning assistance, via the two-way communication system, and written identification of the area of refuge location shall be posted adjacent to the two-way communication system.

7.2.10.6 Windows Facing Exterior Areas of Refuge. Windows facing exterior areas of refuge shall not be openable and shall be protected in accordance with any one of the requirements of 7.2.10.6.1 through 7.2.10.6.4, unless otherwise permitted by Chapters 19 through 21.

7.2.10.6.1 Windows facing exterior areas of refuge shall not be required to meet any integrity and shall be fitted with an A-60 Class steel shutter.

7.2.10.6.2 Windows facing exterior areas of refuge shall be required to be A-60 Class divisions.

7.2.10.6.3 Windows facing exterior areas of refuge shall be required to be A-0 Class divisions and be protected with sprinklers along the windows inside the space.

7.2.10.6.4* Windows facing exterior areas of refuge shall not be required to meet any integrity and shall be protected with window sprinklers in accordance with 9.2.7.

7.2.10.7 The door to the area of refuge shall be identified by signage.

7.2.10.8 Protection of Exterior Boundaries Below Exterior Areas of Refuge. Exterior boundaries below areas of refuge but above the waterline, including windows, shall be minimum A-0 Class divisions.

7.2.10.9 Embarkation Areas. Embarkation areas shall be protected as required for exterior areas of refuge. Windows in any spaces below embarkation spaces shall be protected in accordance with 7.2.10.6.

7.2.11* General Requirements for Aisles and Aisle Accessways.

7.2.11.1 The width of aisle accessways and aisles shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle accessway or aisle. Where aisle accessways or aisles converge to form a single path of egress travel, the required egress capacity of that path shall not be less than the combined required capacity of the converging aisle accessways and aisles.

7.2.11.2 Those portions of aisle accessways and aisles where egress is possible in either direction shall be uniform in required width.

7.2.11.3 Where nonfixed seating is located between a table and an aisle accessway or aisle, the measurement of required clear width of the aisle accessway or aisle shall be made to a line 50 cm (19.7 in.) away from the edge of the table. The 50 cm (19.7 in.) distance shall be measured perpendicular to the edge of the table.

7.2.11.4 The minimum required clear width of an aisle accessway within areas with fixed table locations shall be 30 cm (11.8 in.). The path of travel from any seat shall not exceed 10 m (32.8 ft) to the closest aisle or exit.

7.2.11.5 Aisle accessways between rows of theater-type seating shall have a clear width of not less than 30 cm (11.8 in.) and a maximum travel distance to an aisle or an exit of no more than 10 m (32.8 ft).

7.2.11.6 The minimum clear width of aisles shall be 50 cm (19.7 in.).

7.2.11.7 Aisle Stairs and Ramps.

7.2.11.7.1 Aisles that have a gradient steeper than 1 in 20, but not steeper than 1 in 8, shall consist of a ramp. Aisles that have a gradient steeper than 1 in 8 shall consist of an aisle stair.

7.2.11.7.2 Aisle stairs shall conform to the following:

(1) There shall be no variation exceeding 0.5 cm (0.2 in.) in the depth of adjacent treads.
(2) Treads shall be a minimum 28 cm (11 in.).
(3) Riser heights shall be a minimum 10 cm (3.9 in.) and a maximum 22 cm (8.7 in.) and shall be uniform to within 0.5 cm (0.2 in.) between adjacent risers.

7.2.11.8 Aisle Handrails. Ramped aisles having a gradient exceeding 1 in 12 and aisle stairs shall be provided with handrails at one side or along the centerline.

7.3 Capacity of Means of Egress.

7.3.1 Occupant Load.

7.3.1.1 The total capacity of the means of egress for any deck, balcony, or other occupied space shall be sufficient for the occupant load thereof.

7.3.1.2 The occupant load in any vessel or portion thereof shall not be assumed to be less than the number determined by dividing the deck area by the occupant load factor that corresponds to the assigned use as specified in Chapters 10 through 18 for individual occupancies. Where both gross and net area figures are given for the same occupancy, calculations shall be made applying the gross area figure to the gross area of the portion of the vessel devoted to its specified use and applying the net area figure to the net area of the specified use.

7.3.1.3 The occupant load permitted in any vessel or portion thereof shall be permitted to be increased from that number established for the given use as specified in 7.3.1.2, where all other requirements of this code are also met, based on such increased number. The authority having jurisdiction shall be permitted to require an approved aisle, seating, or fixed equipment diagram to substantiate any increase in occupant load and shall be permitted to require that such diagram be posted in an approved location.

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7.3.1.4 Where exits serve more than one deck, only the occupant load of each deck considered individually shall be required to be used in computing the capacity of the exits at that deck, provided that the required egress capacity of the exit shall not be decreased in the direction of egress travel.

7.3.1.5 Where means of egress from decks above and below converge at an intermediate deck, the capacity of the means of egress from the point of convergence shall be not less than the sum of the two.

7.3.1.6 Where any required egress capacity from a mezzanine passes through the space below, that required capacity shall be added to the required egress capacity of the space in which it is located.

7.3.2 Measurement of Means of Egress. Width of means of egress shall be measured in the clear (independent of permitted projections) at the narrowest point of the exit component under consideration. Projections not to exceed 8 cm (3.1 in.) on each side shall be permitted at and below handrail height.

7.3.3 Egress Capacity.

7.3.3.1 Egress capacity for components of means of egress shall be based on the requirements in 7.3.3.1.1 through 7.3.3.1.3.

7.3.3.1.1 Stairway width shall be 0.8 cm (0.3 in.) per person.

7.3.3.1.2 Level components and ramp widths shall be 0.5 cm (0.2 in.) per person.

7.3.3.1.3 Stairway widths shall be permitted to be sized in accordance with IMO Assembly Resolution A757(18), *Standard for the Calculation of the Width of Stairways Forming Means of Escape on Passenger Ships.*

7.3.3.2 The required capacity of a corridor shall be the occupant load utilizing the corridor for exit access divided by the required number of exits to which the corridor connects, but shall not be less than the required capacity of the exit to which the corridor leads.

7.3.4 Minimum Width.

7.3.4.1 The minimum width of any means of egress shall be as specified for a given egress component by Section 7.2, for individual occupancies by Chapters 10 through 21, or as indicated in 7.3.4.2.

7.3.4.2 The minimum width exit access formed by furniture and movable partitions, serving not more than six people and less than 15 m (49.2 ft) in length, shall be not less than 50 cm (19.7 in.) at and below 100 cm (39.4 in.) height or 70 cm (27.6 in.) above 100 cm (39.4 in.) height, provided the minimum 90 cm (35.4 in.) can be provided without moving permanent bulkheads.

7.3.4.3 Where a single exit access leads to an exit, its capacity in terms of width shall be at least equal to the required capacity of the exit to which it leads. Where more than one exit access leads to an exit, each shall have a width adequate for the number of persons it shall accommodate.

7.4 Number of Separate Means of Egress.

7.4.1 General.

7.4.1.1 The minimum number of separate means of egress from any deck, occupancy, or portion thereof shall be two, unless a single means of egress is permitted by Chapters 10 through 21. A mezzanine shall be permitted to have a single means of egress, provided the common path of travel limitations of Chapters 10 through 21 are not exceeded.

7.4.1.2 Only the egress requirements of each level considered individually shall be required to be used in computing the number of means of egress at that level, provided that the required number of means of egress shall not be decreased in the direction of egress travel.

7.5 Arrangement of Means of Egress.

7.5.1 General.

7.5.1.1 Exits shall be located and exit access shall be arranged so that exits are unobstructed and accessible at all times.

7.5.1.2 Where exits are not immediately accessible from an open area, safe and continuous passageways, aisles, or corridors leading directly to every exit shall be maintained and shall be arranged to provide access for each occupant to at least two exits by separate ways of travel unless a single exit is permitted by Chapters 10 through 21.

7.5.1.3 Where common paths of travel are permitted for an occupancy by Chapters 10 through 21, such common paths of travel shall be permitted but shall not exceed the limit specified.

7.5.1.4 Where more than one exit is required from an occupancy, such exits shall be remotely located from each other and shall be arranged and constructed to minimize the possibility that more than one can be blocked by any one fire or other emergency condition.

7.5.1.5* If two exits or exit access doors are required, they shall be placed at a distance from one another equal to, but not less than, one-half the length of the maximum overall diagonal dimension of the occupancy or area to be served, measured in a straight line between the nearest edge of the exit doors or exit access doors, unless otherwise provided in 7.5.1.6. Where exit enclosures are provided as the required exits and are interconnected by a passageway conforming to the requirements of 7.1.3.5, exit separation shall be permitted to be measured along the line of travel within the corridor. Where more than two exits or exit access doors are required, at least two of the required exits or exit access doors shall be located so that if one becomes blocked, the others will be available.

7.5.1.6 In vessels protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.2.7, the minimum separation distance between two exits or exit access doors measured in accordance with 7.5.1.5 shall be not less than one-third the length of the maximum overall diagonal dimension of the area to be served.

7.5.1.7* Interlocking or scissor stairs shall be permitted to be considered separate exits if enclosed in accordance with 7.1.3.1 and separated from each other by A-Class divisions. There shall be no penetrations or communicating openings, whether protected or not, between the stair enclosures.

7.5.1.8 Exit access shall be arranged so that there are no dead ends in corridors, unless otherwise permitted by Chapters 10 through 21.

7.5.1.9 Exit access from spaces shall be permitted to be through adjoining or intervening spaces or areas, provided such adjoining spaces are accessory to the area served. Foyers, lobbies, and reception rooms constructed as required for corridors shall not be construed as intervening spaces.

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7.5.2 Impediments to Egress. See also 7.1.7 and 7.2.1.5.

7.5.2.1 Access to an exit shall not be permitted to be through galleys, storerooms, restrooms, engineering and machinery spaces, closets, staterooms or similar spaces, or any spaces with doors that can be locked, except that exit access in specific occupancies shall be permitted to pass through rooms or spaces subject to locking, as provided in Chapter 11.

7.5.2.2 Exit access and exit doors shall be designed and arranged to be clearly recognizable.

7.5.2.2.1 Hangings or draperies shall not be placed over exit doors or otherwise located to conceal or obscure any exit.

7.5.2.2.2 Mirrors shall not be placed on exit doors.

7.5.2.2.3 Mirrors shall not be placed in or adjacent to any exit in such a manner as to confuse the direction of exit.

7.5.3 Exterior Ways of Exit Access.

7.5.3.1 Exit access shall be permitted to be by means of any exterior landing or open deck that conforms to the requirements of Chapter 7.

7.5.3.2 The long side of the landing or open deck shall be at least 50 percent open and shall be arranged to prevent the accumulation of smoke.

7.5.3.3 Exterior exit–access landings shall be separated from the interior of the vessel by bulkheads and opening protectives as required for corridors, unless the exterior exit–access landing is served by at least two remote stairs that can be accessed without any occupant needing to travel past an unprotected opening to reach one of the stairs.

7.5.3.4 There shall be no obstruction by railings, barriers, or gates that divides the open space into sections appurtenant to individual rooms or other subdivisions.

7.5.3.5 An exterior exit access shall be arranged so that there are no dead ends in excess of 7 m (23 ft).

7.5.3.6 Any landing or other exterior exit access that projects beyond the outside bulkhead of the vessel shall comply with the requirements of Chapter 7 as to width and arrangement.

7.5.3.7 An exterior exit access shall have solid, approximately level decks and shall have guards that are at least equivalent to those specified in 7.2.2.4 on unenclosed sides more than 75 cm (29.5 in.) above the deck or level below.

7.6 Measurement of Travel Distance to Exits.

7.6.1 The maximum travel distance in any occupied space to at least one exit, measured in accordance with the following requirements, shall not exceed the limits specified by Chapters 10 through 21.

7.6.2 The travel distance to an exit shall be measured on the deck or other walking surface along the centerline of the natural path of travel starting from the most remote point subject to occupancy, curving around any corners or obstructions with a 0.3 m (1.0 ft) clearance therefrom, and ending at the center of the doorway or other point at which the exit begins. Where measurement includes stairs, the measurement shall be taken in the plane of the tread nosing.

7.6.3 Where open stairways or ramps are permitted as a path of travel to required exits, such as between mezzanines or balconies and the deck below, the distance shall include the travel on the stairway or ramp and the travel from the end of the stairway or ramp to an outside door or other exit in addition to the distance traveled to reach the stairway or ramp.

7.6.4* Where any part of an exterior exit is within 3 m (9.8 ft) horizontal distance of any unprotected vessel opening, as permitted by 7.2.2.6.2 for outside stairs, the travel distance to the exit shall include the length of travel to the embarkation area or area of refuge.

7.7 Discharge from Exits.

7.7.1 All exits shall terminate directly at an exit discharge, an area of refuge, or an embarkation area, unless otherwise permitted in 7.7.2 and 7.7.5. Open decks, or other portions of the exit discharge, shall be of required width and size to provide all occupants with safe access to an embarkation area.

7.7.2 At least 50 percent of the required number of exits, comprising at least 50 percent of the required egress capacity, shall discharge directly to an area of refuge or an embarkation area. Exits that do not discharge to an area of refuge or an embarkation area shall meet the requirements in 7.7.2.1 through 7.7.2.3.

7.7.2.1 The exit shall lead to a free and unobstructed way to an area of refuge or embarkation area that is visible and identifiable from the point of discharge from the exit.

7.7.2.2 The exit shall provide protection throughout by an approved, automatic sprinkler system or have the portion of the level of discharge used for this purpose protected by an approved, automatic sprinkler system and separated from the nonsprinklered portion of the deck by fire resistance–rated construction that meets the requirements of 7.1.3.1, unless otherwise provided by Chapters 19 through 21.

7.7.2.3 The exit shall provide separation from areas below by construction that has a fire resistance rating not less than that required for the exit enclosure, except that levels below the level of discharge shall be permitted to be open to the level of discharge in an atrium in accordance with 21.3.1.2.

7.7.3 The exit discharge shall be arranged and marked to make clear the direction of egress to an area of refuge or an embarkation area. *(See 7.2.2.3.6.)*

7.7.4 Doors, stairs, ramps, passageways, landings, and other components of an exit discharge shall comply with the detailed requirements of Chapter 7 for such components.

7.7.5 Weather deck exit discharge shall be permitted where the following requirements are met:

(1) Discharge is to open decks.
(2) The open deck has a fire resistance rating at least the equivalent of that required for the exit enclosure.
(3) There is a continuous and safe means of egress from the open deck to an area of refuge or an embarkation area.

7.8 Illumination of Means of Egress.

7.8.1 General.

7.8.1.1 Illumination of means of egress shall be provided in accordance with Section 7.8 for every vessel where required in Chapters 10 through 21. For the purposes of this requirement, exit access shall include only designated stairs, aisles, ramps, and passageways leading to an exit. For the purposes of this requirement, exit discharge shall include only designated stairs, aisles, ramps, walkways, and passageways leading to an area of refuge or an embarkation area.

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7.8.1.2 Illumination of means of egress shall be continuous during the time that the conditions of occupancy require that the means of egress be available for use. Artificial lighting shall be employed at such places and for such periods of time as required to maintain the illumination to the minimum criteria values herein specified.

7.8.1.3* The decks and other walking surfaces within an exit and within the portions of the exit access and exit discharge designated by 7.8.1.1 shall be illuminated to values of not less than 10 lx (1 fc) measured at the deck.

7.8.1.4 Any required illumination shall be arranged so that the failure of any single lighting unit, such as the burning out of an electric bulb, will not leave any area in darkness.

7.8.1.5 The equipment or units installed to meet the requirements of Section 7.10 shall be permitted also to serve the function of illumination of means of egress, provided that all applicable requirements of Section 7.8 for such illumination are met.

7.8.2 Sources of Illumination.

7.8.2.1 Illumination of means of egress shall be from the main power source.

7.8.2.2 No battery-operated electric light nor any type of portable lamp or lantern shall be used for primary illumination of means of egress. Battery-operated electric lights shall be permitted to be used as an emergency source to the extent permitted under Section 7.9.

7.9 Emergency Lighting.

7.9.1 General.

7.9.1.1 Emergency lighting shall be provided for required means of egress, areas of refuge, and embarkation areas in accordance with Section 7.9 for all occupancies as required in Chapters 10 through 21.

7.9.1.2 Where maintenance of illumination depends upon changing from one energy source to another, interruption of illumination during the changeover shall be in accordance with 7.9.1.2.1 and 7.9.1.2.2.

7.9.1.2.1 Where emergency lighting is provided by a prime mover–operated electric generator, a delay of not more than 45 seconds shall be permitted.

7.9.1.2.2 If the emergency generator cannot meet the 45-second requirement, then a transitional power source shall be required.

7.9.2 Performance of System.

7.9.2.1 In the event of failure of normal lighting, emergency lighting shall be in accordance with IEEE Standard 45, *Recommended Practice for Electric Installations on Shipboard*.

7.9.2.1.1 Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 10 lx (1 fc) and a minimum at any point of 1 lx (0.1 fc) measured along the path of egress at deck level.

7.9.2.1.2 Illumination levels shall be permitted to decline to 6 lx (0.6 fc) average and a minimum at any point of 0.6 lx (0.06 fc) at the end of the emergency lighting time duration.

7.9.2.1.3 A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded.

7.9.2.2 The emergency lighting system shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting.

7.9.2.3 Emergency generators used to provide power to emergency lighting systems shall be installed, tested, and maintained in accordance with 46 CFR, Subchapter J, "Electrical Engineering," Part 112.

7.9.2.4 Battery-operated emergency lights shall use only types of rechargeable batteries provided with facilities for maintaining them in a charged condition. Batteries used in such lights or units shall be approved for their intended use and shall comply with 46 CFR, Subchapter J, "Electrical Engineering," Parts 110–113.

7.9.2.5 The emergency lighting system shall be either continuously in operation or shall be capable of repeated automatic operation without manual intervention.

7.9.3 Testing and Maintenance. Emergency lighting shall be tested at least quarterly.

7.10 Marking of Means of Egress.

7.10.1 General.

7.10.1.1 Means of egress markings, where required by Chapters 10 through 21, shall be in accordance with Section 7.10 or comply with IMO Resolution A.760(18), *Symbols Related to Life-Saving Appliances and Arrangements*.

7.10.1.2 Exits shall be marked by an approved sign, visible from any direction of exit access.

7.10.1.3 Access to exits shall be marked by approved, visible signs in all cases where the exit or way to reach it is not readily apparent to the occupants. Sign placement shall be such that no point in the exit access is more than 30 m (98 ft) from the nearest visible sign.

7.10.1.4 Every sign required by Section 7.10 shall be located and of such size, distinctive color, and design as to be identifiable, and shall provide contrast with decorations, interior finish, or other signs. No decorations, furnishings, or equipment that impairs visibility of an exit sign shall be permitted, nor shall there be any brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required exit sign of such a character as to detract attention from the exit sign.

7.10.2 Size of Signs. Every sign required by Section 7.10 shall have the letters in the word EXIT and other words not less than 15 cm (5.9 in.) high with the principal strokes of letters not less than 2 cm (0.8 in.) wide, except for the signs described in 7.10.3. The word EXIT shall have letters of a width not less than 5 cm (2 in.), except the letter I, and the minimum spacing between letters shall be not less than 1 cm (0.4 in.). Signs larger than the minimum established in this paragraph shall have letter widths, strokes, and spacing in proportion to their height.

7.10.3 Listed Exit Signs. Listed exit signs, illuminated in accordance with 7.10.4, shall be permitted to have letters not less than 15 cm (5.9 in.) in height with the principal strokes of letters not less than 0.5 cm (0.2 in.) in width with a letter width not less than 4 cm (1.6 in.), except the letter I.

7.10.4 Illumination of Signs.

7.10.4.1 Every sign required by 7.10.1.2 or 7.10.1.3 shall be illuminated, unless the sign provides evenly illuminated letters with a minimum luminance of 0.21 cd/m^2 (0.06 fl) as measured by a color-corrected photometer. Signs shall be visible in both the normal and emergency lighting mode.

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7.10.4.2 Every sign required by 7.10.1.4 shall provide evenly illuminated letters having a minimum luminance of 0.2 cd/m^2 (0.06 fl), unless the sign complies with the requirements of 7.10.4.3.

7.10.4.3 Every sign required to be illuminated by 7.10.3 shall be continuously illuminated as required under the provisions of Section 6.8, except that illumination for signs shall be permitted to flash on and off upon activation of the fire alarm system.

7.10.5 Specific Requirements.

7.10.5.1 Directional Signs.

7.10.5.1.1 A sign in compliance with 7.10.2 that reads EXIT or that has an indicator showing the direction of travel shall be placed in every location where the direction of travel to reach the nearest exit is not apparent.

7.10.5.1.2 The directional indicator shall be located outside of the EXIT legend, not less than 1 cm (0.4 in.) from any letter, and shall be permitted to be integral to or separate from the sign body.

7.10.5.1.2.1 The directional indicator shall be of a chevron type as shown in Figure 7.10.5.1.2.1 and shall be identifiable as a directional indicator at a minimum distance of 30 m (98.4 ft) under all space illumination conditions.



FIGURE 7.10.5.1.2.1 Chevron-Type Indicator.

7.10.5.1.2.2 The directional indicators shall not be located at the end of the sign opposite the direction indicated.

7.10.5.2 Special Signs. Any door, passageway, or stairway that is neither an exit nor a way of exit access, and that is located or arranged so that it is likely to be mistaken for an exit, shall be identified by a sign reading NO EXIT. Such sign shall have the word NO in letters 5 cm (2 in.) high with stroke width of 1 cm (0.4 in.) and the word EXIT in letters 2.5 cm (1 in.) high, with the word EXIT below the word NO.

7.11 Low-Location Lighting.

7.11.1 General.

7.11.1.1 Low-location lighting shall be provided in accordance with Section 7.11 for all occupancies where required in Chapters 10 through 21.

7.11.1.2 If an emergency generator is used to power the low-location lighting system, a transitional power source shall be required if the emergency generator cannot meet the 45-second requirement. The emergency generator shall be installed, tested, and maintained in accordance with 46 CFR, Subchapter J, "Electrical Engineering," Part 112.

7.11.2 Performance of Systems.

7.11.2.1 The means of egress shall be marked with low-location lighting in the event that the normal emergency lighting is less effective because of smoke or loss of power.

7.11.2.2 Low-location lighting systems shall function for at least 60 minutes after activation.

7.11.2.3 Low-location lighting systems shall meet the requirements of IMO Resolution A752(18), *Guidelines for the Evaluation, Testing, and Application of Low-Location Lighting on Passenger Ships*, and ISO 15370, *Low-Location Lighting on Passenger Ships*.

7.11.2.4 If batteries are used to power the low-location lighting system, they shall be types of rechargeable batteries provided with facilities for maintaining them in a charged condition. Batteries used in such lights or units shall be approved for their intended use and shall comply with 46 CFR, Subchapter J, "Electrical Engineering," Parts 110–113.

7.11.2.5 The low-location lighting system shall be either continuously in operation or shall be capable of repeated automatic operation without manual intervention.

7.11.2.6 If low-location lighting is fitted in a machinery, service, or other space where the egress path is not bounded by bulkheads, such lighting shall be installed on the deck.

7.11.3 Testing and Maintenance. The low-location lighting system shall be tested at least weekly.

Chapter 8 Features of Fire Protection

8.1 General.

8.1.1 Application.

8.1.1.1 The features associated with a vessel's fire protection construction shall comply with this chapter.

8.1.1.2 Vessels classified in accordance with Chapters 19 through 21 that have individual occupancies as classified in Chapters 10 through 18 shall meet the minimum construction requirements of those chapters.

8.2 Construction and Compartmentation.

8.2.1 Construction. The hull, structural bulkheads, columns and stanchions, superstructures, deckhouses, and divisional bulkheads shall be constructed of noncombustible material, unless otherwise permitted by Chapters 10 through 21.

8.2.2* Noncombustible Material. A material shall be considered noncombustible if the criteria in 8.2.2.1 or 8.2.2.2 are satisfied.

8.2.2.1 A material shall be considered noncombustible if it meets the criteria of Part 1 of the IMO *Fire Test Procedures Code*.

8.2.2.2 A material shall be considered noncombustible if it meets the criteria of 46 CFR 164.009, "Noncombustible Materials for Merchant Vessels."

8.2.2.3 Noncombustible materials shall be listed.

8.2.3 Steel or Equivalent Material. A material shall be considered as having equivalent load-carrying capability compared to steel when tested in accordance with MSC/Circ. 732, *Interim Guidelines on the Test Procedure for Demonstrating the Equivalence of Composite Materials to Steel Under the Provisions of the 1974 SOLAS Convention*.

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8.2.4 Fire Barriers.

8.2.4.1 Fire-rated deck and bulkhead assemblies used as fire barriers to form fire-rated divisions, as well as any exposed stanchions, frames, stiffeners, beams, girders, or trusses supporting such assemblies, shall be of a design that has been tested to meet the conditions of acceptance as stipulated herein.

8.2.4.2 Where permitted by Chapters 10 through 18, combustible, decorative finishes or veneers on bulkheads, decks, or ceilings designated as fire barriers shall meet the requirements of Section 8.3 and shall not degrade the fire rating for the required separation.

8.2.4.3 Fire barriers, as well as any assemblies used to provide enclosure of openings in the fire barriers, shall be rated in accordance with 8.2.4.3.1.

8.2.4.3.1 A-Class divisions shall be constructed of steel or equivalent material and shall be stiffened and made intact with the main structure of the vessel. A Class includes A-60 Class divisions and A-0 Class divisions.

8.2.4.3.1.1 A-60 Class divisions shall meet one of the following criteria:

(1) A-60 Class divisions shall be constructed such that when the barrier assembly is subjected to a standard fire test given in ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*; ISO 834, *Fire Resistance Tests — Elements of Building Construction*; or the equivalent, the assembly shall prevent the passage of smoke and flame for 1 hour. Additionally, the assembly shall provide thermal protection such that the average temperature on the unexposed side does not rise more than 140°C (284°F) above the original (ambient) temperature, nor shall the temperature at any single point, including any joint, rise more than 180°C (356°F) above the original temperature within the 1-hour time period.
(2) The assembly shall satisfy the performance requirements for A-60 Class divisions when tested in accordance with Part 3 of the IMO *Fire Test Procedures Code*.

8.2.4.3.1.2 A-0 Class divisions shall meet the requirements of 8.2.4.3.1.1(1), except that there are no thermal protection requirements. B-15 Class divisions that, when tested according to 8.2.4.3.2.1(1), prevented the passage of flame and hot gases for 60 minutes shall be permitted to be used as components of A-Class divisions.

8.2.4.3.2 B-Class divisions shall meet the criteria for either B-15 Class divisions or B-0 Class divisions.

8.2.4.3.2.1 When tested without a surface finish, B-15 Class divisions shall meet one of the following criteria:

(1) B-15 Class divisions shall be constructed of noncombustible materials such that when the barrier assembly is subjected to the standard fire test ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*; ISO 834, *Fire Resistance Tests — Elements of Building Construction*; or the equivalent, the assembly shall prevent the passage of flame for 30 minutes. Additionally, the assembly shall provide thermal protection such that the average temperature on the unexposed side does not rise more than 140°C (284°F) above the original (ambient) temperature, nor shall the temperature at any single point, including any joint, rise more than 225°C (437°F) above the original temperature within the initial 15 minutes of the test.
(2) The assembly shall satisfy the performance requirements for B-15 Class divisions when tested in accordance with Part 3 of the *IMO Fire Test Procedures Code*.

8.2.4.3.2.2 B-0 Class divisions shall meet the requirements of 8.2.4.3.2.1(1), excluding the thermal protection requirements. Any bulkhead panels used as B-Class divisions shall be listed.

8.2.4.3.3 C-Class divisions shall include the following criteria:

(1) C-Class divisions shall be constructed of noncombustible materials and shall not be required to meet any requirements relative to the passage of smoke and flame or the limiting of temperature rise.
(2)*C'-Class divisions shall be constructed of noncombustible material(s) and shall be constructed to prevent the passage of smoke between adjacent areas.
(3) Where C- or C'-Class divisions are required, B- or A-Class divisions shall be permitted.

8.2.4.4 Door assemblies in fire-rated bulkheads shall have at least the same fire resistance rating as the barrier in which they are installed.

8.2.4.4.1 Fire doors shall be self-closing or automatic-closing in accordance with 7.2.1.7 and, where used within the means of egress, shall comply with the provisions of 7.2.1. A-Class doors shall meet one of the following criteria:

(1) They shall be tested in accordance with ASTM F 1384, *Standard Test Method for Fire Tests of Marine Joiner Doors,* as follows:
   (a) The door and frame assembly shall remain closed in the opening for 60 minutes.
   (b) The door and frame assembly shall stop the penetration of flame for 60 minutes.
   (c) The door shall not separate from the frame more than one and one-half times the thickness of the door.
   (d) The average, unexposed face temperature rise of the door, as determined by the 5 thermocouples located as stated in 7.2.1 and 7.2.2 of ASTM F 1384, shall not be more than 140°C (284°F), and the temperature rise, recorded by any of the individual unexposed face thermocouples, shall not be more than 180°C (356°F) during the period of 60 minutes for A-60 Class and 0 minutes for A-0 Class.
(2) They shall be tested in accordance with NVIC 9-97, *Guide to Structural Fire Protection Aboard Merchant Vessels*.
(3) They shall be tested in accordance with Part 3 of the IMO *Fire Test Procedures Code*.

8.2.4.4.2 B-Class doors shall meet one of the following criteria:

(1) They shall be tested in accordance with ASTM F 1384, *Standard Test Method for Fire Tests of Marine Joiner Doors,* as follows:
   (a) The door and frame assembly shall remain closed in the opening for 30 minutes.
   (b) The door and frame assembly shall stop the penetration of flame for 30 minutes.
   (c) The door shall not separate from the frame more than one and one-half times the thickness of the door.
   (d) The average, unexposed face temperature rise of the door, as determined by the 5 thermocouples located as stated in 7.2.1 and 7.2.2 of ASTM F 1384, *Standard Test Method for Fire Tests of Marine Joiner Doors*, shall not be more than 140°C (284°F), and the temperature rise, recorded by any of the individual unexposed face thermocouples, shall not be more than 225°C (437°F) during the period of 15 minutes for B-15 Class and 0 minutes for B-0 Class.

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(2) They shall be tested in accordance with NVIC 9-97, *Guide to Structural Fire Protection Aboard Merchant Vessels*.
(3) They shall be tested in accordance with Part 3 of the IMO *Fire Test Procedures Code*.

8.2.4.5 Structural Insulations. Any insulation used as a component of A- or B-Class divisions shall be listed as meeting 46 CFR 164.007, *Structural Insulations*.

8.2.4.6 Deck Coverings. Any deck coverings used as a component of A- or B-Class divisions shall be listed as meeting 46 CFR 164.006, *Deck Coverings for Merchant Vessels*.

8.2.4.7* Fire window assemblies shall be permitted in fire-rated bulkheads provided they meet the criteria of Part 3 of the IMO *Fire Test Procedures Code*, including the radiation criteria in Appendix 1 of the IMO code, unless otherwise permitted by Chapter 7 or Chapters 10 through 21 of this code.

8.2.4.8 Every opening in a fire barrier shall be protected to limit the spread of fire and restrict the movement of smoke from one side of the fire barrier to the other. The fire protection rating for opening protectives shall be identical to that of the barrier in which it is installed.

8.2.4.9 Penetrations and Miscellaneous Openings in Fire Barriers.

8.2.4.9.1 Openings in fire barriers for air-handling ductwork or air movement shall be protected in accordance with Section 9.4.

8.2.4.9.2 Pipes, conduits, bus ducts, cables, wires, air ducts, pneumatic tubes and ducts, drive shafts, and similar service equipment that pass through fire barriers shall be protected in accordance with 8.2.4.9.2.1 through 8.2.4.9.2.4.

8.2.4.9.2.1 The space between the penetrating item and the fire barrier shall be filled with a listed material capable of maintaining the fire resistance of the barrier, or it shall be protected by a listed device that is designed for that specific purpose and that maintains the fire resistance of the barrier.

8.2.4.9.2.2 Where the penetrating item uses a sleeve to penetrate the fire barrier, the sleeve shall be continuously welded on at least one side of the fire barrier, and the space between the item and the sleeve shall be filled with a material capable of maintaining the fire resistance of the barrier, or it shall be protected by a device that is designed for that specific purpose and that maintains the fire resistance of the barrier.

8.2.4.9.2.3 Insulation and coverings for pipes and ducts shall not pass through the fire barrier unless the material is capable of maintaining the fire resistance of the barrier or is protected by a device that is designed for that specific purpose and that maintains the fire resistance of the barrier.

8.2.4.9.2.4 Where designs take transmission of vibration into consideration, any vibration isolation shall be made on either side of the fire barrier or shall be made by a device that is designed for that specific purpose and that does not degrade the fire resistance of the barrier.

8.2.5 Vertical Openings.

8.2.5.1 All decks contiguous for the full width of a space or compartment shall be constructed as class divisions minimum A-0 or as otherwise provided in Chapter 7 or Chapters 10 through 21, except as indicated in 8.2.5.1.1 and 8.2.5.1.2.

8.2.5.1.1 Decks where C'-Class divisions are permitted by Chapters 10 through 21 shall be permitted to be reduced to C'-Class.

8.2.5.1.2 Decks where Class A-60 divisions are required by Chapters 10 through 21 shall be permitted to be Class A-60.

8.2.5.2 Openings through decks, such as stairways; hoistways for elevators, dumbwaiters, inclined and vertical conveyors; shaftways used for light, ventilation, or services; or joints used to allow structural movements or vibration isolation, shall be enclosed with fire barriers (vertical) meeting the requirements for decks in 8.2.5.1, such as bulkheads or partition assemblies, unless otherwise provided for elsewhere in 8.2.5. Such enclosures shall be continuous from deck to deck. Openings shall be protected as appropriate for the fire resistance rating of the barrier.

8.2.5.3 Shafts.

8.2.5.3.1 Vertical openings (shafts) that penetrate one or more decks shall be enclosed at the lowest and highest levels of the shaft, with construction in accordance with 8.2.5.4.

8.2.5.3.2 Shafts shall be permitted to terminate in a room or space that has a use related to the purpose of the shaft, provided that the room or space is separated from the remainder of the vessel by construction that has a fire resistance rating and opening protectives in accordance with 8.2.5.4 and 8.2.4.7.

8.2.5.4* All deck openings shall be protected to the same fire resistance rating as the deck in which they are installed.

8.2.5.5 A vertical opening that connects only two adjacent decks shall be permitted to be open to one of the two decks.

8.2.5.6 Service openings for conveyors, elevators, and dumbwaiters, where required to be open on more than one deck at the same time for purposes of operation, shall be provided with closing devices in accordance with 7.2.1.7.

8.2.5.7 Escalators or moving walks not constituting an exit shall have their floor openings enclosed or protected as required for other vertical openings. Escalators or moving walks or groups of escalators or moving walks shall not span more than two decks, unless otherwise provided for in 8.2.5.7.1 or 8.2.5.7.2.

8.2.5.7.1 In occupancies protected throughout by an approved, automatic sprinkler system in accordance with 9.2.7, escalators or moving walk openings shall be permitted to be protected in accordance with the method detailed in NFPA 13, *Standard for the Installation of Sprinkler Systems*, or in accordance with a method approved by the authority having jurisdiction.

8.2.5.7.2 Escalators in large open areas, such as atriums, shall not be required to have their floor openings enclosed or protected as required for other vertical openings.

8.2.6 Mezzanines.

8.2.6.1 Area Limitations.

8.2.6.1.1 The aggregate area of mezzanines within accommodation spaces shall not exceed one-fourth the open area of the space in which the mezzanines are located. Enclosed space shall not be included in a determination of the size of the space in which the mezzanine is located, except that this shall not apply to engineering or machinery space occupancies.

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8.2.6.1.2 There shall be no limit on the number of mezzanines in a space.

8.2.6.1.3 To determine the allowable mezzanine area, the area of mezzanines shall not be included in the area of the space.

8.2.6.2 Openness. All portions of a mezzanine shall be open to and unobstructed from the space in which the mezzanine is located, unless otherwise provided for in 8.2.6.2.1 or 8.2.6.2.2.

8.2.6.2.1 Bulkheads or railings not more than 110 cm (43 in.) high shall not be required to be open to and unobstructed from the space in which the mezzanine is located.

8.2.6.2.2 A mezzanine that has two or more means of egress need not open into the space in which it is located if at least one of the means of egress provides direct access to an exit at the mezzanine level.

8.2.7 Concealed Spaces.

8.2.7.1 Draft Stops.

8.2.7.1.1 Draft stops shall be provided for all concealed spaces that do not meet one of the following criteria:

(1) Are fully protected in accordance with 9.2.7 or 9.2.8
(2) Serve as plenums as described in NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*
(3) Are interstitial spaces on vessels that do not have overnight accommodations and where the compartment that contains the interstitial space is completely bounded by A-Class divisions or the outer shell of the vessel

8.2.7.1.2 Draft stops shall be fitted as follows:

(1) Vertical concealed spaces shall have draft stops installed that are constructed as minimum B-0 Class divisions at each deck level.
(2)*All interstitial spaces (between ceiling and deck above) shall have draft stops installed for the full depth of the interstitial space by partitions qualifying as B-0 Class divisions not greater than 14 m (45 ft) apart.

8.2.7.2 Combustible Materials in Concealed Spaces. The only combustible materials permitted in concealed spaces shall be those indicated in Section 8.2.

8.2.7.2.1 Cabling. Electrical and fiber optic cabling in concealed spaces shall meet the general requirements of Section 9.6 and the fire safety requirements of Section 8.5.

8.2.7.2.2 Insulation and Coverings for Pipe or Ventilation Duct. Insulation and coverings, including any facing, lagging, or protective covering, for pipe or ventilation ducts shall be noncombustible or shall exhibit a flame spread index not exceeding 25, a smoke developed index not exceeding 50, and no flaming drips, when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials,* or with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* using the specimen preparation and mounting procedures of ASTM E 2231, *Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics.*

8.2.7.2.3 Insulation and Coverings for Cold Service Piping. Insulation and coverings, including any facing, lagging, or protective covering, for cold service piping insulation shall be either noncombustible or exhibit a flame spread index not exceeding 25, a smoke developed index not exceeding 50, and no flaming drips, when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, or with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* using the specimen preparation and mounting procedures of ASTM E 2231, *Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics.*

8.2.7.2.4 Combustible Veneers. Any combustible veneers shall meet the requirements of 8.3.3.

8.2.7.2.5 Fire Suppression Piping. Listed nonmetallic fire suppression piping shall be permitted in concealed spaces under either of the following conditions:

(1) Installed behind a B-15 or higher class division
(2) Tested to the criteria for level 2 or higher piping systems in accordance with "Guidelines for the Application of Plastic Pipes on Ships" contained in the IMO *Fire Test Procedures Code*

8.2.7.2.6 Ventilation Ducting. Ventilation ducting that meets the requirements of 9.4.2.1 shall be permitted.

8.2.7.2.7 Plastic Pipe. Plastic pipe that meets the criteria for 8.3.3 shall be accepted.

8.3 Interior Finish.

8.3.1 General.

8.3.1.1 Interior finish shall include interior wall and ceiling finish and interior deck finish.

8.3.1.2 Interior finish shall be considered to mean the exposed interior surfaces of vessels including, but not limited to, fixed or movable partitions and overheads.

8.3.1.3 Interior deck finish shall be considered to mean the exposed deck surfaces of vessels that include coverings that could be applied over a finished deck or stair, including risers.

8.3.2 Use of Interior Finishes.

8.3.2.1 Requirements for interior finish shall apply as specified elsewhere in this code for specific occupancies. *(See Chapter 7 and Chapters 10 through 21.)*

8.3.2.2 Requirements for interior deck finish shall apply except where indicated otherwise by Chapters 10 through 21.

8.3.3* Interior Finish Classification. Where required by Chapters 10 through 21, interior finish shall be listed and shall meet the requirements of 8.3.3.1, 8.3.3.2, or 8.3.3.3.

8.3.3.1 Burning Characteristics of Interior Finish Surface.

8.3.3.1.1 Interior finish materials, other than textile wall or ceiling coverings, shall have a flame spread index not exceeding 20 and a smoke developed index not exceeding 10 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, or with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, unless otherwise provided for in 8.3.3.1.2.

8.3.3.1.2 Interior finish materials tested according to NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, shall not exhibit flashover during the test, and shall exhibit a maximum heat release rate not exceeding 800 kW and a total

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smoke release not exceeding 1000 m^2 (10,764 ft^2) throughout the test.

8.3.3.1.3 Paint not exceeding 0.9 mm (1/28 in.) in thickness shall be permitted to be used as interior finish material without complying with 8.3.3.1.1 or 8.3.3.1.2.

8.3.3.1.4 Textile wall or ceiling coverings shall be permitted to be used as interior finish materials if the finished manufactured assembly is tested [in actual-use thickness, with a maximum testing thickness of up to 100 mm (4 in.)] according to NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, and complies with the requirements of 8.3.3.1.2.

8.3.3.2 Interior finishes shall meet the requirements in 8.3.3.2.1 and 8.3.3.2.2.

8.3.3.2.1 The finish shall comply with Part 5 of the IMO *Fire Test Procedures Code* or ASTM E 1317, *Standard Test Method for Flammability of Marine Surface Finishes*.

8.3.3.2.2 The average specific optical density of smoke of interior wall and ceiling finishes shall not exceed 200 under any test condition when tested by one of the following methods:

(1) Part 2 of the IMO *Fire Test Procedures Code*. The toxicity test criteria shall not apply.
(2) NFPA 270, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber*, under the following conditions:
   (a) Irradiance of 25 kW/m^2, with pilot flame
   (b) Irradiance of 25 kW/m^2, without pilot flame
   (c) Irradiance of 50 kW/m^2, without pilot flame
(3) ASTM E 1995, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single-Closed Chamber, with the Specimen Oriented Horizontally*, under the following conditions:
   (a) Irradiance of 25 kW/m^2, with pilot flame
   (b) Irradiance of 25 kW/m^2, without pilot flame
   (c) Irradiance of 50 kW/m^2, without pilot flame

8.3.3.2.3 Interior wall and ceiling finish materials that exhibit a net heat of combustion of less than 45 MJ/m^2 when tested in accordance with ISO 1716, *Reaction to Fire Tests for Building Products — Determination of the Heat of Combustion,* shall be exempt from the requirements of 8.3.3.2.2.

8.3.3.3 Interior finishes shall be permitted to be used in sprinklered areas when the finished manufactured assembly is tested [in actual-use thickness, with a maximum testing thickness of up to 100 mm (4 in.)], if the entire assembly complies with the following two requirements:

(1) The assembly exhibits a flame spread index not exceeding 75 and a smoke developed index not exceeding 450 when tested according to NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, or ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.
(2) Flashover does not occur during the test and the total smoke released by the assembly does not exceed 1000 m^2 (10,764 ft^2) throughout the test when the assembly is tested according to NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*.

8.3.4* Interior Deck Finishes and Deck Overlays.

8.3.4.1 Where required by Chapters 10 through 21, interior deck finishes and deck overlays shall be listed and shall meet the requirements of 8.3.4.2 or 8.3.4.3 and 8.3.4.4.

8.3.4.2 Interior deck finishes shall meet criteria for the properties in 8.3.4.2.1 and 8.3.4.2.2. Additionally, the interior deck finishes shall comply with either 8.3.4.2.3 or 8.3.4.2.4.

8.3.4.2.1 The interior deck finish shall resist ignition by a methenamine pill in accordance with the criteria of ASTM D 2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*, or of 16 CFR 1630, "Standard for the Surface Flammability of Carpets and Rugs."

8.3.4.2.2 The interior deck finish shall exhibit an average specific optical density of smoke of no more than 500 under any test condition when tested by one of the following methods:

(1) Part 2 of the IMO *Fire Test Procedures Code*. The toxicity test criteria shall not apply.
(2) NFPA 270, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber*, under the following conditions:
   (a) Irradiance of 25 kW/m^2, with pilot flame
   (b) Irradiance of 25 kW/m^2, without pilot flame
   (c) Irradiance of 50 kW/m^2, without pilot flame
(3) ASTM E 1995, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single-Closed Chamber, with the Specimen Oriented Horizontally*, under the following conditions:
   (a) Irradiance of 25 kW/m^2, with pilot flame
   (b) Irradiance of 25 kW/m^2, without pilot flame
   (c) Irradiance of 50 kW/m^2, without pilot flame

8.3.4.2.3 The interior deck finish shall exhibit a critical radiant flux no less than 0.45 W/cm^2 when tested in accordance with NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, or ASTM E 648, *Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source*.

8.3.4.2.4 The interior deck finish shall comply with Part 5 or Part 6 of the IMO *Fire Test Procedures Code* as an alternative to meeting the critical radiant heat flux criterion.

8.3.4.2.5 Interior deck finishes that consist of 100 percent wool shall not be required to be tested to the criteria in 8.3.4.2.1 through 8.3.4.2.4.

8.3.4.3 If an underlayment is used, it shall meet the requirements of 8.3.4.2 except for deck finish materials that meet the requirements of 8.3.4.2 when tested with the underlayment.

8.3.4.4 Deck Overlays. Deck overlays shall not exceed 10 mm (0.4 in.) in thickness.

8.3.4.5 Interior deck finishes and deck overlays within spaces other than in exits and exit accesses that are fully protected by sprinkler or water mist systems shall not be required to meet the requirements of 8.3.4.3 and 8.3.4.4.

8.3.5 Trim and Incidental Finish. The total volume of combustible face trim, moldings, and decorations, including veneers, in any space shall not exceed a volume equivalent of 2.5 mm (0.1 in.) veneer on the combined area of the bulkheads and overhead. Such trim, molding, or decorations shall not perform any structural function.

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8.4 Furnishings. The fire performance of furnishings shall comply with 8.4.1 or 8.4.2 through 8.4.6 as required by Chapters 10 through 21.

8.4.1 Furnishings within spaces other than in exits and exit accesses that are fully protected by sprinkler or water mist systems shall not be required to meet the requirements of 8.4.2 through 8.4.6.

8.4.2* Upholstered Furniture. Upholstered furniture shall comply with ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture Items*, with a maximum rate of heat release of 80 kW and a maximum total heat released, within the first 10 minutes of test, of 25 MJ.

8.4.3 Mattresses, Mattress Pads, and Mattresses with Foundations.

8.4.3.1 Mattresses, mattress pads, and mattresses with foundations shall comply with 16 CFR 1632, "Standard for the Surface Flammability of Mattresses and Mattress Pads."

8.4.3.2* Mattresses, mattress pads, and mattresses with foundations shall exhibit a maximum rate of heat release of 100 kW and a maximum total heat released, within the first 10 minutes of test, of 25 MJ when tested in accordance with ASTM E 1590, *Standard Test Method of Fire Testing of Mattresses*.

8.4.4 Case Furniture.

8.4.4.1 Case furniture constructed entirely of noncombustible materials, with a maximum 3 mm (0.12 in.) thickness of combustible veneer, shall be permitted to be used if the veneer meets the requirements of 8.3.3.

8.4.4.2 Case furniture shall be permitted to be constructed of materials that meet heat and smoke requirements when tested in accordance with ASTM E 2257, *Standard Test Method Room Fire Test of Wall and Ceiling Materials and Assemblies*, or ISO 9705, *Room Fire Test in Full Scale for Surface Products*. The ASTM E 2257 or the ISO 9705 test shall be conducted with the ignition source at 100 kW for 10 minutes and then at 300 kW for an additional 10 minutes, and the room shall be lined on three walls and ceiling. The following test requirements shall be met:

(1) Flashover shall not occur during the test.
(2) The 30-second average rate of heat release shall not exceed 500 kW.
(3) The overall average rate of heat release shall not exceed 100 kW.
(4) The 60-second average rate of smoke production shall not exceed 8.3 m^2/sec.
(5) The overall average rate of smoke production shall not exceed 0.25 m^2/sec.

8.4.5* Draperies. Draperies or other vertically hung textiles shall be constructed with materials that pass NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, or Part 7 of the IMO *Fire Test Procedures Code*.

8.4.6* Stacking Chairs. Stacking chairs either shall be constructed of noncombustible materials or shall exhibit fire performance such that each stacking chair is incapable of causing flashover in the space on its own. Stacking chairs shall be chairs that are capable of being stacked vertically in groups of three or more. Each chair in a stack shall comply with the requirements for fire performance of upholstered furniture stated in 8.4.2.

8.4.7* Nonmetallic Rubbish Containers. Nonmetallic rubbish containers exceeding a capacity of 5.3 ft^3 [40 gal (0.15 m^3)] shall be manufactured of materials having a peak rate of heat release not exceeding 300 kW/m^2 at a flux of 50 kW/m^2 when tested in accordance with ASTM E 1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, or with NFPA 271, *Standard Method of Test for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*.

8.4.8 Combustible Waste and Refuse.

8.4.8.1 Combustible waste and laundry containers exceeding a capacity of 5.3 ft^3 [40 gal (0.15 m^3)] shall be stored in metal containers with tight-fitting lids.

8.4.8.2 Such containers shall be permanently labeled to indicate capacity and peak rate of heat release.

8.5 Fire Safety Requirements of Electrical and Fiber Optic Wires and Cables. Unless otherwise stated, the term *cable* includes all electrical and fiber optic wires and cables.

8.5.1 Cables shall be permitted to be installed in merchant vessels if they meet the requirements of Section 9.6 and either 8.5.1.1 or 8.5.1.2.

8.5.1.1 Cables listed as meeting the requirements of IEEE 1202, *Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies*, or of "Vertical Flame Test — Cables in Cable Trays," in CSA C 22.2, No. 0.3-01, *Test Methods for Electrical Wires and Cables*, or ANSI/UL 1581, Section 1164, *Reference Standard for Electrical Wires, Cables and Electrical Cords*, with damage (char length) not exceeding 1.5 m (4 ft 11 in.).

8.5.1.2 Grounding requirements shall not apply to cables listed as meeting the requirements of mineral-insulated metal-sheathed cable (Type MI, Article 330 of NFPA 70, *National Electrical Code*), metal-clad cable (Type MC, Article 334 of NFPA 70, *National Electrical Code*), or armored cable (Type AC, Article 333 of NFPA 70, *National Electrical Code*).

8.5.1.3 Cables listed as meeting the requirements of riser cables or plenum cables, according to 8.5.3, shall be considered to satisfy the requirements of 8.5.1.1. Cables meeting the requirements of 8.5.1.1 shall be permitted to be installed in vertical runs that penetrate more than one floor, in shafts (risers), or in ducts, plenums, and other spaces used for environmental air, if enclosed in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, metal wireway, surface metal raceway with metal cover, flexible metal conduit, or liquidtight flexible metal conduit.

8.5.1.4 Cables listed as meeting the requirements of 8.5.1.1 that have limited-smoke characteristics shall be permitted to be identified with the suffix LS. A cable shall be permitted to be listed as having limited-smoke characteristics if the cable damage height does not exceed 1.5 m (4 ft 11 in.) when measured from the lower edge of the burner face, the total smoke released is 150 m^2 (1615 ft^2) or less, and the peak smoke release is 0.40 m^2/sec (4.31 ft^2/sec) or less when tested in accordance with the FT4/IEEE 1202 vertical tray flame exposure described in UL 1685, *Standard for Vertical-Tray Fire Propagation and Smoke-Release Tests for Electrical and Optical Fiber Cables*.

8.5.2 Cables installed in merchant vessels shall be listed.

8.5.2.1 Nonmetallic Sheathed Cable. Type NM shall meet the requirements of Article 336 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply.

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8.5.2.2 Power and Control Tray Cables.

8.5.2.2.1 Type TC shall meet the requirements of Article 340 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply. These cables shall be used for control, indicating, communication, electronic, and similar circuits where multiple parallel conductor cables are required. Type TC tray cable shall be permitted to be used for the following purposes:

(1) For power, lighting, control, and signal circuits
(2) In cable trays, or in raceways, or where supported in outdoor locations by a messenger wire
(3) In cable trays in hazardous (classified) locations where the conditions of maintenance and supervision ensure that only qualified persons will service the installation
(4) For Class 1 circuits as permitted in 8.5.2.4.1
(5) For non-power-limited fire alarm circuits if conductors comply with the requirements of Section 760.67 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply

8.5.2.2.2 Type TC tray cables shall not be installed under the following conditions:

(1) Where they will be exposed to physical damage
(2) As open cable on brackets or cleats
(3) Where they will be exposed to direct rays of the sun, unless identified as sunlight resistant

8.5.2.3* Cables Supplying Information Technology and Data Processing Equipment. Power cables, communications cables, connecting cables, and interconnecting cables associated with data processing and information technology equipment shall be permitted under a raised floor or in a concealed space with a minimum B-0 fire resistance rating, provided the cables are installed in accordance with the requirements of 46 CFR Subchapter J, "Electrical Engineering," and UL 1309, *Standard for Marine Shipboard Cable*, or with IEEE Standard 45, *Recommended Practice for Electrical Installations on Shipboard*, and Section 300.11 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply. Cables meeting the requirements of 8.5.1.1 shall be listed as Type DP cable.

8.5.2.4 Remote-Control, Signaling, and Power-Limited Circuits. Remote-control, signaling, and power-limited circuits that are not an integral part of a device or appliance shall meet the requirements of Article 725 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply. These cables shall be selected in accordance with ANSI/UL 13, *Standard for Power-Limited Circuit Cables*.

8.5.2.4.1 Class 1 circuits are the portion of the wiring system between the load side of the overcurrent device or power-limited supply and the connected equipment. They shall be classified as follows:

(1) *Class 1 Power-Limited Circuits.* These circuits shall be supplied from a source having a rated output of not more than 300 volts and 1000 volt-amperes.
(2) *Class 1 Remote-Control and Signaling Circuits.* These circuits shall not exceed 600 volts; the power output of the source shall not be required to be limited.

8.5.2.4.2 Class 2 and Class 3 Circuits. Class 2 circuits shall be the portion of the wiring system between the load side of a Class 2 power source and the connected equipment. Class 3 circuits shall be the portion of the wiring system between the load side of a Class 3 power source and the connected equipment. Class 2 and Class 3 power sources shall meet the requirements described in Section 725.41 of NFPA 70, *National Electrical Code*.

8.5.2.5 Fire Alarm Systems. The wiring and equipment for fire alarm systems shall meet the requirements of Article 760 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply.

8.5.2.6 Optical Fiber Cables and Raceways. Optical fiber cables transmit light for control, signaling, and communications through an optical fiber. The wiring and equipment for optical fiber cables shall meet the requirements of Article 770 of NFPA 70, *National Electrical Code*.

8.5.2.7 Communications Systems. Wiring for telephone, telegraph (except radio), exterior wiring for fire alarm and burglar alarm, and central station wiring systems shall meet the requirements of Article 800 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply. These cables shall be selected in accordance with UL 444, *Standard for Communications Cables*.

8.5.2.8 Radio and Television Equipment. Wiring for antennas for radio and television equipment, including radio transmitting and receiving equipment, shall meet the requirements of Article 810 of NFPA 70, *National Electrical Code*, except that grounding requirements shall not apply.

8.5.2.9 Type CWCMC Cable. Continuously corrugated metal clad (CWCMC) cable shall meet the requirements of UL 1309, *Standard for Marine Shipboard Cable*, and shall be used exclusively in areas that are not subjected to repeated flexing or bending, high vibration, or twisting and that are not subjected to excessive movement between units.

8.5.2.10 Heat Tracing Cables. Heat tracing cables installed in merchant vessels shall meet the requirements of IEEE 515, *Standard for the Testing, Design Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications*, and the recommendations of IEEE 844, *Recommended Practice for Electrical Impedance, Induction, and Skin Effect Heating of Pipelines and Vessels*.

8.5.3 Applications of Cables.

8.5.3.1 Plenum. Cables installed in ducts, plenums, and other spaces used for environmental air shall be listed as suitable for use as plenum cables, by virtue of having adequate fire-resistant and low smoke-producing characteristics. Cables shall be listed as plenum cables by establishing an acceptable value of the smoke produced when tested in accordance with NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*, to a maximum peak optical density of 0.5 and a maximum average optical density of 0.15, and a maximum allowable flame travel distance of 1.52 m (5 ft).

8.5.3.2 Wiring Methods. Wiring methods listed for use in plenums or other spaces used for environmental air and consisting of Type MI cable, or Type MC cable employing a smooth or corrugated impervious metal sheath without an overall nonmetallic covering shall be permitted for use in plenums. Cables and conductors installed in electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, rigid metal conduit, flexible metal conduit or, where accessible, surface metal raceways or metal wireways with metal covers shall also be permitted for use in plenums. Wiring material with a nonmetallic enclosure listed for use in plenums by virtue of having adequate fire-resistant and low smoke-producing characteristics shall be permitted for such use.

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8.5.3.3 Riser. Cables installed in vertical runs and penetrating more than one floor, or cables installed in a shaft shall be listed as suitable for use as riser cables by virtue of having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor. Cables listed for use as plenum cables shall be permitted for use as riser cables. Cables shall be listed as riser cables if they pass the requirements of ANSI/UL 1666, *Standard for Test for Flame Propagation Height of Electrical and Optical Fiber Cable Installed Vertically in Shafts.*

8.5.3.4 Tray. All other cables installed in merchant vessels shall be listed as suitable for use as tray cables by virtue of being resistant to the spread of fire. Cables listed for use as plenum cables shall be permitted for use as tray cables. Cables listed for use as riser cables shall be permitted for use as tray cables. Cables that are flame retardant and have limited-smoke characteristics shall be permitted to be identified with the suffix LS. Cables shall be listed as meeting the requirements of tray cables if they meet the requirements of IEEE 1202, *Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies*, or of "Vertical Flame Test — Cables in Cable Trays," in CSA C22.2, No. 0.3-01, *Test Methods for Electrical Wires and Cables*, with damage (char length) not exceeding 1.5 m (4 ft 11 in.). A cable shall be permitted to be listed as having limited-smoke characteristics if the cable damage height does not exceed 1.5 m (4 ft 11 in.) when measured from the lower edge of the burner face, the total smoke released is 150 m^2 (1615 ft^2) or less, and the peak smoke release rate is 0.40 m^2/sec (4.31 ft^2/sec) or less when tested in accordance with the FT4/IEEE 1202 vertical tray flame exposure described in UL 1685, *Standard for Vertical-Tray Fire Propagation and Smoke-Release Tests for Electrical and Optical Fiber Cables.*

Chapter 9 Vessel Services and Fire Detection and Protection Equipment

9.1* Fire Detection, Alarm, and Communications Systems.

9.1.1 Application. Fire detection, alarm, and communications systems shall meet the requirements of Section 9.1 and comply with 46 CFR 161.002 or meet the requirements of *NFPA 72, National Fire Alarm Code.* Nothing in this system shall be construed as a restriction on new technologies or alternatives to those requirements, provided that the level of protection is maintained.

9.1.2 Installation Requirements. Fire detection, alarm, and communications systems shall be installed in accordance with 46 CFR 161.002, "Fire Protection Systems (Fire Detection Systems)," or meet the requirements of *NFPA 72, National Fire Alarm Code.*

9.1.3 Design Requirements. Fire detection, alarm, and communications systems shall meet design requirements of 46 CFR 161.002, "Fire Protection Systems (Fire Detection Systems)," or meet the requirements of *NFPA 72, National Fire Alarm Code.*

9.1.3.1 Fire detection, alarm, and communications equipment and devices shall be listed for marine use.

9.1.3.2 The installation of all wiring, cable, and power equipment shall be in accordance with Section 9.6.

9.1.4 Inspection, Testing, and Maintenance of Fire Alarm and Detection Systems. To ensure operational integrity, the fire detection and alarm system shall be maintained and tested in accordance with the requirements of Chapter 10 of *NFPA 72, National Fire Alarm Code.*

9.2 Fire Protection Systems and Equipment.

9.2.1 General. Components and machinery installed in fire protection systems shall be designed so as to ensure proper operations in a marine environment aboard a vessel under inclination conditions cited in American Bureau of Shipping, *Rules for Building and Classing Steel Vessels Under 90 Meters in Length*, Part 4, Section 1, Table 4/1.1.

9.2.2* Foam-Water Sprinkler and Spray Systems. Foam deluge systems shall be listed and shall be designed and installed in accordance with 46 CFR 76.17, "Fire Protection Equipment (Foam Extinguishing Systems, Details)."

9.2.3 Pressure Tanks. Pressure tank(s) that support sprinkler systems shall be designed and installed in accordance with NFPA 22, *Standard for Water Tanks for Private Fire Protection*, and NFPA 13, *Standard for the Installation of Sprinkler Systems.* Foam systems shall be installed in accordance with 9.2.9.

9.2.4 Drainage and Dewatering. Vessels protected by water-based extinguishing systems shall be designed to remove water from those vessels at a rate no less than the maximum possible rate of water admittance from the extinguishing system.

9.2.5 Automatic Engine Shutdown. Where fixed gaseous extinguishing systems are installed in spaces that contain internal combustion engines that draw intake air from within the protected space, automatic engine shutdowns shall be provided upon actuation of the extinguishing system.

9.2.6 Inspection, Testing, and Maintenance. All water-based systems required by this code shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

9.2.7 Automatic Sprinklers. Where required, automatic sprinkler systems shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

9.2.8 Water Mist Systems. Water mist systems shall be listed and designed in accordance with NFPA 750, *Standard on Water Mist Fire Protection Systems.*

9.2.9 Low-Expansion Foam Systems. Low-expansion foam systems shall be listed, designed, and installed in accordance with NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam.*

9.2.10 Carbon Dioxide Extinguishing Systems. Carbon dioxide extinguishing systems shall be listed, designed, and installed in accordance with 46 CFR 76.15, "Fire Protection Equipment," 34.15, "Firefighting Equipment," and 95.15, "Fire Protection Equipment."

9.2.11 Clean Agent Systems. Clean agent systems shall be listed, designed, and installed in accordance with NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems.*

9.2.12 Halon Systems. No new halon extinguishing systems shall be installed.

9.2.13 Inert Gas Systems. On vessels that have cargo tanks where an inert gas system is required, the inert gas system shall be installed in accordance with SOLAS II-2, Regulation 62.

9.2.14 Dry and Wet Chemical Extinguishing Systems. Dry and wet chemical systems shall be in accordance with NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, and NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, respectively.

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9.2.15 Portable Fire Extinguishers.

9.2.15.1 Portable fire extinguishers (including mounting) shall be listed for marine use and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

9.2.15.2 Extinguishers shall be classed in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

9.2.16 Fire Main, Fire Pumps, Hydrants, and Hose.

9.2.16.1 General. Each vessel shall have an installed fire main, pumps, hydrants, hose, hose accessories, and nozzles and shall be capable of delivering the required supply of water to all portions of the vessel for the purpose of fighting fires, in accordance with SOLAS II-2 Regulation 4 as modified by 9.2.16.2 through 9.2.16.11. This provision shall not apply where indicated in 9.2.16.1.1 through 9.2.16.1.4.

9.2.16.1.1 This section shall not apply if provided otherwise by Chapters 10 through 21.

9.2.16.1.2 Fog applicators shall not be required at fire stations when fire hose located at such fire stations are outfitted with variable pattern nozzles meeting NFPA 1964, *Standard for Spray Nozzles (Shutoff and Tip)*.

9.2.16.1.3 Reference to American Bureau of Shipping, *Rules for Building and Classing Steel Vessels Under 90 Meters in Length*, Part 4, Section 9.5 through Section 9.9 in lieu of SOLAS II-2, Regulation 4 shall be acceptable when determining a vessel's fire main, fire pump, hydrant, and hose requirement.

9.2.16.1.4 Fire main piping and pumps shall be permitted to be combined and sized to simultaneously supply water-based fire suppression systems in accordance with Section 9.2.

9.2.16.2* Fire Main Pressure. The fire main pressure shall be sufficient to support all provided fire-fighting equipment as recommended by the manufacturer of the equipment.

9.2.16.3 Diesel Engine Starting Arrangements. Engines shall be provided with a starting arrangement that utilizes stored energy and supervises the adequacy of the stored energy.

9.2.16.3.1 These means shall enable the diesel-driven power source to be started at least 6 times within a period of 30 minutes and at least twice within the first 3 minutes.

9.2.16.3.2 Any diesel-driven power source for the pump shall be capable of being started in its cold condition down to a temperature of 0°C (32°F) by manual cranking.

9.2.16.3.3 If lower temperatures are likely to be encountered, heating arrangements shall be provided so that starting will be assured.

9.2.16.3.4 The pump controller shall be listed or approved.

9.2.16.4 Required Fuel Reserves for Fire Pumps. Any service fuel tank shall contain sufficient fuel to enable the pump to run on full load for at least 3 hours, and sufficient reserves of fuel shall be available outside the main machinery space to enable the pump to be run on full load for an additional 15 hours.

9.2.16.5 Location of Fire Pump. Where located in a space other than a machinery space, the space containing the fire pump shall be insulated to a standard of structural fire protection equivalent to that required in Chapter 13 for a control station. No direct access shall be permitted between the machinery space and the space containing the emergency fire pump and its source of power, except that a remote-operated, watertight door shall be permitted, provided remote operation is from the bridge, engineering control station, and fire control station, if any.

9.2.16.6 Ventilation Requirements. Ventilation arrangements to the space containing the independent source of power for the emergency fire pump shall be such as to preclude, as far as practicable, the possibility of smoke from a machinery-space fire entering or being drawn into that space.

9.2.16.7* Fire Main Water Supply. In machinery spaces that are periodically unattended or when only one person is required on duty, water delivery from the fire main system shall be possible without entering the machinery space.

9.2.16.8 Operation of Fire Pumps. Fire pumps shall be capable of being started at the pump and from the central control station.

9.2.16.9 International Shore Connection. International shore connections shall be designed and installed in accordance with SOLAS II-2, Regulation 19.

9.2.16.10 Fire Hose. Fire hose shall be listed in accordance with UL 19, *Standard for Safety Lined Fire Hose and Hose Assemblies*. At least one length of hose shall be provided for each hydrant. Hose shall be connected to hydrants at all times, unless otherwise provided for in 9.2.16.11.

9.2.16.11 Fire Hose on Open Decks. On open decks where no protection is afforded to the hose in heavy weather, or where the hose is susceptible to damage from the handling of cargo, the hose shall be permitted to be removed from the hydrant and stowed in an accessible nearby location.

9.3 Fire Fighter Protective Clothing, SCBA Equipment, and Fire Control Plans.

9.3.1 Fire Fighter Protective Clothing. Personal fire-fighting protection equipment shall include protective clothing and a flashlight and self-contained breathing apparatus (SCBA). All fire fighter protective clothing shall consist of turnout gear, helmet, gloves, boots, and hood and shall comply with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Such equipment shall be located in vessel areas that allow for ready fire fighter access and easy donning.

9.3.2 Self-Contained Breathing Apparatus (SCBA). SCBA units and spare cylinders shall comply with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, be NIOSH-certified for an open-circuit pressure-demand type, have a full facepiece, and be rated for a minimum of 30 minutes.

9.3.2.1 A minimum of one spare SCBA cylinder shall be maintained for each required SCBA unit and all SCBA cylinders shall be interchangeable. All SCBA units outfitted aboard a vessel are to be of like kind (i.e., make, model, and manufacturer).

9.3.2.2 All SCBA units and cylinders shall be maintained operational in accordance with the manufacturers' recommendations, and maintenance records shall be maintained aboard the vessel.

9.3.2.3 The required number of SCBA units to be carried for fire-fighting purposes shall be in accordance with Chapters 19 through 21.

9.3.2.4 Storage of the SCBA units shall allow for ready donning by the fire fighter. All SCBA units shall be protected from the weather when not in use.

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9.3.2.5 SCBA Recharging Systems. Where required by Chapters 10 through 21, an installed SCBA recharging system shall comply with the requirements in Section 9.3.

9.3.2.5.1* Type of SCBA Recharge or Refill Systems. SCBA air refill systems shall be permitted to consist of any combination of the following to achieve the required air refill capacity:

(1) Air compressor with air purification and refill station system
(2) Fixed air reservoirs (single or manifold storage bottles in cascade arrangement)
(3) Additional filled spare SCBA cylinders fitted with integral pressure gauges and fill indicator

9.3.2.5.1.1 SCBA recharge systems shall be permitted to be used for other vessel requirements such as scuba cylinder recharging, provided safeguards are in place to ensure the quality of air to fill the SCBA is not degraded and the system continues to meet the minimum SCBA recharge requirements of 9.3.2 at all times.

9.3.2.5.2 SCBA Recharge Compressors. Oil or oil-less compressor systems shall be acceptable. Recharge compressors shall have air purification systems installed to meet the air quality standard cited in Section 9.3. SCBAs being charged shall be contained in air refill stations to protect the operator from SCBA explosion. Connecting air tubing shall comply with 46 CFR 56, "Piping Systems and Appurtenances." Compressors shall have over-pressurization safety valve(s) installed, and they shall not be capable of being isolated. Audible and visual alarms shall be installed to indicate unacceptable air output. Operating and safety instructions and systems schematic shall be permanently mounted on or near the compressor unit in plain view of the operator to address compressor, purification, and refill operations.

9.3.2.5.3 Fixed Air Reservoirs (Storage Bottles) Requirement. Storage cylinders shall comply with 49 CFR 173.34, "Qualification, Maintenance and Use of Cylinders." Connecting tubing shall comply with 46 CFR 56, "Piping Systems and Appurtenances." Cylinders shall be mounted vertically and shall be secured to the structure of the vessel. Cylinder bottoms shall not sit directly on steel decking. Cylinders shall be arranged to facilitate inspection, testing, and maintenance of the cylinders and tubing.

9.3.2.6 SCBA Recharge System Capacity and Spare Cylinder Quantity. A recharge rate and spare cylinder quantity shall meet the requirements needed to support the largest anticipated fire team considered necessary for the worst case, machinery space fire re-entry scenario.

9.3.2.6.1 One or both of the following requirements shall be met:

(1) There shall be a recharge system rate to support a minimum of three consecutive fire team entries.
(2) There shall be charged spare cylinders to support a minimum of three consecutive fire team entries.

9.3.2.7 Air Quality of SCBA Recharge System Air. All compressed air used to refill SCBA cylinders and contained in SCBA cylinders shall comply with the requirements of the Compressed Gas Association, *Commodity Specifications for Air*, G-7.1 for Grade E, 25 ppm water–vapor air.

9.3.2.8 Location of Recharge Facilities. Recharge facilities shall be located where access will not be cut off in the event of a fire or heavy smoke. Recharge facilities shall be protected from the effects of weather and mechanical damage.

9.3.2.9 Emergency Power. Electrically driven air compressors shall have an automatic means for receiving power from the emergency bus.

9.3.2.10 Compression Air Supply Source. Air compressors shall be fitted with air inlets that take suction from weather and have minimal chance of ingesting smoke, exhaust air from exhaust vents, diesel exhaust, foul air, or other source of noxious substances.

9.3.2.11 Testing, Inspection, and Maintenance. Air recharge systems and equipment shall be inspected, tested, and maintained in accordance with manufacturers' recommendations.

9.3.2.12 Availability of SCBA Refill Systems. The SCBA refill systems shall be ready for immediate use at all times while the vessel is considered to be in an operational status, whether at sea or in port.

9.3.3 Fire Control Plans. All vessels shall be provided with fire control plans that comply with ASTM F 1626, *Standard Practice for Preparing Shipboard Fire Control Plans*, and that shall be mounted in accordance with SOLAS II-2, Part A, Regulation 20.

9.4 Ventilation. See Annex B.

9.4.1* General. Depending on the space requirements, ventilation air shall be permitted to be supplied and exhausted by natural draft, mechanical means, or a combination of both. Because the ductwork for a ventilation system is common to many spaces, it can cause the spread of flame or smoke and shall therefore be evaluated as a component of the vessel's structural fire protection system.

9.4.2 Ducting Design.

9.4.2.1 Ventilation ducting shall be constructed of noncombustible materials and shall not degrade the integrity of the A-, B-, or C'-Class divisions or smokeproof enclosures that the ducting could penetrate.

9.4.2.1.1 Duct sections shall be permitted to be constructed of combustible material only if the criteria in 9.4.2.1.1.1 through 9.4.2.1.1.5 are all met.

9.4.2.1.1.1 The duct is less than 2.0 m (6.56 ft) long.

9.4.2.1.1.2 The duct is less than or equal to 0.02 m^2 (0.215 ft^2) in cross-sectional area.

9.4.2.1.1.3 The material of construction of the duct shall exhibit a flame spread index not to exceed 20 and a smoke developed index not to exceed 10 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, or with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

9.4.2.1.1.4 The duct shall be used only at the end of a ventilation device.

9.4.2.1.1.5 The duct shall be located at least 600 mm (23.6 in.) from an opening in an A-, B-, or C'-Class division.

9.4.2.2 Penetrations of A-Class Divisions.

9.4.2.2.1 Penetrations of A-Class divisions shall be tightfitting in accordance with one of the following methods:

(1)*The duct shall be continuously welded to one side of the division.
(2) The duct shall be flanged, with the flanges bolted to both sides of the division.

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(3) The duct shall be sealed using an approved firestop in accordance with ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Firestops*.

9.4.2.2.2 Where ducting penetrates an A-Class division, an automatic A-Class fire damper complying with 9.4.3 shall be installed.

9.4.2.3 Penetrations of B-Class Divisions. Penetrations of B-Class divisions shall comply with one of the following:

(1) The duct shall be tightfitting where the duct meets B-Class integrity.
(2) The duct shall be fitted with an automatic fire damper complying with 9.4.3.
(3) The duct shall meet the requirements of an A-Class penetration.

9.4.2.4 Vent ducting and fans serving stairway enclosures shall serve no other spaces.

9.4.2.5 In all ventilation systems, manually operated dampers shall be provided in accessible locations to shut off the passage of air in the event of fire. The means for manual damper control shall be located in an unlocked compartment, outside the spaces served by the ventilation system.

9.4.2.6 Insulation of Ducts. Any insulation installed for heat, comfort, refrigeration (including air conditioning), or for any other purpose, and all material incidental to the installation, shall be made of approved, noncombustible materials. Ducts penetrating divisions shall be insulated to either of the following requirements:

(1) Insulation providing the same protection as the penetrated division shall be applied to the duct for a distance of 300 mm (12 in.) from the division.
(2) Penetrations tested to Part 3 of the IMO *Fire Test Procedures Code* shall be insulated as tested.

9.4.3 Damper Design. Where required, fire dampers shall comply with the requirements of Section 9.4, except as permitted in 9.4.3.1.

9.4.3.1 Fire dampers listed for 1½–hour fire endurance that are capable of manual operation and fitted adjacent to the bulkhead shall be permitted.

9.4.3.2 The damper and the portion of the duct containing the damper shall be constructed of at least 3.0 mm steel (in A-Class bulkhead penetration) or 1.6 mm steel (in B-Class bulkhead penetration), except as indicated in 9.4.3.3. A maximum 3.0 mm (0.125 in.) gap between the blade and casing shall be permitted. All springs, hinges, and other damper components shall be constructed of stainless or protected steel to prevent corrosion. No insulation shall be necessary on the damper blade. The damper shall be accessible for periodic inspection by means of a hinged or bolted plate in the duct. All dampers shall be capable of manual operation.

9.4.3.3 Dampers that prevent the passage of smoke and flame for 1½ hours when tested according to ANSI/UL 555S, *Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems*, or meet Part 3 of the IMO *Fire Test Procedures Code* shall be acceptable.

9.4.3.4 Where automatic fire dampers are required, they shall be provided with a fusible link assembly rated at approximately 74°C (165°F).

9.4.3.4.1 In high ambient heat areas, such as the exhaust duct leading from the galley, automatic dampers shall be provided with a fusible link assembly rated at approximately 100°C (212°F).

9.4.3.4.2 The dampers shall be arranged to close against the anticipated draft in the duct.

9.4.3.4.3 Other types of automatic dampers shall be permitted to be used, if approved.

9.4.3.5 Automatic fire dampers shall be fitted adjacent to the bulkhead.

9.4.3.5.1 The damper shall be fitted on at least one side of the bulkhead with a visible indicator showing whether the damper is in the open or closed position.

9.4.3.5.2 The local damper indicator shall be capable of always showing the actual position of the damper and shall be marked to indicate the damper position.

9.4.3.5.3 Dampers shall be capable of being remotely closed from the central control station or of being manually closed from both sides of the bulkhead.

9.4.4 Duct Heating Units.

9.4.4.1 Where installed, duct heaters shall be provided with a thermal overheat–protection safety device and interlocked with the fan to prevent the heater from operating when the fan is not operating. The heater shall be designed to limit the surface temperature of the heating element to a maximum of 232°C (450°F).

9.4.4.2 Space Heaters. Electric radiators and bulkhead-mounted convection space heaters shall be listed and installed in accordance with SOLAS II-2, Regulation 18.3 and Section 9.6 herein.

9.4.5 Ventilation Control.

9.4.5.1 Spaces serviced by a power ventilation system shall be provided with remote means for stopping the ventilation system that services it in case of a fire. The remote means shall be permitted to be located immediately outside the space, at the fire control station, and/or on the bridge.

9.4.5.2 Powered ventilation systems serving spaces protected by fixed-gas fire-extinguishing systems shall be capable of being secured prior to the discharge of the extinguishing agent.

9.4.5.2.1 The shutdown of the ventilation system and the means to close all vents shall be interlocked with and accomplished automatically by the operation of the fixed-gas fire-extinguishing system release mechanism.

9.4.5.2.2 Time for the ventilation system to run down and stop shall be allowed before actual release of the agent, or a make-up extinguishing agent shall be designed into the system.

9.4.5.3 Provisions to secure ventilation to the protected space from outside that space shall be provided for spaces having natural ventilation and protected by a fixed-gas fire-extinguishing system.

9.4.5.4 Requirements for activation of ventilation systems in smokeproof enclosures shall be in accordance with 7.2.3.9.

9.4.5.5 Electrical equipment subject to arcing shall be ventilated or placed in ventilated compartments where flammable gases, acidic fumes, or oil vapors cannot accumulate. Electrical requirements shall be in accordance with Section 9.6.

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9.4.6 Ventilation Through Doors. Vent grilles or louvers shall not be used in doors penetrating A-Class bulkheads, although such doors shall be permitted to be undercut not to exceed 13 mm (0.5 in.) above the door sill or the top of approved deck covering. Doors in B- or lesser-Class bulkheads shall be permitted to contain vent grilles or louvers with a net area not to exceed 0.2 m^2 (2 ft^2) in the lower half of the door and shall be permitted to be undercut not to exceed 25 mm (1 in.) above the door sill or the top of deck covering.

9.4.7 Ventilation for Spaces Containing High-Risk Fuels. In all spaces not designed specifically for the storage of fuel, an independent exhaust system, employing a nonsparking, centrifugal fan, shall be provided to exhaust these spaces. The exhaust shall discharge directly to the weather. The nonsparking fan shall be located outside of the space serviced and at least 3 m (10 ft) from the discharge end of the exhaust duct. Where this distance requirement cannot be met, the nonsparking fan shall be equipped with an explosion-proof motor.

9.4.8* Smoke-Control Ventilation. A smoke-control system shall confine smoke to the general area of fire origin, maintain use of the means of egress systems, and provide for the removal of smoke and heat by means of a fixed system or systems.

9.4.9 Plans, Marking, and Documentation. Ventilation equipment deemed necessary to operate in an emergency shall be shown on the fire-control plan per 9.3.3. All dampers shall be marked to indicate their open and closed positions. Remote damper shutdowns shall be clearly marked to identify the spaces served.

9.5 Elevators, Escalators, Dumbwaiters, and Other Transfer Devices. Vessel elevators and other vertical lift devices shall be designed in accordance with ASME A17.1, *Safety Code for Elevators and Escalators*. Testing and inspection procedures for shipboard elevators shall be in accordance with ASME A17.2, *Guide for Inspection of Elevators, Escalators, and Moving Walks*.

9.6* General Requirements for Electrical Equipment.

9.6.1 Design, installation, and maintenance of electrical equipment shall be in accordance with 46 CFR, Subchapter J, "Electrical Engineering," and the recommendations of IEEE 45, *Recommended Practice for Electric Installations on Shipboard*, and IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms*.

9.6.2 Wires and cables on merchant vessels shall comply with the requirements of UL 1309, *Standard for Marine Shipboard Cable*, or the recommendations of IEEE 45, *Recommended Practice for Electric Installations on Shipboard*, and IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms*.

9.6.3 Electrical and fiber optic wires and cables shall meet the fire safety requirements of Section 8.5 and IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms*.

9.7 Fixed Electric Heating Equipment for Pipelines, Vessels, De-icing, and Snow Melting. All fixed electric heating equipment installed on merchant vessels for heating pipelines and vessels, as well as electric heating equipment installed for prevention of ice formation on floors, decks, doors, or hatches, shall comply with Articles 426, 427, and 500 of NFPA 70, *National Electrical Code*.

Chapter 10 Accommodation Spaces

10.1 General Requirements.

10.1.1 Application. The requirements of Chapter 10 shall apply to all accommodation spaces.

10.1.2 Classification of Occupancy.

10.1.2.1* Subclassification of Accommodation Occupancies. Accommodation spaces shall be limited to combustible fire loads no greater than 37.5 kg/m^2 (7.5 lb/ft^2) and shall be subclassified as follows:

(1) High risk contains a fuel load greater than 15 kg/m^2 (3 lb/ft^2) and less than or equal to 37.5 kg/m^2 (7.5 lb/ft^2).
(2) Medium risk contains a fuel load greater than 5 kg/m^2 (1 lb/ft^2) and less than or equal to 15 kg/m^2 (3 lb/ft^2).
(3) Low risk contains a fuel load less than or equal to 5 kg/m^2 (1 lb/ft^2).

10.1.2.2 Accommodation spaces, on vessels that are fully sprinklered in accordance with 9.2.7 or fully protected with a water mist system in accordance with 9.2.8, shall be considered low risk.

10.1.3 Minimum Construction and Minimum Separation Requirements. Accommodation spaces shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 10.1.3. Decks shall be constructed in accordance with 8.2.1.

10.1.4 Occupant Load.

10.1.4.1* Occupant Load Factors. The occupant load permitted in any accommodation space shall be determined on the basis of the following occupant load factors:

(1) *Fixed seating criterion*. Design capacity.
(2) *Public spaces without fixed seating*. One person for each 1 m^2 (10 ft^2) of gross deck area and 0.65 m^2(7 ft^2) of net deck area. The occupant load of any open mezzanine or balcony shall be added to the deck below for the purpose of determining exit capacity.
(3) *Staterooms and office areas*. Design capacity.
(4) *Public sales (shops) areas*. One person per each 3 m^2 (32 ft^2) of gross deck area.
(5) *Bleachers, pews, and other bench-type seating*. One person per 45 linear cm (18 linear in.).

10.1.4.1.1 For a space with mixed occupant load factors that contain flexible arrangements, the arrangement that would yield the highest occupancy load shall apply.

10.1.4.2 Occupant load shall be permitted to be increased above that permitted by 10.1.4.1 if the necessary aisles and exits are provided.

10.1.4.2.1 To increase the occupant load, a diagram indicating placement of equipment, aisles, exits, and seating shall be provided to, and approved by, the authority having jurisdiction prior to any increase in occupant load.

10.1.4.2.2 In areas not greater than 750 m^2 (8073 ft^2) the occupant load shall not exceed 1 person in each 0.5 m^2 (5.5 ft^2).

10.1.4.2.3 In areas greater than 750 m^2 (8073 ft^2) the occupant load shall not exceed 1 person in 0.65 m^2 (7 ft^2).

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Table 10.1.3 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements		
	High-Risk Accommodation Areas	Medium-Risk Accommodation Areas	Low-Risk Accommodation Areas
High-risk accommodation	B-15	B-15	B-15
Medium-risk accommodation	B-15	B-0	B-0
Low-risk accommodation	B-15	B-0	C'
Medical, health care, and child care	B-15	B-15	B-0
High-risk service	A-60	A-0	A-0
Low-risk service	B-15	B-15	B-0
Electrical and control	A-60	A-0	B-0
Low-risk engineering and machinery	A-0	A-0	B-0
High-risk engineering and machinery	A-60	A-60	A-60
High-risk storage	A-60	A-60	A-0
Low-risk storage	B-15	B-0	C
Cargo	A-60	A-0	A-0
Open deck	A-0	A-0	C'
Helicopter deck	A-60	A-60	A-60
Voids	A-0	A-0	C'

10.2 Means of Egress Requirements.

10.2.1 General. All means of egress shall be in accordance with Chapter 7 and Section 10.2.

10.2.2 Means of Egress Components.

10.2.2.1 General. Components of means of egress shall be limited to the types described in 10.2.2.2 through 10.2.2.3.

10.2.2.2 Doors. Doors shall comply with 7.2.1.

10.2.2.3 Ramps. Ramps shall comply with 7.2.5 or with 10.2.2.4.

10.2.2.4 Ramps serving only stages or nonpublic areas and ramped aisles shall be permitted to have a slope not steeper than 1 in 8.

10.2.3 Means of Egress Arrangement.

10.2.3.1 At least two separate exit accesses shall be provided. Each exit access shall be remotely located from the other as required by Section 7.5, except that a single exit access shall be permitted in any of the following exit areas:

(1) Staterooms
(2) Office areas with an occupant load less than 20, provided the exit access is directly into an exit access corridor
(3) Public sales areas (shops) where the exit access opens directly to an exit access corridor

10.2.3.2 All accommodation spaces with an occupant load greater than 500 shall be provided with at least 3 separate means of egress. Public spaces with an occupancy greater than 1000 shall have at least 4 separate means of egress.

10.2.3.3 Mezzanines having an occupant load not greater than 30 shall be permitted to be served by a single means of egress, and such means of egress shall be permitted to lead to the deck below.

10.2.3.4 Mezzanines having an occupant load greater than 30, but not more than 60, shall have at least 2 remote means of egress, but both such means of egress shall be permitted to lead to the deck below.

10.2.3.5 Mezzanines having an occupant load greater than 60 shall have means of egress provided as for a separate deck.

10.2.4 Travel Distance to Exits. In fully sprinklered vessels, exits shall be arranged so that the total length of travel from any point to reach an exit shall not exceed 45 m (147.6 ft). In all other vessels, travel distances to an exit shall not exceed 30 m (98.4 ft).

10.2.5 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

10.2.6 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

10.3 Protection.

10.3.1 Protection of Miscellaneous Openings in Fire Barriers. All penetrations shall be protected in accordance with 8.2.4.9, except as indicated in 10.3.1.1 or 10.3.1.2.

10.3.1.1 Ducting installed in connection with air-handling systems that service accommodation occupancies and that utilize passageways as part of their return air system shall not be required to meet the fire resistance rating of the connecting barrier if it meets the requirements in 10.3.1.1.1 through 10.3.1.1.3.

10.3.1.1.1 The duct penetration of the barrier shall be installed low, such that no portion of the ductwork is higher than 50 cm (19.7 in.) above the deck.

10.3.1.1.2 The cross-sectional area of the penetration shall not exceed 0.05 m^2 (0.54 ft^2).

10.3.1.1.3 The duct shall not provide a direct connection between the originating compartment and the passageway; that is, the duct shall terminate in a utility space adjoining both the passageway and originating compartment.

10.3.1.2 Vertical ventilation ducts that service cargo or main machinery spaces that pass through accommodations or safety areas shall be insulated to the applicable division requirements for 1.8 m (6 ft) beyond the division.

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10.3.2 Interior Finish. Interior finish shall comply with Section 8.3.

10.3.3 Furnishings.

10.3.3.1 Furnishings shall comply with Section 8.4.

10.3.3.2 The combustibility of furniture installed in high-risk accommodation spaces shall not be restricted as to the materials of construction.

10.3.4 Detection, Alarm, and Communication Systems.

10.3.4.1 All accommodation spaces shall be provided with a manual alarm system in accordance with Section 9.1.

10.3.4.2 All overnight accommodation spaces shall be provided with a smoke detection system in accordance with Section 9.1 that additionally provides an audible alarm at the actuated device. Where suites of overnight accommodations are interconnected and intended for use by a single occupant or group of occupants, the smoke detectors shall be arranged such that activation of one smoke detector in the suite shall cause the audible alarm for all of the smoke detectors in the suite to activate.

10.3.4.3* Smoke detectors shall be installed in all stairways, corridors, and means of egress serving accommodation spaces. Where smoke detectors are installed within ducts, they shall be listed for that purpose.

10.3.4.4 Occupant notification shall be by means of voice announcements, initiated by a person in a central control station.

10.3.4.4.1 The public address system shall provide at least 75 decibels and at least 10 decibels above the background noise in all areas occupied by passengers and crew.

10.3.4.4.2 The public address system shall be supplied with a backup emergency source of power.

10.3.5 Extinguishment Requirements. Unless otherwise provided for in Chapters 19 through 21, all overnight accommodation spaces shall be protected throughout with an automatic sprinkler system in accordance with 9.2.7 or with an automatic water mist system in accordance with 9.2.8.

Chapter 11 Medical, Health Care, and Child Care Spaces

11.1 General Requirements.

11.1.1 Application. Medical, health care, and child care spaces shall comply with Chapter 11.

11.1.2 Special Term: Hospital. See 3.3.37.

11.1.3 Minimum Construction and Minimum Separation Requirements. Medical, health care, and child care spaces shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 11.1.3. Decks shall be constructed in accordance with 8.2.5.

11.1.4 Occupant Load. The occupant load for which means of egress shall be provided for any deck shall be the maximum number of persons intended to occupy that deck but not less than one person for each 11 m^2 (118.4 ft^2) of gross deck area in sleeping areas for health care and medical care and 3 m^2 (32.3 ft^2) for child care. Gross deck areas shall be measured within the exterior vessel bulkheads with no deductions. *(See Chapter 3.)*

Table 11.1.3 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements
High-risk accommodation	B-15
Medium-risk accommodation	B-15
Low-risk accommodation	B-0
Medical, health care, and child care	B-0
High-risk service	A-60
Low-risk service	A-0
Electrical and control	A-0
Low-risk engineering and machinery	A-0
High-risk engineering and machinery	A-60
Low-risk storage	B-0
High-risk storage	A-0
Cargo	A-60
Open deck	A-0
Helicopter deck	A-60
Voids	A-0

11.2* Means of Egress Requirements.

11.2.1 General. Every aisle, passageway, corridor, exit discharge, exit location, and access shall be in accordance with Chapter 7.

11.2.2 Means of Egress Components.

11.2.2.1 Components of means of egress shall be limited to the types described in 11.2.2.2.

11.2.2.2 Doors complying with 7.2.1 shall be permitted.

11.2.2.2.1 Locks shall not be permitted on patient sleeping area doors.

11.2.2.2.1.1 Key-locking devices on doors that restrict access to the patient sleeping area from the passageway shall be permitted if they are operable from the corridor side by the staff only. Such devices shall not restrict egress from the patient sleeping area.

11.2.2.2.1.2 Other locking arrangements shall not be permitted on patient sleeping area doors.

11.2.2.2.2 Doors not in a required means of egress shall be permitted to be subject to locking.

11.2.2.2.3 Doors within a required means of egress shall not be equipped with a latch or lock that requires the use of a tool or key from the egress side.

11.2.2.2.4 Horizontal sliding doors, as permitted by 6.2.1.10, that are not automatic-closing shall be limited to a single leaf and shall have a latch or other mechanism that will ensure that doors will not rebound into a partially open position if forcefully closed in an emergency.

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11.2.2.2.5 The minimum clear width for doors leading from sleeping areas; diagnostic and treatment areas, such as x-ray, surgery, or physical therapy; and nursery areas shall be 1 m (3.3 ft), except as indicated in 11.2.2.2.6 through 11.2.2.2.8.

11.2.2.2.6 Doors that are located so as not to be subject to use by any health care occupant shall be not less than 0.8 m (26 in.) in clear width.

11.2.2.2.7 Doors in exit stair enclosures shall be not less than 0.8 m (26 in.) in clear width.

11.2.2.2.8 Where a pair of doors is provided in sleeping areas, at least one of the doors shall provide a minimum 0.8 m (26 in.) clear width opening, and a rabbet, bevel, or astragal shall be provided at the meeting edge. The inactive leaf shall have an automatic flush bolt to provide positive latching.

11.2.3 Egress Capacity. Egress capacity for components of means of egress shall be based on the following measurements:

(1) Stairway width of 1.0 cm per person (0.4 in. per person)
(2) Level components and ramps width of 0.5 cm per person (0.2 in. per person)

11.2.4 Means of Egress Arrangement.

11.2.4.1 At least two exit accesses of the types described in 11.2.2.2, remotely located from each other, shall be provided for spaces having an occupant load greater than five persons.

11.2.4.2 Exit Access.

11.2.4.2.1 At least one exit access from each separate occupancy shall be one of the following:

(1) A door to an embarkation area, or an area of refuge
(2) A door to a stair
(3) A door to a smokeproof enclosure
(4) A door leading to a ramp
(5) A door to an exit passageway

11.2.4.2.2 Any hospital area not meeting the requirements of 11.2.4.2.1 shall be considered part of an adjoining occupancy.

11.2.4.2.3 Egress shall not require return through the compartment of fire origin.

11.2.4.3 At least two exits of the types described in 11.2.2.2 shall be accessible from each compartment. Egress shall be permitted through adjacent compartment(s) but shall not require return through the compartment of fire origin.

11.2.4.4 Every habitable area shall have an exit access door leading directly to an exit access corridor, unless otherwise provided in 11.2.4.4.1 through 11.2.4.4.4.

11.2.4.4.1 A habitable area shall be permitted not to have an exit access door leading directly to an exit access corridor if there is an exit door opening directly outside the vessel or to an area of refuge.

11.2.4.4.2 Patient sleeping areas shall be permitted to have an intervening area between the sleeping area and the exit access corridor, if the intervening area is not used as an exit access for more than eight patient sleeping areas.

11.2.4.4.3 Special nursing suites shall be permitted to have one intervening area between the sleeping area and the exit access corridor, if the arrangement allows for direct and constant visual supervision by nursing personnel.

11.2.4.4.4 For areas other than patient sleeping areas, one or more adjacent areas shall be permitted to intervene between the sleeping area and the exit access corridor, in accordance with 11.2.4.7.

11.2.4.5 Any patient sleeping area or any suite of more than 93 m^2 (1000 ft^2) that includes patient sleeping areas shall have at least two exit access doors remotely located from each other.

11.2.4.6 Any suite of spaces that complies with the requirements of 11.2.5 shall be permitted to be subdivided with C-Class partitions.

11.2.4.7 Intervening Areas.

11.2.4.7.1 Suites of spaces, other than patient sleeping areas, shall be permitted to have one intervening area if the travel distance within the area to the exit access door is not greater than 30 m (100 ft).

11.2.4.7.2 Suites of spaces, other than patient sleeping areas, shall be permitted to have two intervening areas if the travel distance within the area to the exit access door is not greater than 15 m (50 ft).

11.2.4.8 Every corridor serving medical, health care, and child care spaces shall provide access to at least two exits without passing through any intervening areas or spaces.

11.2.5 Travel Distance to Exits. Travel distance shall be measured in accordance with Section 7.6.

11.2.5.1 The travel distance between any door required as an exit access and an exit shall not exceed 45 m (150 ft).

11.2.5.2 The travel distance between any point in a space and an exit shall not exceed 60 m (200 ft).

11.2.5.3 The travel distance between any point in a health care sleeping area and an exit access door in that area shall not exceed 15 m (50 ft).

11.2.5.4 The travel distance between any point in a suite of sleeping berths, as permitted by 11.2.5, and an exit access door of that suite shall not exceed 30 m (100 ft).

11.2.5.5 Travel distance between any point in a suite of sleeping spaces, as permitted by 11.2.5, shall meet the requirements of 11.2.5.2.

11.2.6 Emergency Lighting.

11.2.6.1 Emergency lighting shall be provided in accordance with Section 7.9.

11.2.6.2 Vessels equipped with or in which patients require the use of life-support systems shall have emergency lighting supplied by the life safety branch of the electrical system as described in NFPA 99, *Standard for Health Care Facilities*, except that self-luminous signs shall be permitted to flash on and off upon activation of the fire alarm system, as indicated in 7.10.4.3.

11.3 Protection.

11.3.1 Interior Finish. Interior finish shall comply with Section 8.3.

11.3.2 Detection, Alarm, and Communication Systems.

11.3.2.1 Medical, health care, and child care spaces shall be provided with a fire detection and alarm system in accordance with Section 9.1.

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11.3.2.2 Fire Alarm Initiation.

11.3.2.2.1 All required sprinkler systems and water flow alarms shall initiate the required fire alarm system.

11.3.2.2.2 All required detection systems and detection devices shall initiate the required fire alarm system.

11.3.2.2.3 All required fire alarm systems shall be capable of manual initiation.

11.3.2.3 Fire alarm pull stations in patient sleeping areas shall not be required at exits if located at all nurses' control stations or other continuously attended staff location, provided such pull stations are visible and continuously accessible.

11.3.2.4 Notification.

11.3.2.4.1 Occupant Notification. Occupant notification, other than in critical care areas, shall be accomplished automatically in accordance with Section 9.1.

11.3.2.4.2 Occupant Notification in Critical Care Areas. In critical care areas, occupant notification by means of visible alarm-indicating appliances shall be permitted to be used in lieu of audible alarm signals.

11.3.2.4.3 Emergency Forces Notification. Crew notification shall be accomplished in accordance with Section 9.1.

11.3.2.4.4 Alarm Annunciation. Alarm annunciation shall be provided in accordance with Section 9.1.

11.3.2.5 Emergency Control. Actuation of any initiating device in the required fire alarm system shall be arranged to accomplish automatically any control functions to be performed by that device.

11.3.3 Extinguishment Requirements. Medical, health care, and child care spaces shall be protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.2.

11.4 Vessel Services.

11.4.1 Power for alarms, emergency communications systems, and the illumination of generator set locations shall be in accordance with the life safety branch requirements of NFPA 99, *Standard for Health Care Facilities*.

11.4.2 Any health care occupancy that uses life-support devices, for other than emergency purposes, shall have electrical systems designed and installed in accordance with NFPA 99, *Standard for Health Care Facilities*.

Chapter 12 Service Spaces

12.1 General Requirements.

12.1.1 Application. Service spaces shall comply with Chapter 12.

12.1.2* Subclassification of Occupancies. Any space containing heat-producing appliances capable of producing temperatures that exceed 120°C (248°F) that are not fully protected by sprinkler or water mist systems shall be considered high risk.

12.1.3 Separation requirements for low-risk and high-risk service spaces shall be in accordance with Table 12.1.3.

12.1.4 Minimum Construction and Minimum Separation Requirements. Service spaces shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 12.1.3. Decks shall be constructed in accordance with 8.2.5.

Table 12.1.3 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements: Low-Risk Service	Separation Requirements: High-Risk Service
High-risk accommodation	B-15	A-60
Medium-risk accommodation	B-15	A-0
Low-risk accommodation	B-0	A-0
Medical, health care, and child care	A-0	A-60
High-risk service	A-0	C
Low-risk service	A-0	C
Electrical and control	B-0	A-0
Low-risk engineering and machinery	A-0	A-0
High-risk engineering and machinery	A-0	A-60
High-risk storage	A-0	A-0
Low-risk storage	C	A-0
Cargo	A-0	A-0
Open deck	A-0	A-0
Helicopter deck	A-0	A-0
Voids	C'	A-0

12.1.5 Occupant Load. Occupant load shall not be required to be applied to service spaces. Sufficient egress capacity shall be provided in accordance with Section 7.3.

12.2 Means of Egress Requirements.

12.2.1 General. All means of egress shall be in accordance with Chapter 7 and Section 12.2.

12.2.2 Means of Egress Components.

12.2.2.1 General. Components of means of egress shall be limited to the types described in 12.2.2.2.

12.2.2.2 Doors. Doors shall comply with 7.2.1.

12.2.3 Number of Exit Accesses. High-risk service spaces greater than 15 m^2 (161.5 ft^2) shall have at least two exit accesses. Multiple exit accesses shall not be required for other spaces.

12.2.4 Arrangement of Means of Egress.

12.2.4.1 Where multiple exit accesses are required, exit accesses shall be located remote from each other and shall be arranged to minimize the probability of being blocked in an emergency.

12.2.4.2 Means of egress shall be permitted through accommodation spaces.

12.2.4.3 Common Path of Travel. In vessels fully protected in accordance with 9.2.7 and 9.2.8, the common path of travel shall not exceed 25 m (82 ft). In all other vessels the common path of travel shall not exceed 15 m (49.2 ft).

12.2.5 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

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12.3 Protection.

12.3.1 Interior Finish. Interior finish shall comply with Section 8.3.

12.3.2 Detection, Alarm, and Communication Systems.

12.3.2.1 All service spaces shall be provided with a manual alarm system in accordance with Section 9.1.

12.3.2.2 Service spaces that are not provided with an automatic fire suppression system complying with Section 9.2 shall be provided with heat detection in accordance with Section 9.1.

12.3.3 Extinguishing Requirements.

12.3.3.1 Galley Extinguishing Requirements. Unless specifically provided by Chapters 19 through 21, galley equipment shall be protected by an automatic fire-extinguishing system complying with ANSI/UL 300, *Standard for Safety Fire Testing of Fire-Extinguishing Systems for Protection of Restaurant Cooking Areas*. The suppression system shall be installed to protect all parts of the range, cooking appliances, plenum, and ducts, except as provided in Chapters 19 through 21.

12.3.3.2 Portable Extinguishers. One B-II extinguisher complying with 9.2.15 shall be provided for each 250 m^2 (2691 ft^2) of deck area or fraction thereof.

Chapter 13 Electrical and Control Spaces

13.1 General Requirements.

13.1.1 Application. Electrical and control spaces shall comply with Chapter 13.

13.1.2 Minimum Construction and Minimum Separation Requirements. Electrical and control spaces shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 13.1.2. Decks shall be constructed in accordance with 8.2.5.

Table 13.1.2 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements
High-risk accommodation	A-60
Medium-risk accommodation	A-0
Low-risk accommodation	B-0
Medical, health care, and child care	A-0
High-risk service	A-0
Low-risk service	B-0
Electrical and control	C'
Low-risk engineering and machinery	A-0
High-risk engineering and machinery	A-60
High-risk storage	A-0
Low-risk storage	A-0
Cargo	A-0
Open deck	A-0
Helicopter deck	A-60
Voids	C

13.1.3 Minimum separation requirements from high-risk engineering and machinery spaces where redundant controls are provided shall be permitted to be reduced to A-0.

13.1.4 Occupant Load.

13.1.4.1 Occupant load shall not be required to be applied to electrical and control spaces.

13.1.4.2 Sufficient egress capacity shall be provided in accordance with Section 7.3.

13.2 Means of Egress Requirements.

13.2.1 General. All means of egress shall be in accordance with Chapter 7 and Section 13.2.

13.2.2 Means of Egress Components.

13.2.2.1 Components of means of egress shall be limited to the types described in 13.2.2.2.

13.2.2.2 Doors shall comply with 7.2.1.

13.2.3 Means of Egress Arrangement.

13.2.3.1 Multiple exit accesses shall not be required.

13.2.3.2 Means of egress shall be permitted through adjacent spaces of any type.

13.2.4 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

13.3 Protection.

13.3.1 Interior Finish. Interior finish shall comply with Section 8.3.

13.3.2 Detection, Alarm, and Communication Systems.

13.3.2.1 All manned electrical and control spaces shall be provided with a manual alarm system in accordance with Section 9.1.

13.3.2.2 All electrical and control spaces shall be provided with smoke detection in accordance with Section 9.1.

13.3.3* Extinguishing Requirements. Spaces that present low fire risk shall not be required to be provided with portable fire extinguishers. For every other electrical and control space, one B:C II extinguisher shall be provided for each electrical and control space.

Chapter 14 Engineering and Machinery Spaces

14.1 General Requirements.

14.1.1 Application. The requirements of Chapter 14 apply to machinery spaces of high and low risk.

14.1.2 Special Terms.

14.1.2.1 Manned Space. See 3.4.3.

14.1.2.2 Unmanned Space. See 3.4.7.

14.1.3 Classification of Occupancy. The following are low-risk and high-risk occupancies:

(1) Low risk — all engineering and machinery spaces that are not high risk
(2) High risk — engineering and machinery spaces that contain high-risk fuel(s)

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14.1.4 Minimum Construction and Minimum Separation Requirements. Engineering and machinery spaces shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 14.1.4. Decks shall be constructed in accordance with 8.2.5.

Table 14.1.4 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements	
	Low-Risk Machinery Spaces	High-Risk Machinery Spaces
High-risk accommodation	A-60	A-60
Medium-risk accommodation	A-0	A-60
Low-risk accommodation	B-0	A-60
Medical, health care, and child care	A-0	A-60
High-risk service	A-0	A-60
Low-risk service	A-0	A-0
Electrical and control	A-0	A-60
Low-risk engineering and machinery	C'	A-0
High-risk engineering and machinery	A-0	A-0
Low-risk storage	C	C
High-risk storage	A-0	A-0
Cargo	A-0	A-0
Open deck	A-0	A-0
Helicopter deck	A-60	A-60
Voids	C'	A-0

14.2 Means of Egress Requirements.

14.2.1 General. All means of egress shall be in accordance with Chapter 6 and Section 14.2.

14.2.2 Means of Egress Components. A periodically unattended engine room shall be considered a manned space for purposes of fire protection and egress.

14.2.2.1 Means of egress components shall be limited to the types described in 14.2.2.2 through 14.2.2.5.

14.2.2.2* Doors. Doors shall comply with 7.2.1, unless otherwise provided for in 14.2.2.2.1 and 14.2.2.2.2.

14.2.2.2.1 Watertight doors and weathertight doors shall not be required to comply with the construction requirements of Chapter 6.

14.2.2.2.2 Doors shall be permitted to have a minimum width of 700 mm (28 in.).

14.2.2.3 Stairs.

14.2.2.3.1 Service stairs and ladders complying with 7.2.7 shall be permitted.

14.2.2.3.2 Vertical ladders complying with 7.2.8 and alternating tread devices complying with 7.2.9 shall be permitted as a secondary means of egress.

14.2.2.3.3 In engineering and machinery space occupancies and in storage occupancies, the clear distance between intermediate rails measured at right angles to the rails shall not exceed 50 cm (19.7 in.).

14.2.2.4 Escape Trunks.

14.2.2.4.1 Where used, escape trunks that are more than 5 m (16.4 ft) in height shall be separated from the machinery space by minimum A-60 Class divisions.

14.2.2.4.2 Escape trunks shall be provided with emergency lighting complying with Section 7.9 and with self-closing doors complying with 7.2.1.7 to allow protected egress from the machinery space.

14.2.2.4.3 Escape trunks that are 5 m (16.4 ft) or less in height shall be permitted to be reduced to a minimum A-0 Class division.

14.2.2.4.4 Where an escape trunk does not provide direct access to the weather, self-closing doors or hatches shall be provided.

14.2.2.5 Shaft Tunnels. Shaft tunnels shall be permitted to serve as an egress route.

14.2.3 Means of Egress Arrangement.

14.2.3.1 All machinery spaces shall be provided with a minimum of two separated means of egress, except as provided in 14.2.3.1.1 and 14.2.3.1.2.

14.2.3.1.1 Low-risk machinery spaces shall not be required to have two separated means of egress.

14.2.3.1.2 Unmanned machinery spaces that open directly to weather or an exit access shall not be required to have two separated means of egress.

14.2.3.2 Exits shall be located remotely from each other, and at least one shall not require passage through a watertight door.

14.2.3.3 Escape trunks shall be provided as indicated in 14.2.3.3.1 through 14.2.3.3.4.

14.2.3.3.1 Escape trunks shall be provided at every engine control room located within the fire-resistive boundaries of the machinery space.

14.2.3.3.2 Escape trunks shall be provided at the lowest deck of the machinery space.

14.2.3.3.3 Escape trunks shall be provided at every high-risk machinery space.

14.2.3.3.4 Escape trunks shall not be required for machinery spaces where the vertical distance from the lower level of the space to the weather deck, exit enclosure, or exit access is less than 5 m (16.4 ft).

14.3 Protection.

14.3.1 High-risk machinery spaces shall be protected throughout by one of the following systems in accordance with Section 9.2:

(1) Water mist system
(2) Carbon dioxide extinguishing system
(3) Clean agent system

14.3.2 Energy Sources.

14.3.2.1 Fire protection equipment shall not be the sole protection for the space in which it is located.

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14.3.2.2 All feeder and control wiring, switchgear, fuel oil, and starting equipment shall be located such that fire damage in the protected spaces will not impair the system. When such equipment is located outside the space it is protecting, all feeder and control wiring, switchgear, fuel oil, and starting equipment shall be located such that fire damage in the protected spaces will not impair the system.

14.3.2.3 Automatic fire protection systems shall be provided with at least two sources of power, one of which shall be provided from outside the protected space.

14.3.2.4 Machinery space fire protection systems that require electrical power for operation shall be provided with two sources of electrical power, one normal source and the second from an emergency source.

14.3.2.5* For all machinery spaces in excess of 120 m^3 (4237.8 ft^3) in volume, at least one source of power for the installed fire protection systems shall be provided from outside the protected space.

14.3.2.6 Wiring and switchgear for fire protection system pumps and controls shall be such that fire damage in the protected space will not impair the system.

14.3.3 Hydrants. Hydrants shall be installed as provided in 14.3.3.1 and 14.3.3.2, unless otherwise provided by Chapters 19 through 21.

14.3.3.1 Hydrants shall be located within or outside machinery spaces such that all areas of the space can be reached by at least two single-length hose lines from separate outlets. The hose line closest to the machinery space shall not exceed 25 m (82 ft). At least one hydrant shall be located outside of the machinery space.

14.3.3.2 Hydrants within the machinery space and those immediately outside the protected space that are connected to a fixed foam system shall be capable of providing low-expansion aqueous film-forming foam (AFFF) or other suitable foam for 30 minutes at rated flow from any 2 hydrants.

14.3.4 Fire Alarm Detection.

14.3.4.1 All machinery spaces, except as provided in 14.3.4.2, shall be fitted with a manual alarm system and automatic fire detectors in accordance with Section 9.1. The system shall initiate visual and audible alarms in the machinery space, machinery control room, navigation bridge, and central control station.

14.3.4.2 In periodically unattended machinery spaces, the fire detection system shall be so designed and the detectors so positioned as to rapidly detect the onset of fire in any part of those spaces and under any of the designed operating conditions of the machinery and variations of ventilation as required by the possible range of ambient temperatures.

14.3.5* Emergency Escape Breathing Device (EEBD). The minimum number of National Institute for Occupational Safety and Health (NIOSH)–approved EEBDs shall be required in all machinery spaces where the exit travel distance exceeds 15 m (49.2 ft). EEBDs shall be distributed such that no point in the machinery space is more than 15 m (49.2 ft) horizontal travel distance from an EEBD. The number of EEBDs provided shall be the greater of either of the following:

(1) Twice the number manning the watch
(2) The maximum number of personnel expected to be working in the space at any given time

14.4 Vessel Services.

14.4.1 Emergency Lighting. All of the following areas shall be provided with emergency lighting:

(1) Manned spaces
(2) Escape routes
(3) Areas housing fire-extinguishing equipment and damage-control equipment

14.4.2 Low-Location Lighting. In manned, high-risk machinery spaces, low-location lighting shall be provided in accordance with Section 7.11.

14.5 Compartmentation.

14.5.1 There shall be no access between cargo pump rooms and other machinery spaces.

14.5.2* Unless otherwise provided in Chapters 19 through 21, there shall be no doors between high-risk machinery spaces, engine casings, or fiddley areas, and the following types of spaces:

(1) Passenger egress stairs
(2) Public spaces
(3) Embarkation areas
(4) Refuge areas
(5) Passenger muster stations
(6) Bridge
(7) Radio room
(8) Emergency generator space
(9) Cabin areas for passengers
(10) Fan rooms serving spaces other than the machinery space

14.6* Pressurized Oil Systems.

14.6.1 Flexible fuel and lubricating oil lines operating above 10 bar (145 psi) shall be provided with double-wall tubing and fittings in accordance with SOLAS Chapter II-2, Regulation 15.

14.6.2 Pressurized oil systems shall be provided with remote shutdown controls located as follows:

(1) Immediately outside the machinery space and adjacent to the fixed fire-extinguishing system actuation controls
(2) On the bridge deck in an area accessible to all officers

14.6.3* Splash guards to avoid oil spray or oil leakages onto hot surfaces or into machinery air intakes shall be provided for the following:

(1) Strainers for pressurized oil systems
(2) Fuel injection pumps
(3)*Around all fittings, which include takedown joints (flanges, unions, and so forth), valve bonnets, and other areas where leakage can occur

14.6.4* Fuel injector pipelines for all machinery operating at or above 375 kW (500 hp) or operating in excess of 10 bar (145 psi) shall be double-walled, with arrangements provided for an alarm to be given in case of leakage.

14.7 Ventilation Systems.

14.7.1 Machinery space ventilation systems shall be provided with remote shutdown controls located immediately outside the machinery space and adjacent to the fixed fire-extinguishing system actuation controls.

14.7.2 Machinery space ventilation systems shall be provided with remote shutdown controls located on the bridge deck in an area accessible to all officers.

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14.8 Hot Surfaces.

14.8.1 Heated pipes, exhaust manifolds, flues, and other hot surfaces shall be insulated such that the exposed surfaces do not pose an ignition source for sprayed or spilled oils.

14.8.2 External surface temperatures shall not exceed 150°C (302°F).

14.9 Bilges.

14.9.1 Where a water mist extinguishing system is installed in high-risk machinery spaces to satisfy the requirements of 14.3.1, one of the following systems shall be installed to protect the bilges:

(1) Low-expansion foam
(2) High-expansion foam
(3) Water mist

14.9.2 Bilge plating shall be solid for walkways to escape routes.

14.10* Incinerator Spaces.

14.10.1 Incinerator spaces shall be provided with remote shutdown controls located immediately outside the machinery space and adjacent to the fixed fire-extinguishing system actuation controls.

14.10.2 Incinerator spaces shall be considered high-risk machinery spaces.

14.11 Portable Extinguishers. Portable fire extinguishers shall be provided in accordance with 9.2.15 and the following:

(1) One B-II for each 750 kW (1000 hp) of internal combustion or gas turbine machinery, but not less than two or more than six, and one B-III
(2) One B-V and two B-II for spaces containing oil-fired boilers or oil fuel units
(3) One C-II for each electrical generator
(4) Unmanned machinery spaces shall be provided with at least one B:C II extinguisher inside the space.

Chapter 15 Storage Spaces

15.1 General Requirements.

15.1.1 Application. Storage spaces shall comply with Chapter 15.

15.1.2 Subclassification of Occupancies. A high-risk storage space shall be considered to be any space that contains high-risk fuels or flammable aerosols. It shall also include any space that is dedicated for trash storage or that contains pyrotechnics or explosives. All storage spaces that are not high risk shall be considered to be low-risk storage spaces. The following fuels shall not be considered toward classification of an occupancy as a high-risk storage space:

(1) Alcohol beverages less than 100 proof or stored in containers not exceeding 10 L (2.64 gal)
(2) Flammable liquids and aerosols stored in containers in accordance with NFPA 30, *Flammable and Combustible Liquids Code*

15.1.3 Minimum Construction and Minimum Separation Requirements. Storage spaces shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 15.1.3. Decks shall be constructed in accordance with 8.2.5.

Table 15.1.3 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements	
	Low-Risk Storage	High-Risk Storage
High-risk accommodation	B-15	A-60
Medium-risk accommodation	B-0	A-60
Low-risk accommodation	C	A-0
Medical, health care, and child care	B-0	A-0
High-risk service	A-0	A-0
Low-risk service	C	A-0
Electrical and control	A-0	A-0
Low-risk engineering and machinery	C	A-0
High-risk engineering and machinery	C	A-0
High-risk storage	A-0	A-0
Low-risk storage	C	A-0
Cargo	A-0	A-0
Open deck	A-0	A-0
Helicopter deck	A-0	A-0
Voids	A-0	A-0

15.1.4 Occupant Load. Occupant load shall not be applied to storage spaces.

15.2 Means of Egress Requirements.

15.2.1 General. All means of egress shall be in accordance with Chapter 7 and Section 15.2.

15.2.2 Means of Egress Components.

15.2.2.1 General. Components of means of egress shall be limited to the types described in 15.2.2.2 and 15.2.2.3.

15.2.2.2 Doors. Doors shall comply with 7.2.1.

15.2.2.3 Ramps. Ramps shall comply with 7.2.5.

15.2.3 Means of Egress Arrangement.

15.2.3.1 Multiple exit accesses shall not be required from storage spaces.

15.2.3.2 Means of egress shall be permitted through adjacent spaces of any type.

15.2.4 Travel Distance to Exits. Exits shall be arranged so that the total length of travel from any point to reach an exit shall not exceed 40 m (131 ft).

15.2.5 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9 in storage spaces larger than 50 m^2 (538.2 ft^2).

15.3 Protection.

15.3.1 Interior Finish. Interior finish shall comply with Section 8.3.

15.3.2 Detection, Alarm, and Communication Systems. Unless otherwise provided for in Chapters 19 through 21, all storage spaces shall be provided with a smoke detection system in accordance with Section 9.1. Flammable materials storage and

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flammable materials lockers with flammable liquids shall additionally be provided with a heat detection system in accordance with Section 9.1.

15.3.3 Extinguishing Requirements. High-risk storage spaces and storage spaces exceeding 5 m^2 (53.8 ft^2) shall be fitted with a fixed automatic fire protection system in accordance with Section 9.2.

15.4 Special Provisions for High-Risk Fuels Storage.

15.4.1 The provisions of Sections 15.1 through 15.3 shall be met except as modified by 15.4.2 and 15.4.3.

15.4.2 Storage of high-risk fuels shall be in sealed, shatterproof containers. Shelves and storage fixtures shall limit movement of containers with the normal motion of the vessel.

15.4.3 Electrical equipment in high-risk fuels storage shall be installed in accordance with Article 500 of NFPA 70, *National Electrical Code*.

Chapter 16 Cargo Spaces and Fuel Tanks

16.1 General Requirements.

16.1.1 Application. Cargo spaces and fuel tanks shall comply with Chapter 16.

16.1.2 Special Term: Restricted Access Spaces. See 3.4.5.

16.1.3 Minimum Separation Requirements. Minimum separation requirements for cargo spaces and fuel tanks shall comply with Table 16.1.3.

Table 16.1.3 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements
High-risk accommodation	A-60
Medical, health care, and child care	A-60
All other spaces adjacent to cargo spaces intended for the carriage of explosives	A-60
Voids	C
All other spaces	A-0

16.1.4 Occupant Load. Occupant load shall not be applied to cargo spaces and fuel tanks.

16.2 Means of Egress Requirements.

16.2.1 Means of egress shall be in accordance with Chapter 7 and Section 16.2.

16.2.2 Unless required by Chapters 19 through 21, means of egress from restricted access cargo spaces and fuel tanks shall not be required to comply with Chapter 7.

16.3 Protection.

16.3.1 Cargo spaces and fuel tanks shall be in accordance with this section.

16.3.2 Requirements for Tank Vessels.

16.3.2.1 Inert Gas System. Tankers carrying crude oil, petroleum oils other than crude, or any products with a flash point less than 60°C (140°F) shall be fitted with an inert gas system complying with 9.2.13.

16.3.2.2* Tank vessels carrying flammable or combustible liquid cargoes shall be fitted with a deck foam system in accordance with 9.2.9. The type of foam required for chemical cargoes and the application rates shall be as provided in 9.2.9.

16.3.3 Requirements for Cargo Vessels.

16.3.3.1 General. A fire protection system meeting the requirements of 9.2.10 shall be installed in all cargo spaces.

16.3.3.2 Cargo spaces intended solely for the following purposes shall not be required to comply with 16.3.3.1:

(1) Spaces for the carriage of ore, coal, grain, or unseasoned timber
(2) Cargo in emergency schedules (EMS) B2, B3, B4, B5, B6, B7, B9, B10, B12, or B14 as defined in the IMO *International Maritime Dangerous Goods Code*
(3) Spaces intended solely for the carriage of liquids or gases

16.3.4 Protection of Vehicle Spaces. Vehicle spaces, other than covered open decks, shall be protected with a fire protection system meeting the requirements of Section 9.2. Portable foam equipment or foam hydrants meeting the requirements of 9.2.9 shall be available on each vehicle deck.

16.3.4.1 Covered open decks shall be permitted to be protected with manual sprinkler systems in accordance with 46 CFR 76.23, "Fire Protection Equipment (Manual Sprinkling Systems, Details)."

16.3.4.2 Vehicle spaces that are accessible to passengers shall not be protected with a carbon dioxide extinguishing system.

16.4* Refrigerated Cargo Holds. Combustible insulation shall be protected from fire.

Chapter 17 Open Decks

17.1 General Requirements.

17.1.1 Application. Open decks shall comply with Chapter 17.

17.1.2* Minimum Separation Requirements.

17.1.2.1 Separation between open decks and helicopter decks shall comply with 18.1.2.

17.1.2.2 Open deck separation requirements shall also apply to sideshell integrity.

17.1.3* Unrated windows shall not be permitted where open decks face machinery spaces.

17.1.3.1 Where not required to be protected or rated by other sections of this code, windows in exterior locations or facing open decks shall not be required to be rated and shall be permitted to be openable or omitted.

17.1.4 Occupant Load. The occupant load permitted on any open deck shall be determined on the basis of the occupant load factors in 17.1.4.1 through 17.1.4.4.

17.1.4.1 Occupant load for fixed seating on an open deck shall be determined based on design capacity.

17.1.4.2 Occupant load for bleachers, pews, and other bench-type seating shall be determined based on having one person per 45 cm (18 in.).

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17.1.4.3 Occupant load for open areas shall be determined based on having one person for each 1 m^2 (10 ft^2) of gross deck area and 0.65 m^2 (7 ft^2) of net area.

17.1.4.4 Occupant load shall not be required to be applied to open deck areas that are not intended to be occupied.

17.1.5 Storage of Cargo. Open decks intended for the carriage of cargo shall also meet the requirements of Chapter 16.

17.1.6 Storage. Open decks intended for the storage of ship's stores shall comply with Section 17.3.

17.2 Means of Egress Requirements. Means of egress shall be permitted to be entirely by exterior stairways and open decks. Otherwise, all means of egress shall be in accordance with Chapter 7.

17.3 Special Considerations for Open Decks Intended for Storage of Ship's Stores.

17.3.1 Storage areas shall not impede means of egress.

17.3.2 Storage areas shall be capable of being reached by two fire hose streams.

17.3.3 Deck house construction adjacent to storage areas shall be at least A-0.

17.3.4 Storage areas shall be designed with provisions for spill or leak containment.

17.3.5 Storage areas shall be remote from the vessel superstructure.

17.3.6 Storage areas shall have permanent means for fastening or lashing containers to the vessel.

Chapter 18 Helicopter Decks

18.1* General Requirements.

18.1.1 Application. Helicopter decks shall comply with Chapter 18.

18.1.2 Minimum Construction and Minimum Separation Requirements. Helicopter decks shall be separated from adjoining spaces by divisions that are constructed in accordance with Table 18.1.2. Decks shall be constructed in accordance with 8.2.5.

18.1.3 Occupant Load. Occupant load shall not be required to be applied to helicopter decks.

18.2 Means of Egress Requirements. Means of egress shall be in accordance with Chapter 7 and this section.

18.2.1 Means of Egress Components. Means of egress components shall be limited to the types described in 18.2.1.1 and 18.2.1.2.

18.2.1.1 Stairs. Steel stairs complying with 7.2.2 shall be permitted.

18.2.1.2 Service Stairs and Ladders. Service stairs and ladders complying with 7.2.7 shall be permitted.

18.2.2 Each helicopter deck shall have two means of egress.

18.3 Protection.

18.3.1* Each helicopter deck shall be fitted with a foam system complying with 9.2.9. Hydrants for manual application of foam shall be accessible from each of the means of egress required by 18.2.1.

Table 18.1.2 Minimum Separation Requirements

Adjoining Occupancies	Separation Requirements
High-risk accommodation	A-60
Medium-risk accommodation	A-60
Low-risk accommodation	A-60
Medical, health care, and child care	A-60
High-risk service	A-0
Low-risk service	A-0
Electrical and control	A-60
Low-risk engineering and machinery	A-60
High-risk engineering and machinery	A-60
High-risk storage	A-0
Low-risk storage	A-0
Cargo	A-0
Open deck	C
Voids	A-0

18.3.1.1 Four B:C-II extinguishers shall be provided.

18.3.1.2 Each helicopter hangar shall be equipped with an overhead deluge foam–water sprinkler system complying with 9.2.2. Control switches shall be provided inside and outside the hangar.

18.3.1.2.1 There shall be at least one foam station per hangar for manual application of foam.

18.3.2 Drainage.

18.3.2.1 Each helicopter deck shall have drainage facilities that collect liquids and prevent liquids from spilling on other parts of the ship.

18.3.2.2 Drainage shall be overboard.

18.3.2.3 Drainage piping shall extend down at least 30 mm (12 in.) over the side.

18.3.3* Communications. Communication capability shall be available between the bridge, fire-fighting foam control stations, hangar, and the helicopter deck.

Chapter 19 Towing Vessels

19.1 General Requirements.

19.1.1 Application.

19.1.1.1 Ocean-going towing vessels shall comply with Chapter 20.

19.1.1.2 This chapter shall apply to all towing vessels that are not defined as ocean-going towing vessels.

19.1.1.3* This chapter shall not apply to towing vessels if they are exempted by the authority having jurisdiction.

19.1.1.4 This chapter shall not apply to towing vessels if they are used solely in a limited geographic area, such as a fleeting area for barges or a commercial facility.

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19.1.1.5 This chapter shall not apply to towing vessels if they are used solely for a restricted service, such as making up or breaking larger tows.

19.1.1.6 This chapter shall not apply to towing vessels if they are used solely for assistance towing as defined in 46 CFR 10.103, "Licensing of Maritime Personnel, Definitions."

19.1.1.7 This chapter shall not apply to towing vessels if they are used solely for pollution response.

19.1.2 Occupant Load. Occupant load shall not be required to be applied to towing vessels.

19.2 Means of Egress. Chapter 7 shall not apply to towing vessels.

19.3 Protection. (Reserved)

19.4 Accommodation Spaces. Chapter 10 shall not apply to towing vessels. Accommodation spaces on towing vessels shall comply with this section.

19.4.1 Separation. Accommodation spaces shall be separated from engineering and machinery spaces and from fuel tanks by minimum A-0 Class divisions.

19.4.2 Detection. Single-station smoke detectors complying with UL 217, *Single and Multiple Station Smoke Alarms*, shall be provided in each accommodation space.

19.5 Medical, Health Care, and Child Care Spaces. Chapter 11 shall not apply to towing vessels.

19.6 Service Spaces. Chapter 12 shall not apply to towing vessels.

19.7 Electrical and Control Spaces. Chapter 13 shall not apply to towing vessels.

19.8 Engineering and Machinery Spaces. Chapter 14 shall not apply to towing vessels. Engineering and machinery spaces on towing vessels shall comply with this section.

19.8.1 Separation. Engineering and machinery spaces shall be separated from accommodation spaces by minimum A-0 Class divisions.

19.8.2 Detection.

19.8.2.1 Smoke or heat detectors complying with 9.1.3 shall be provided in all engineering and machinery spaces.

19.8.2.2 Means shall be provided such that detector activation is indicated at the operating station.

19.8.3 Fire Protection Systems and Equipment.

19.8.3.1 Engine rooms on towing vessels shall be provided with a fixed suppression system.

19.8.3.2 The fire suppression system required by 19.8.3.1 shall comply with the applicable paragraphs in Section 9.2.

19.8.4 Remote Main Engine Shutdown and Fuel Shutoff.

19.8.4.1 All towing vessels shall be fitted with a main engine shutdown.

19.8.4.2 All towing vessels shall have a means of securing ventilation systems and dampers.

19.8.4.3 A remotely operated fuel shutoff for securing the flow of fuel to the machinery shall be provided.

19.8.5 Fuel Oil Systems.

19.8.5.1 Portable Fuel Systems. Portable fuel systems shall not be permitted unless intended for portable bilge pumps, portable tanks, and fuel lines meeting ABYC-25, *Portable Containers for Flammable Liquids*.

19.8.5.2 Fuel Restrictions. Fuel for main propulsion and ship's service generators shall not have a flash point less than 43°C (110°F).

19.8.5.3 Pressurized Oil Systems. Flexible fuel oil lines operating above 10 bar (145 psi) shall be provided with double-wall tubing and fittings.

19.9 Storage Spaces. Chapter 15 shall not apply to towing vessels.

19.10 Fuel Tanks. Chapter 16 shall not apply to towing vessels. Integral fuel tanks shall comply with this section.

19.10.1 Each fuel tank shall be fitted with a vent pipe connected to the highest point of the tank that terminates in a 3.14-radian (180-degree) bend on a weather deck and that is fitted with a flame screen. Vents from two or more tanks may combine in a system that discharges on a weather deck.

19.10.2 The net cross-sectional area of the vent pipe required by 19.10.1 shall be 312 mm^2 (0.484 $in.^2$), except that where provisions are made to fill a tank under pressure, the net cross-sectional area of the vent pipe shall be permitted to be reduced to not less than the net cross-sectional area of the fill pipe.

19.10.3 Fuel Piping.

19.10.3.1 All fuel piping shall be seamless. Fuel piping shall be made of steel, copper-nickel, annealed copper, or nickel-copper and shall have a wall thickness of at least 0.9 mm (0.035 in.), unless otherwise indicated in 19.10.3.1.1 or 19.10.3.1.2.

19.10.3.1.1 Aluminum piping shall be permitted on aluminum vessels if it is installed outside the machinery space and is at least 2.4 mm (0.95 in.) thick (Schedule 80).

19.10.3.1.2 Nonmetallic flexible hose shall be permitted if it meets the following conditions:

(1) It is not used in a length exceeding 0.8 m (2.6 ft).
(2) It is installed in a visible location.
(3) It does not penetrate any watertight bulkheads.
(4) It is fabricated with an inner tube and a cover of synthetic rubber reinforced with a wire braid.
(5) It is fitted with corrosion-resistant compression fittings.
(6) It is installed with two clamps that do not rely on spring tension at each end of the hose, if the hose is intended to be secured with clamps.

19.10.3.2 A fuel line subject to internal head pressure from fuel in the tank shall be fitted with a positive shutoff valve that is operable from outside the machinery space.

19.11 Open Decks. Chapter 17 shall not apply to towing vessels.

19.12 Helicopter Decks. Chapter 18 shall not apply to towing vessels.

19.13 Vessel Services.

19.13.1 Fire Protection Systems and Equipment.

19.13.1.1 Fire Pumps, Fire Mains, Hydrants, and Hose.

19.13.1.1.1 Fire pumps, fire mains, hydrants, and hose shall comply with 19.13.1.1.1.1 through 19.13.1.1.1.3.

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19.13.1.1.1.1 Fire Pumps. A fire pump capable of supplying the two highest outlets at a flow rate not less than 300 L/min (80 gpm), at a pressure not less than 350 kPa (50 psi), shall be provided.

(A) The fire pump shall be provided with means to be started at the pump and remotely started from outside the space where the pump is located.

19.13.1.1.1.2 Fire Main and Hydrants. A fire main and a suitable number of hydrants shall be installed such that all portions of the vessel can be reached with a single length of hose of a maximum of 25 m (82 ft) in length.

19.13.1.1.1.3 Fire Hose. The hose shall be lined commercial fire hose, at least 40 mm (1.5 in.) in diameter, 15 m (50 ft) in length, and fitted with a nozzle made of corrosion-resistant material capable of providing a solid stream and a spray pattern, and is capable of being shut off at the nozzle.

19.13.2 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with Table 19.13.2.

Table 19.13.2 Portable Fire Extinguisher Requirements

	Extinguishers	
Space	**Number**	**Type**
Control spaces	1 for each space	B-I, C-I, A-II, B-II, C-II
Engineering and machinery spaces	1 for each space	B-II, C-II, and B-V if oil-fired boilers are present
Accommodation spaces	1 for each 250 m^2 (2691 ft^2)	A-II
Service spaces	1 for each space	A-II, B-II

19.13.3 General Alarm.

19.13.3.1 A general alarm shall be installed.

19.13.3.2 The general alarm shall be equipped with both an audible and a visual component in spaces other than the machinery space.

19.13.3.3 The general alarm shall be equipped with a visual component in the machinery space.

19.13.4 Two-Way Communication. A fixed internal or portable communication system capable of providing two-way communication between the wheelhouse and the engine room or a space adjacent to the engine room shall be provided.

Chapter 20 Cargo and Tank Vessels

20.1 General Requirements.

20.1.1 Application. This section shall apply to vessels that carry cargo and to oceangoing towing vessels.

20.1.2* Application to Vessels That Engage in International Voyages.

20.1.2.1 Vessels that engage in international voyages shall comply with the *International Convention for the Safety of Life at Sea,* as amended.

20.1.2.2 Vessels engaged in international trade shall not be required to comply with Chapter 20.

20.1.3 Special Term: Tank Ship. See 3.3.56.

20.1.4 Occupant Load. Occupant load shall be in accordance with Chapters 10 through 18.

20.2 Means of Egress. Means of egress shall only be required to comply with Chapter 7 as specified in this section.

20.2.1 Definitions. The special terms in 7.1.2 shall apply.

20.2.2 Separation of Means of Egress. Separation of means of egress shall comply with 7.1.3.

20.2.3 Interior Finish and Furnishings in Exits and Exit Accesses. Interior finish and furnishings in exits and exit accesses shall comply with 7.1.4.

20.2.4 Impediments to Egress. Impediments to egress shall comply with 7.1.7.

20.2.5 Means of Egress Components. Means of egress components shall be limited to those described in 20.2.5.1 through 20.2.5.7.

20.2.5.1 Doors.

20.2.5.1.1 A door assembly, including the door opening, frame, door, and necessary hardware, shall be designated as a door.

20.2.5.1.2 Doors shall comply with 7.2.1.2, 7.2.1.4.2, 7.2.1.4.3, 7.2.1.5.1, and 7.2.1.5.3. The permission for a door to have key-operated locks from the egress side, as described in 7.2.1.5.2, shall be specifically authorized.

20.2.5.1.3 Every door that is required to serve as an exit shall be designed and constructed so that the way of exit travel is obvious and direct. All doors, except for stateroom doors and doors opening to exit passageways, shall swing in the direction of egress travel.

20.2.5.1.4 A door designed normally to be kept closed in a means of egress shall be a self-closing door and shall not be secured in the open position at any time.

20.2.5.1.5 Watertight doors in a means of egress shall be either a quick-acting type or a power-operated door complying with the requirements in 46 CFR 170, "Stability Requirements for All Inspected Vessels."

20.2.5.2 Stairs.

20.2.5.2.1 Stairs used in machinery spaces shall comply with 7.2.2.1 through 7.2.2.3.7 except that noncombustible, grated treads and landings shall be permitted to be used.

20.2.5.2.2 Stairs in spaces other than machinery spaces shall comply with 7.2.2.1 through 7.2.2.3.7.

20.2.5.2.3 For stairs continuing beyond the level of exit discharge, the partitions, doors, or other means required to serve as interruptions at the level of exit required by 7.2.2.3.6 are not required, provided the exit discharge is clearly marked.

20.2.5.2.4 Where there are more than two decks, not including the bridge deck, a minimum of one stairtower shall be used to connect them. Stairs, platforms, and landings used in the construction of stairtowers shall be of noncombustible materials throughout and protected in accordance with 7.1.3.1, except that stairs with a minimum clear width of 70 cm (28 in.) shall be permitted.

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20.2.5.2.5 Exterior Stairs.

20.2.5.2.5.1 Exterior stairs complying with 7.2.2.5.2 through 7.2.2.5.4 shall be permitted to be used as a means of egress.

20.2.5.2.5.2 The dimensions of the stairs shall be required to comply only with the requirements in Table 7.2.2.5.5 for exterior stairs serving 10 or fewer persons.

20.2.5.2.5.3 The separation required by 7.2.2.6.2 shall not be required.

20.2.5.3 Smokeproof Enclosures. Where provided, smokeproof enclosures shall comply with 7.2.3.1 through 7.2.3.6, 7.2.3.7, 7.2.3.10, and 7.2.3.13.

20.2.5.4 Exit Passageways. Exit passageways shall comply with 7.2.6.1 through 7.2.6.3.

20.2.5.5 Service Stairs and Ladders. Service stairs and ladders shall comply with 7.2.7.1 through 7.2.7.3.

20.2.5.6 Vertical Ladders.

20.2.5.6.1 Vertical ladders shall comply with 7.2.8.

20.2.5.6.2 Vertical ladders shall be permitted to be used as one of the required means of egress.

20.2.5.7 Alternating Tread Devices. Alternating tread devices complying with 7.2.9 shall be permitted to be used as one of the required means of egress.

20.2.6 Guards.

20.2.6.1 Guards shall comply with 7.2.2.4.1 and 7.2.2.4.3.

20.2.6.2 Guard details shall comply with 7.2.2.4.6.1 through 7.2.2.4.6.3.

20.2.7 Handrails.

20.2.7.1 Handrails shall comply with 7.2.2.4.2.

20.2.7.2 Handrail details shall comply with 7.2.2.4.5.1 through 7.2.2.4.5.8.

20.2.8 Number of Separate Means of Egress.

20.2.8.1 The number of separate means of egress shall comply with Section 7.4.

20.2.8.2 Access to at least one of the required exits shall be independent of watertight doors.

20.2.9 Arrangement of Means of Egress.

20.2.9.1 The arrangement of the means of access shall comply with 7.5.1.3, 7.5.1.4, and 7.5.2.1, except that galley areas shall be permitted to be used as a means of egress from mess areas.

20.2.9.2 Dead-end corridors not exceeding 7 m (23 ft) in length shall be permitted.

20.2.10 Travel Distance to Exits. Travel distance to exits shall not be limited on cargo or tank vessels.

20.2.11 Discharge from Exits.

20.2.11.1 All exits shall terminate directly at an exit discharge, an embarkation area, or to an open deck area that leads to an embarkation area that is visible and identifiable from the point of discharge from the exit.

20.2.11.2 Weatherdeck exit discharge shall be permitted in accordance with 7.7.5.

20.2.12 Illumination of Means of Egress. Illumination of means of egress shall comply with Section 7.8.

20.2.13 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

20.2.14 Marking of Means of Egress. Means of egress shall be marked in accordance with Section 7.10.

20.3 Protection. Features of fire protection shall be in accordance with Chapter 8 for cargo vessels, tank vessels, and ocean-going towing vessels.

20.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed in accordance with 8.2.4.

20.3.2 Passageways. Passageways shall be constructed in accordance with 7.1.3.5.

20.3.3* On tank vessels, exterior boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks that support such accommodation shall be insulated to A-60 up to the underside of the navigating bridge for the whole of the portions that face the cargo area.

20.4 Accommodation Spaces.

20.4.1 Accommodation spaces shall be in accordance with Chapter 10 and this section.

20.4.1.1* Isolation from Cargo Tanks. On tank ships, all accommodation spaces shall normally be positioned aft of all cargo tanks, slop tanks, and spaces that isolate cargo or slop tanks from machinery spaces.

20.4.1.2 Accommodation spaces situated above cargo spaces shall be permitted only in roll-on/roll-off (RO/RO) vessels or above open deck cargo spaces.

20.4.2* Isolation from Deck Spills. On tank ships, a means shall be provided to keep deck spills away from the accommodation and service areas.

20.4.3 Openings.

20.4.3.1 On tank ships, access doors, air inlets, and openings to accommodation spaces shall not face the cargo area.

20.4.3.2 Openings shall be located on the transverse bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse at a distance of at least 4 percent of the length of the ship but not less than 3 m (9.8 ft) from the end of the superstructure or deckhouse facing the cargo area. This distance shall not be required to exceed 5 m (16.4 ft).

20.4.4 Windows and Sidescuttles.

20.4.4.1 On tank ships, windows and sidescuttles facing the cargo area and on the sides of the superstructures and deckhouses within the limits specified in 20.4.3 shall be of the fixed, non-opening type.

20.4.4.2 Windows and sidescuttles in the first tier on the main deck shall be fitted with inside covers of steel or other equivalent material where such windows are located in the areas described in 20.4.4.1.

20.4.5 Automatic sprinkler systems and water mist systems shall not be required in overnight crew accommodation spaces.

20.5 Medical Spaces. Medical spaces shall be in accordance with Chapter 11.

20.6 Service Spaces. Service spaces shall be in accordance with Chapter 12.

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20.7 Electrical and Control Spaces. Electrical and control spaces shall be in accordance with Chapter 13.

20.8 Engineering and Machinery Spaces. Engineering and machinery spaces shall be in accordance with Chapter 14.

20.9 Storage Spaces.

20.9.1 Storage spaces shall be in accordance with Chapter 15 and 20.9.2.

20.9.2 Automatic actuation shall not be permitted for carbon dioxide extinguishing systems protecting manned high-risk storage spaces.

20.10 Cargo Spaces and Fuel Tanks. Cargo spaces and fuel tanks shall be in accordance with Chapter 16.

20.11 Open Decks. Open decks shall be in accordance with Chapter 17.

20.12 Helicopter Decks. Helicopter decks shall be in accordance with Chapter 18.

20.13 Vessel Services.

20.13.1 Fire Detection and Alarm.

20.13.1.1 A fire detection and alarm system complying with Section 9.1 shall be installed in all accommodation spaces, cargo holds, service spaces, and means of egress.

20.13.1.2 A heat detection system shall be permitted to be used in RO/RO cargo space areas in lieu of smoke detectors.

20.13.2 Fire Protection Systems and Equipment.

20.13.2.1 Sprinkler Systems. Where installed, sprinkler systems shall comply with 9.2.7.

20.13.2.2 Fire Pumps, Fire Mains, Hydrants, and Hose.

20.13.2.2.1 General.

20.13.2.2.1.1 Fire-main hydrants complying with Section 9.2 and Table 20.13.2.2.1.1 shall be provided.

20.13.2.2.1.2 Two 40 mm (1.5 in.) hose with nozzles connected to a wye fitting shall be permitted in lieu of 65 mm (2.5 in.) hose.

20.13.2.2.2 Placement.

20.13.2.2.2.1 Hydrants shall be located so that each part of the ship that is accessible by the crew is able to be reached by a single 25 m (75 ft) maximum length of hose.

20.13.2.2.2.2 Weather deck hydrants on tank ships shall be equipped with a length of hose sufficient to permit "goosenecking" a hose over the side for a floating oil fire.

20.13.2.2.3 Fire Pumps. Fire pumps shall comply with 9.2.16 and Section 20.13.

20.13.2.2.3.1 Capacity of Fire Pumps.

(A) Each of the required fire pumps (other than any emergency pump) shall have a capacity not less than 80 percent of the total required capacity divided by the minimum number of required fire pumps but, in any case, not less than 25 m^3/hr (110 gpm).

(B) Each such pump shall be capable of delivering at least two required jets of water 344.75 kPa (50 psi) at the hydraulically most remote point.

(C) These fire pumps shall be capable of supplying the fire-main system under the required conditions.

(D) Where 40 mm (1.5 in.) hose is permitted in lieu of 65 mm (2.5 in.) hose by Table 20.13.2.2.1.1, the pump capacity shall be determined on the same basis as if 65 mm (2.5 in.) hose had been required.

20.13.2.2.3.2 Number of Fire Pumps. At least two independently driven fire pumps shall be provided.

20.13.2.2.3.3 Multiple-Use Pumps. Sanitary, ballast, bilge, or general service pumps shall be permitted to be accepted as fire pumps, provided that they are not used for pumping oil.

20.13.2.2.3.4 Isolation Valves. Isolation valves shall be fitted in the fire main in a position protected from the cargo tanks at the forward bulkhead of the deck house and on the tank deck at intervals of not more than 40 m (131.2 ft) to preserve the integrity of the fire-main system in case of fire or explosion.

20.13.2.2.4 Fire Hose. Fire hose meeting 9.2.16.10 and Table 20.13.2.2.1.1 shall be provided.

20.13.2.3 Portable Fire Extinguishers. All fire extinguishers shall be as specified in 9.2.15 and shall be provided in accordance with classification society rules.

20.13.2.4 Spare Charges. Charges for 100 percent of all extinguishers that are capable of onboard recharging shall be provided.

20.13.2.4.1 An additional 10 percent of extinguishers shall be required on a vessel that is not capable of recharging the extinguishers.

20.13.2.4.2 For periodically unattended engine rooms, the number of duplicate extinguishers required shall be equal to the number of extinguishers on the most remote engine room level.

20.13.3 Fire-Fighting Clothing and Equipment.

20.13.3.1 Eight sets of fire fighter protective clothing meeting the requirements of 9.3.1 shall be provided for vessels at least 60 m (197 ft) in length.

Table 20.13.2.2.1.1 Requirements for Fire Hose and Nozzles

Vessel Length		Area of Vessel (Exterior) Hydrant, Hose, and Nozzle Sizes		Area of Vessel (Interior) Hydrant, Hose, and Nozzle Sizes	
m	ft	mm	in.	mm	in.
0–20	0–65.6	1 B-V extinguisher (instead of nozzle)		1 B-V extinguisher (instead of nozzle)	
20–80	65.6–262.4	40	1.5	40	1.5
80–130	262.4–426.5	65	2.5	40	1.5
130+	426.5+	65	2.5	65	2.5

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20.13.3.2 Vessels less than 60 m (197 ft) in length shall be provided with a minimum of two fire fighters' outfits.

20.13.3.3 A corresponding number of SCBA meeting the requirements of 9.3.2 shall be provided for each set of fire fighter protective clothing as required by 20.13.3.1.

20.13.4 Ventilation Systems. Ventilation systems shall comply with Section 9.4.

20.13.5 Elevators, Escalators, and Dumbwaiters. Where installed, elevators, escalators, and dumbwaiters shall comply with Section 9.5.

20.13.6 Electrical installations shall comply with Section 9.6.

Chapter 21 Passenger Vessels

21.1 General Requirements.

21.1.1 Application. This chapter shall apply to all vessels that carry more than 12 passengers. Portions of vessels that are primarily intended for another service that also carry passengers (i.e., a cargo vessel with passenger accommodations for more than 12 people) shall comply with this chapter.

21.1.1.1 Group I and Group II Passenger Vessels. Group I and Group II passenger vessels shall comply with Sections 21.1 through 21.13.

21.1.1.2 Group V Passenger Vessels. Group V passenger vessels shall comply with Sections 21.1 and 21.14.

21.1.1.3 Group IV Passenger Vessels. Group IV passenger vessels shall comply with Sections 21.1, 21.13, and 21.15.

21.1.2 Special Terms.

21.1.2.1 High-Speed Vessels. See 3.3.36.

21.1.2.2 Passenger. See 3.3.49.

21.1.2.3 Overnight Accommodations. See 3.3.47.

21.1.3 Subclassification of Passenger Vessels. Passenger vessels shall be categorized as in Table 21.1.3.

Table 21.1.3 Passenger Vessel Subclassification

Group	Number of Day Passengers	Number of Overnight Passengers
I	>3000	>300
II	>1000 ≤3000	≥150 ≤300
III	>150≤1000	≥50 <150
IV	≤150	<50
V	≤450	0

21.1.3.1 Group I Passenger Vessels. Passenger vessels that operate with more than 3000 day passengers or carry more than 300 overnight passengers shall be categorized as Group I.

21.1.3.2 Group II and Group III Passenger Vessels. Passenger vessels that operate with more than 150 day passengers or carry more than 49 overnight passengers shall be categorized as Group II and Group III.

21.1.3.3 Group IV Passenger Vessels. Passenger vessels that operate with no more than 150 day passengers or carry no more than 49 overnight passengers shall be categorized as Group IV.

21.1.3.4* Group V Passenger Vessels. High-speed passenger vessels that operate with no more than 450 day passengers no farther than 4 hours from a harbor of safe refuge shall be categorized as Group V.

21.1.4 Occupant Load. Occupant load shall be in accordance with Chapters 10 through 18.

21.2 Means of Egress. Means of egress shall comply with Chapter 7 and this section.

21.2.1 Changes in Level of Means of Egress.

21.2.1.1 The elevation of the deck surfaces on both sides of a door shall not vary more than 50 mm (2 in.), except as provided in 21.2.1.5.

21.2.1.2 The elevation shall be maintained on both sides of the door opening for a distance at least equal to the width of the widest leaf.

21.2.1.3 Sills at door openings shall not exceed 15 mm (0.6 in.) in height, except as provided for in 21.2.1.4.

21.2.1.4 Doors required to have sill heights to meet downflooding or load-line requirements shall not be required to comply with 21.2.1.3.

21.2.1.5 The maximum elevation changes for decks that have sheer and/or camber shall be 75 mm (3.0 in.).

21.2.2 Doors. Doors shall comply with 7.2.1.

21.2.2.1 Revolving Doors.

21.2.2.1.1 All revolving doors shall comply with the following requirements:

(1) Revolving doors shall be capable of being collapsed into a book-fold position.
(2) When in the book-fold position, the parallel egress paths formed shall provide an aggregate width of 90 cm (35.4 in.).
(3) Revolving doors shall not be used within 3 m (9.8 ft) of the foot of or top of stairs or escalators. Under all conditions, there shall be a dispersal area acceptable to the authority having jurisdiction between the stairs or escalators and the revolving door.
(4) The revolutions per minute (rpm) of revolving doors shall not exceed those listed in Table 21.2.2.1.1.
(5) Each revolving door shall have a conforming side-hinged swinging door in the same wall as the revolving door and within 3 m (9.8 ft) of the revolving door.

21.2.2.1.2 Revolving doors shall be permitted as a component in a means of egress, provided they comply with 21.2.2.1.3 through 21.2.2.1.6.

21.2.2.1.3 Revolving doors shall not be given credit for more than 50 percent of the required egress capacity.

21.2.2.1.4 Each revolving door with a minimum diameter less than 2.5 m (8.2 ft) shall be credited with no more than 50 persons capacity.

21.2.2.1.5 Revolving doors with a minimum 2.5 m (8.2 ft) diameter shall be permitted egress capacity based on the clear opening width provided.

21.2.2.1.6 Revolving doors shall be capable of being collapsed into a book-fold position when a force that shall not be

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Table 21.2.2.1.1 Revolving Door Specifications

Inside Diameter		Power Driven–Type Speed Control (rpm)	Manual-Type Speed Control (rpm)
m	ft		
2.0	6.6	11	12
2.1	6.9	10	11
2.3	7.5	9	11
2.4	7.9	9	10
2.6	8.5	8	9
2.7	8.9	8	9
2.9	9.5	7	8
3.0	9.8	7	8

required to exceed 575 N (130.9 lbf) is applied to wings within 7.5 cm (3 in.) of the outer edge.

21.2.2.2 Doors in Folding Partitions.

21.2.2.2.1 Where permanently mounted folding or movable partitions are used to divide a room into smaller spaces, a swinging door or open doorway shall be provided, except as provided in 21.2.2.2.2.

21.2.2.2.2 The swinging door in the folding partitions shall not be required in a subdivided space with at least two means of egress meeting the remoteness criteria of 7.5.1.4.

21.2.3 Stairs. Stairs shall comply with 7.2.2 and 21.2.3.

21.2.3.1 Curved Stairs. Curved stairs complying with 21.2.3.1.1 through 21.2.3.1.2 shall be permitted as a component in a means of egress.

21.2.3.1.1 The minimum depth of tread shall be 25 cm (9.8 in.) at a point 30 cm (11.8 in.) from the narrower end of the tread.

21.2.3.1.2 The smallest radius shall be not less than twice the stair width.

21.2.3.2 Spiral Stairs. Spiral stairs shall be permitted as a component in a means of egress as provided by 7.2.2.3.7.

21.2.4 Ramps. Every ramp used as a component in a means of egress shall comply with 7.2.5.

21.2.5 Number of Exits.

21.2.5.1 A minimum of two exits, remotely located in accordance with 7.5.1.4, shall be accessible from all spaces.

21.2.5.2* Access to at least one of the required exits from areas normally accessible to passengers and from crew accommodation spaces shall be independent of watertight doors.

21.2.5.3 Dead-end corridors not exceeding 7 m (20 ft) in length shall be permitted in Groups II, III, and IV passenger vessels.

21.2.5.4 A common path of travel shall not exceed 25 m (82 ft).

21.2.6 Horizontal Exits.

21.2.6.1 Application. Horizontal exits shall be permitted as provided by 7.2.4 and 21.2.6.

21.2.6.2 Horizontal exits shall be permitted to be reduced to A-0 Class divisions if the separation is between low-risk accommodation spaces.

21.2.7 Travel Distance to Exits. Travel distance to exits shall not exceed 50 m (164 ft).

21.2.8 Areas of Refuge. Areas of refuge shall meet the requirements of 7.2.10 and 21.2.8.

21.2.8.1 An emergency evacuation plan shall be prepared to identify possible fire scenarios and identify procedures for evacuating the vessel for each scenario.

21.2.8.2 Sufficient areas of refuge shall be provided such that for each scenario, passengers are protected from the effects of fire for a sufficient time for the crew to attempt fire fighting or prepare for evacuation.

21.2.8.3 At least two areas of refuge that meet the requirements of 7.2.10 shall be provided.

21.2.8.4 Each area of refuge shall have enough net area to provide 0.3 m^2 (3.2 ft^2) of space for each person to be accommodated on the vessel.

21.2.8.5 Boundaries of areas of refuge shall be permitted to be in accordance with Chapters 10 through 18 where the area of refuge is bounded by voids, open decks, or low-risk machinery spaces.

21.2.8.6 Where so reduced, exterior boundaries of high- and medium-risk accommodation spaces; machinery spaces; high-risk service spaces; storage spaces; cargo spaces and fuel tanks; and medical, health care, and child care spaces located below the area of refuge shall be minimum A-0.

21.2.9 General Requirements for Aisles and Aisle Accessways.

21.2.9.1 The width of aisle accessways and aisles shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle accessway or aisle.

21.2.9.2 Where aisle accessways or aisles converge to form a single path of egress travel, the required egress capacity of that path shall not be less than the combined required capacity of the converging aisle accessways and aisles.

21.2.9.3 Those portions of aisle accessways and aisles where egress is possible in either direction shall be uniform in required width.

21.2.9.4 Where nonfixed seating is located between a table and an aisle accessway or aisle, the measurement of required clear width of the aisle accessway or aisle shall be made to a line 50 cm (19.7 in.) away from the edge of the table.

21.2.9.5 The 50 cm (19.7 in.) distance shall be measured perpendicular to the edge of the table.

21.2.9.6 The minimum required clear width of an aisle accessway within areas with fixed table locations shall be 30 cm (11.8 in.). The path of travel from any seat shall not exceed 10 m (32.8 ft) to the closest aisle or exit.

21.2.9.7 Aisle accessways between rows of theater-type seating shall have a clear width of not less than 30 cm (11.8 in.).

21.2.9.8 Aisle accessways between rows of theater-type seating shall have a maximum travel distance to an aisle or an exit of no more than 10 m (32.8 ft).

21.2.9.9 The minimum clear width of aisles shall be 50 cm (19.7 in.).

21.2.10 Aisle Stairs and Ramps.

21.2.10.1 Aisles having a gradient steeper than 1 in 20, but not steeper than 1 in 8, shall consist of a ramp. Aisles having a gradient steeper than 1 in 8 shall consist of an aisle stair.

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21.2.10.2 Aisle stairs shall conform to the requirements of 21.2.10.2.1 through 21.2.10.2.4.

21.2.10.2.1 There shall be no variation exceeding 0.5 cm (0.2 in.) in the depth of adjacent treads.

21.2.10.2.2 Treads shall be a minimum 28 cm (11 in.) in depth.

21.2.10.2.3 Riser heights shall be a minimum of 10 cm (3.9 in.) and a maximum of 22 cm (8.7 in.).

21.2.10.2.4 Riser height shall be uniform to within 0.5 cm (0.2 in.) between adjacent risers.

21.2.11 Aisle Handrails. Ramped aisles having a gradient exceeding 1 in 12 and aisle stairs shall be provided with handrails at one side or along the centerline.

21.2.12 Discharge from Exits. Exit discharge shall comply with Section 7.7.

21.2.13 Illumination of Means of Egress.

21.2.13.1 Means of egress shall be illuminated in accordance with Section 7.8.

21.2.13.2 In those accommodation spaces where performances or projections involving directed light are being held, the illumination level of the floors of exit access shall be at least 2 lx (0.2 fc) during performances.

21.2.14 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

21.2.15 Marking of Means of Egress.

21.2.15.1 Means of egress shall have signs in accordance with Section 7.10.

21.2.15.2 Where overnight passengers are carried, a diagram shall be placed in each cabin that clearly shows all escape routes to the open deck or area of refuge.

21.3 Protection. Features of fire protection shall be in accordance with Chapter 8 for passenger vessels.

21.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed or protected in accordance with 8.2.4 or shall be protected in accordance with 21.3.1.

21.3.1.1 Galleries. Galleries shall be permitted if they comply with 21.3.1.1.1 through 21.3.1.1.5.

21.3.1.1.1 The entire deck area of the communicating space shall be open and unobstructed such that a fire in any part of the space will be obvious to the occupants of the space prior to the time it becomes a hazard to them.

21.3.1.1.2 Each level of the space containing the gallery shall have two independent means of egress.

21.3.1.1.3 The communicating space shall be protected throughout by an approved, automatic sprinkler system in accordance with 9.2.2.

21.3.1.1.4 Egress capacity shall be sufficient to provide for all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as a single-deck area when determining the required egress capacity.

21.3.1.1.5* No horizontal dimension between opposite edges of the deck opening shall be less than 6 m (20 ft), and the opening shall have a minimum 100 m^2 (1000 ft^2) unobstructed area. Smaller openings shall be permitted, if protected by the methods detailed in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

21.3.1.2 Atriums. An atrium shall be permitted if it complies with 21.3.1.2.1 through 21.3.1.2.11.

21.3.1.2.1 No horizontal dimension between opposite edges of any deck opening shall be less than 6 m (20 ft), and the unobstructed opening shall be a minimum of 100 m^2 (1000 ft^2), except as provided in 21.3.1.2.2.

21.3.1.2.2 Atriums and spaces where the largest deck has a gross area less than 500 m^2 (5382 ft^2) shall be permitted to have a minimum opening area not smaller than 20 percent of the gross area of the largest deck in the space, provided that the minimum dimension is not smaller than 50 percent of the beam of the vessel or 6 m (20 ft), whichever is smaller.

21.3.1.2.3 Exit access shall be required at each level of the atrium. Exits shall be separately enclosed from the atrium in accordance with 8.2.4.

21.3.1.2.4 Except as required by 21.3.1.2.3, stairs or ramps shall be permitted to be unenclosed within the atrium.

21.3.1.2.5 The occupancy(ies) of the space shall meet the specifications for classification as low or medium risk in accordance with 10.1.2.1.

21.3.1.2.6 The entire atrium and spaces opening directly into the atrium shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.2, except as provided in 21.3.1.2.7.

21.3.1.2.7 In spaces where the ceiling of the atrium is more than 17 m (55 ft) above the lowest deck, the authority having jurisdiction shall be permitted to allow the omission of sprinklers at the top of the atrium.

21.3.1.2.8 On vessels with overnight accommodations, the entire atrium and spaces opening directly into the atrium shall be protected throughout by an approved smoke-detection system in accordance with Section 9.1.

21.3.1.2.9 An engineered smoke-control system complying with 9.4.8 shall be provided.

21.3.1.2.10 If a mechanical system is installed to meet the requirements of 21.3.1.2.9, the mechanical system shall be independently activated by each of the following systems:

(1) Approved smoke detectors located to detect smoke above the highest floor deck level of the atrium and at return air intakes from the atrium
(2) The required automatic sprinkler system
(3) Manual controls that are accessible to the fire personnel

21.3.1.2.11* Corridors, separated from the atrium by construction in accordance with 7.1.3.5, and where fore and aft communication is not possible on the weather deck, shall be provided at each deck for movement fore and aft so that occupants do not have to traverse the atrium.

21.3.2 Mezzanines.

21.3.2.1 Where utilized, mezzanines shall be in accordance with 8.2.6.

21.3.2.2 Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and the main accommodation areas located below the balcony or mezzanine, provided the balcony or mezzanine is open to the main accommodation area.

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21.3.3 Vessel Construction.

21.3.3.1 The hull, superstructure, structural bulkheads, decks, and deckhouses shall be constructed of noncombustible material.

21.3.3.2* Load-carrying structures shall be arranged to distribute load such that there shall be no collapse of the construction of the hull and superstructure when it is exposed to fire for the appropriate fire protection time.

21.3.3.3 The hull, superstructure, and deck houses shall be subdivided by fire barriers as prescribed by Chapters 10 through 18 and 8.2.4.

21.3.4 Wires and Cables.

21.3.4.1 Wires and cables in concealed spaces on passenger vessels shall comply with the fire safety requirements of Section 8.5 and shall exhibit reduced smoke emission characteristics.

21.3.4.2 Cables listed as exhibiting limited-smoke characteristics by meeting the requirements of 8.5.1.4 shall be deemed to comply with 21.3.4.1.

21.3.4.3 Cables listed as plenum cables by meeting the requirements of 8.5.3.1 shall be deemed to comply with 21.3.4.1.

21.4 Accommodation Spaces. Accommodation spaces shall comply with Chapter 10 and this section.

21.4.1 Furniture and Furnishings.

21.4.2 Interior Finish. Interior finish shall comply with Section 8.3.

21.4.2.1 The total area of combustible face trim, moldings, and decorations, including veneers, shall not exceed 10 percent of the total bulkhead and overhead area in fully sprinklered accommodation spaces.

21.5 Medical, Health Care, and Child Care Spaces. Medical, health care, and child care occupancies shall be in accordance with Chapter 11.

21.6 Service Spaces.

21.6.1 Service areas shall be in accordance with Chapter 12.

21.6.2 Laundry and clothes-drying facilities greater than 4 m^2 (43 ft^2) shall be considered high-risk service spaces.

21.7 Electrical and Control Spaces. Electrical and control spaces shall be in accordance with Chapter 13.

21.8 Engineering and Machinery Spaces. Engineering and machinery spaces shall be in accordance with Chapter 14.

21.9 Storage Spaces. Storage spaces shall be in accordance with Chapter 15.

21.10 Cargo Spaces and Fuel Tanks. Cargo spaces and fuel tanks shall comply with Chapter 16.

21.10.1 Cargo spaces, other than vehicle spaces, shall be protected in accordance with Section 20.10.

21.10.2 Vehicle spaces, other than covered open decks, shall be protected with a fire protection system meeting the requirements of Section 9.2. Portable foam equipment or foam hydrants meeting 9.2.9 shall be available on each vehicle deck.

21.10.2.1 Covered open decks shall be permitted to be protected with manual sprinkler systems in accordance with 46 CFR 76.23, "Fire Protection Equipment (Manual Sprinkling System, Details)."

21.10.2.2 Vehicle spaces that are accessible to passengers shall not be protected with a carbon dioxide extinguishing system.

21.11 Open Decks. Open decks shall be in accordance with Chapter 17.

21.12 Helicopter Decks. Helicopter decks shall be in accordance with Chapter 18.

21.13 Vessel Services. On Group I, Group II, and Group III passenger vessels, low-location lighting shall be provided in accordance with Section 7.11.

21.13.1 Fire Detection and Alarm.

21.13.1.1 A fire detection and alarm system complying with Section 9.1 shall be installed to protect all accommodation, service, and storage spaces and all means of egress, except as indicated in 21.3.1.2.

21.13.1.2 On vessels with no overnight accommodations, accommodation spaces that can be assumed to be normally occupied shall only be required to be served by a manual alarm system.

21.13.2 Fire Protection Systems and Equipment.

21.13.2.1 Sprinkler Systems. On Group I and Group II passenger vessels and all passenger vessels with overnight accommodations for passengers, an automatic sprinkler system complying with 9.2.7 or a water mist system complying with 9.2.8 shall be installed to protect all accommodation, service, and storage spaces.

21.13.2.2 Fire Pumps, Fire Mains, Hydrants, and Hose.

21.13.2.2.1 Fire Pumps. Power-driven fire pumps shall be installed in minimum number and capacity in accordance with 9.2.16 and Table 21.13.2.2.1 as modified by 21.13.2.2.1.1 through 21.13.2.2.1.3.

Table 21.13.2.2.1 Fire Pump Requirements

Vessel Type	Minimum Number of Fire Pumps	Minimum Capacity per Pump	
		L/min	gal/min
I	3	800	211
II	2	600	159
III			
>600 passengers	2	600	159
≤600 passengers	2	400	106
IV			
≥20 m (≥66 ft) in length	1	200	53
<20 m (<66 ft) in length	1	40	11

21.13.2.2.1.1 On Group III passenger vessels that carry 600 passengers or less, the fire pump shall not be required to be located in separate spaces or be provided with a separate source of power.

21.13.2.2.1.2 On Group II passenger vessels and Group III passenger vessels that carry more than 600 passengers, the fire pump shall not be required to be located in separate spaces if the space containing the pump is protected with a fire protection system in accordance with Section 9.2.

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21.13.2.2.1.3 On vessels that are fully protected with an automatic sprinkler system complying with 9.2.7 or a water mist system complying with 9.2.8, the minimum number of fire pumps in Table 21.13.2.2.1 shall be permitted to be reduced by one, but in no case shall less than one pump be provided.

21.13.2.2.2 Fire Main and Hydrants.

21.13.2.2.2.1 On all passenger vessels, 40 mm (1.5 in.) fire main and hydrants, hose, and nozzles shall be installed.

21.13.2.2.2.2 Hydrants shall be provided such that any part of the vessel, except void spaces, can be reached using a single 23 m (75 ft) maximum length of fire hose.

21.13.2.2.2.3* All vessels shall be equipped with an international shore connection on both sides of the vessel.

21.13.2.2.3 Fire Hose. Fire hose meeting the requirements of 9.2.16.10 shall be provided.

21.13.2.3 Portable Fire Extinguishers. Portable fire extinguishers shall be installed in accordance with 9.2.15 and 21.13.2.3.

21.13.2.3.1 Group I Passenger Vessels. Portable fire extinguishers shall be provided in accordance with Section 4/9 of the American Bureau of Shipping (ABS) steel vessel rules.

21.13.2.3.2 Group II and Group III Passenger Vessels. Portable fire extinguishers shall be provided in accordance with Table 21.13.2.3.2.

Table 21.13.2.3.2 Portable Fire Extinguisher Requirements

Space	Number Required	Type
Control space	1 for each space	B-I, C-I, A-II, B-II, C-II
Engineering and machinery spaces	1 for each space	B-II, C-II, and B-V if oil-fired boilers are present
Cargo spaces used for vehicles	1 for every 10 vehicles	B-II
Accommodation spaces	1 for each 250 m^2 (2691 ft^2)	A-II
Service spaces	1 for each space	A-II, B-II

21.13.2.3.3 Group IV Passenger Vessels. Portable fire extinguishers shall be provided in accordance with Table 21.13.2.3.2.

21.13.3 Fire-Fighting Clothing and Equipment.

21.13.3.1 Requirements for Group I and Group II Passenger Vessels that Carry More than 600 Passengers.

21.13.3.1.1 A minimum of two sets of fire fighter protective clothing meeting the requirements of 9.3.1 shall be provided. Three additional sets of fire fighter protective clothing meeting the requirements of 9.3.1 shall be provided for each 40 m (131.2 ft) of vessel length. The required fire fighter protective clothing shall be stowed in widely separated compartments.

21.13.3.1.2 A minimum of two sets of SCBA meeting the requirements of 9.3.2 shall be provided. Three additional sets of SCBA meeting the requirements of 9.3.2 shall be provided for each 40 m (131.2 ft) of vessel length. The required SCBA shall be stowed in widely separated compartments.

21.13.3.1.3 On Group I passenger vessels, an SCBA recharging station meeting the requirements of 9.3.2 shall be provided.

21.13.3.2 Group III Carrying 600 or Less Passengers and Group IV. Fire-fighting clothing and equipment shall not be required.

21.13.4 Ventilation Systems. Ventilation systems in Group I, Group II, and Group III passenger vessels shall comply with Section 9.4.

21.13.5 Elevators, Escalators, and Dumbwaiters. Where installed, elevators, escalators, and dumbwaiters shall comply with Section 9.5.

21.13.6 Electrical Installations on Group I, Group II, and Group III Passenger Vessels. Electrical installations shall comply with Section 9.6.

21.14* Group V Passenger Vessels. Group V passenger vessels shall comply with Section 21.1 and the IMO's *High Speed Craft Code* in lieu of this chapter.

21.15 Group IV Passenger Vessels.

21.15.1 General Requirements.

21.15.1.1 Chapters 7 through 18 shall not apply to Group IV passenger vessels, except as specified in Section 21.15.

21.15.1.2 Occupant load shall be determined in accordance with 10.1.4.1.

21.15.2* Means of Egress.

21.15.2.1 Doors.

21.15.2.1.1 Doors accessible to crew and passengers shall be a minimum 860 mm (34 in.) in width. Doors shall meet the swing and force-to-open requirements of 7.2.1.4.

21.15.2.1.2 Doors accessible only to crew shall be permitted to be reduced to a minimum of 700 mm (28 in.) in width.

21.15.2.2 Stairs. Stairs shall meet the minimum dimensional criteria of 7.2.2.2.1.

21.15.2.3 Ladders. Where permitted as a component in a means of egress, a ladder shall comply with the dimensional criteria of 7.2.8.

21.15.2.4 Deck Scuttles. Deck scuttles shall be permitted as a means of egress, provided they are a minimum 450 mm (18 in.) diameter clear area and are fitted with a quick-acting release and a hold-back hook.

21.15.2.5 Capacity of Means of Egress. Egress capacity shall be in accordance with 7.3.3.

21.15.2.6 Number of Exits.

21.15.2.6.1 A minimum of two exits, remotely located in accordance with 7.5.1.4, shall be accessible from all spaces, except as provided in 21.15.2.6.1.1.

21.15.2.6.1.1 A single means of egress shall be acceptable from a space less than 30 m^2 (323 ft^2) in a gross deck area where the characteristics outlined in (1) through (3) apply:

(1) The means of egress is located as far from machinery spaces and fuel tanks as possible.
(2) There is no stove, heater, or other source of fire in the space.
(3) If from an accommodation space, the means of egress does not include a deck scuttle or vertical ladder.

21.15.2.6.2 Access to at least one of the required exits shall be independent of watertight doors.

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21.15.2.6.3 A ladder leading to a deck scuttle shall be permitted as not more than one of the required means of egress where at least one of the following applies:

(1) It is accessible only to crew.
(2) It is fitted on a vessel not more than 20 m (65.6 ft) in length.

21.15.2.6.4 A window shall be permitted as not more than one of the required means of egress where the following applies:

(1) It is fitted on a vessel not more than 20 m (65.6 ft) in length.
(2) It does not lead directly overboard.
(3) It can be opened without the use of tools or is designed to be kicked or pushed out.
(4) It is marked in accordance with Section 7.10.
(5) It is a minimum 450 mm (18 in.) diameter clear area.

21.15.2.6.5 Dead-end corridors exceeding 7 m (23 ft) in length shall not be permitted.

21.15.2.6.6 Means of egress shall be marked in accordance with Section 7.10.

21.15.3 Accommodation Spaces. Accommodation spaces shall be separated from machinery spaces and fuel tanks by a minimum C'-Class division.

21.15.4 Medical, Health Care, and Child Care Spaces. (Reserved)

21.15.5 Service Spaces.

21.15.5.1 All surfaces within 1 m (3.3 ft) of cooking appliances shall exhibit a flame spread index not exceeding 75 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, or with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

21.15.5.2 Curtains, draperies, or free-hanging fabrics shall not be fitted within 1 m (3.3 ft) of cooking or heating appliances.

21.15.6 Electrical and Control Spaces. (Reserved)

21.15.7 Engineering and Machinery Spaces.

21.15.7.1 Dry exhaust systems on vessels of wooden or combustible composite construction shall comply with ABYC P-1, *Installation of Exhaust Systems for Propulsion and Auxiliary Engines*.

21.15.7.2 Fuel lines and hose shall be located as far as possible from heat sources.

21.15.7.3 All machinery spaces shall be separated from accommodation spaces and from electrical and control spaces by bulkheads and decks of minimum B-0 integrity.

21.15.8 Storage Spaces. Paint, high-risk fuels, and flammable aerosols, other than alcohol in containers not exceeding 10 L (2.6 gal), shall be stored in containers in accordance with NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.

21.15.9 Cargo Spaces and Fuel Tanks. (Reserved)

21.15.10 Open Decks. (Reserved)

21.15.11 Helicopter Decks. (Reserved)

21.15.12 Materials of Construction. When fiber-reinforced plastic (FRP) is used, the requirements of 21.15.12 shall apply.

21.15.12.1 FRP using resin that exhibits a flame spread index not exceeding 100 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, or with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, shall be permitted to be used as materials of construction.

21.15.12.2 All service spaces, except as provided in 21.15.12.3, shall be enclosed with bulkheads and decks meeting minimum B-15 integrity.

21.15.12.3 Service spaces that do not contain any cooking equipment with a surface temperature exceeding 120°C (248°F) shall not be required to be enclosed with bulkheads and decks meeting minimum B-15 integrity.

21.15.12.4 Electrical equipment, including switchboards, shall be separated from fuel and water sources.

21.15.12.5 A fire detection system meeting the requirements of Section 9.1 shall be installed to protect all accommodation, service, and storage spaces and all voids that contain surfaces that could exceed a surface temperature of 120°C (248°F).

21.15.12.6 All furniture and furnishings shall meet the criteria for low- and medium-risk accommodation spaces of 21.4.1.

21.15.12.7 All machinery spaces shall be separated from accommodation, electrical, and control spaces by minimum B-0 Class divisions.

21.15.12.8 Group IV vessels shall not have overnight accommodations for more than 12 persons.

21.15.12.9 Gasoline shall not be used for the propulsion machinery, except that outboard engines shall be permitted to be powered by gasoline, provided the fuel is stored in an open-area aft.

21.15.12.10 Group IV vessels shall not carry high-risk or low-risk fuels or combustible materials as cargo.

21.15.12.11 Internal combustion exhausts, boiler and galley uptakes, and similar sources of ignition shall be kept clear and insulated from combustible material.

21.15.13 Ventilation Systems.

21.15.13.1 Ventilation of Enclosed and Partially Enclosed Spaces.

21.15.13.1.1* All spaces shall be ventilated in a manner suitable for the space.

21.15.13.1.2 Power ventilation systems shall be capable of being shut down from the pilot house.

21.15.13.1.3 Enclosed spaces accessible only to crew shall be ventilated. If the space is not capable of being ventilated by natural ventilation, a power ventilation system shall be installed.

21.15.13.1.4 Exhaust ducts ventilating frying equipment shall be a minimum 3.2 mm (11 gauge) steel.

21.15.13.1.5 Combustible materials shall not be located in ventilation ducts, unless they meet the requirements of 21.15.13.1.7 or 21.15.13.1.8.

21.15.13.1.6 No piping or wiring shall be installed in exhaust ducts that ventilate frying equipment.

21.15.13.1.7 Electrical wiring installed in metal conduit or piping that does not interfere with the operation of dampers shall be permitted to be located in ventilation ducts.

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21.15.13.1.8 Electrical and optical fiber wiring meeting the requirements of plenum cables *(see 8.5.3)* shall be permitted to be located in ventilation ducts.

21.15.13.2 Ventilation of Machinery and Fuel Tank Spaces. Ventilation of machinery and fuel tank spaces shall comply with 46 CFR 182, "Machinery Installations."

21.15.14 Electrical Installations. Electrical installations shall be in accordance with 46 CFR 183, "Electrical Installations."

Chapter 22 Reserved

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.5 Permanently moored vessels fall within the scope of NFPA *101, Life Safety Code.*

A.1.2.3 Requirements for crew training can be found in 46 CFR 10, "Licensing of Maritime Personnel," 46 CFR 12, "Certification of Seamen," and the IMO *International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers.*

A.1.3.1 The authority having jurisdiction would have the decision as to whether warships could be covered by this code.

A.1.3.6 Such vessels should comply with the *International Convention for the Safety of Life at Sea*, SOLAS, as amended.

For Canadian registered vessels, SOLAS Ch. II-2, FSS Code and FTP Code (2004 ed.) with MSC/Circulars and IMO Resolutions as amended, should be incorporated by reference in addition to existing Canadian Fire Regulations, including but not limited to CSA 20/TP 4813, *Fire Detection and Extinguishing Equipment Regulations.* Canadian convention vessels should use the SOLAS Ch II-2 and applicable codes in their entirety.

All fire equipment and suppression systems installed on Canadian vessels should be in accordance with SOLAS Ch. II-2 and listed by ULC, UL, or USCG and approved by Transport Canada Marine Safety.

A.1.6.1 The intention of this document is that the requirements be applied in their entirety.

A.1.6.3 Refer to NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up*, for guidance.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.2 Area of Refuge. Areas of refuge should be properly sized and protectively bounded from fire and smoke, and should provide protected access to the embarkation area.

A.3.3.6 Bulkhead Panel. Bulkhead panels are fitted together with joiner components to form a bulkhead.

A.3.3.9 Ceiling. A ceiling is not considered part of the overhead structural deck.

A.3.3.11 Common Path of Travel. Paths that merge are common paths of travel. A common path of travel is measured in the same manner as travel distance but terminates at that point where two separate and distinct routes become available.

A common path of travel exists where a space is arranged so that occupants within that space are able to travel in only one direction to reach any of the exits or to reach the point at which the occupants have the choice of two paths of travel to remote exits. Figure A.3.3.11 is an example of a common path of travel. The portion of the exit access travel for which an occupant is steered in one direction only, without the option of traveling in another independent direction toward an exit, is a common path of travel. Common paths of travel are illustrated by the dashed lines.

A.3.3.12.1 Fire Damper. The damper is designed to slow the spread of fire through the ductwork.

A.3.3.15 Deck Covering. The term *deck covering* should not be confused with the term *primary deck covering* as used in SOLAS, which is analogous to "deck overlay," as used in this document, which is considered interior finish.

A.3.3.16 Deck Finish. Examples include carpet, wood flooring, vinyl tiles, and so forth.

A.3.3.20 Draft Stop. The purpose of a draft stop is to prevent the spread of fire or smoke within concealed spaces.

A.3.3.22 Exit. Includes exterior exit doors, exit passageways, separated exit stairs, and separated exit ramps.

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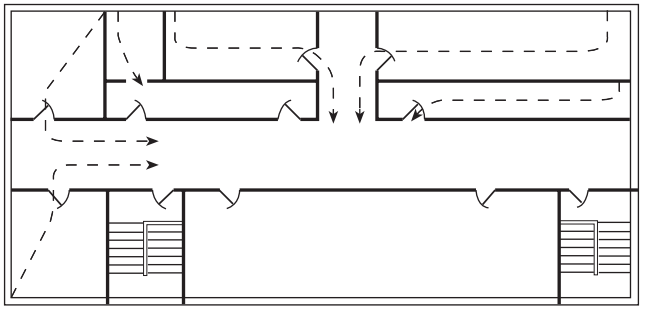


FIGURE A.3.3.11 Common Paths of Travel.

A.3.3.22.1 Horizontal Exit. A horizontal exit should not be confused with egress through doors. Horizontal exits provide protection against serious fire for a long period of time in addition to providing immediate protection from smoke. Horizontal exits are similar in concept to main vertical zones but do not have restrictions on length. Figure A.3.3.22.1 is an example of a horizontal exit. A-60 (as shown in the figure) is generally required for horizontal exits but can be modified as allowed by Chapters 18 through 20.

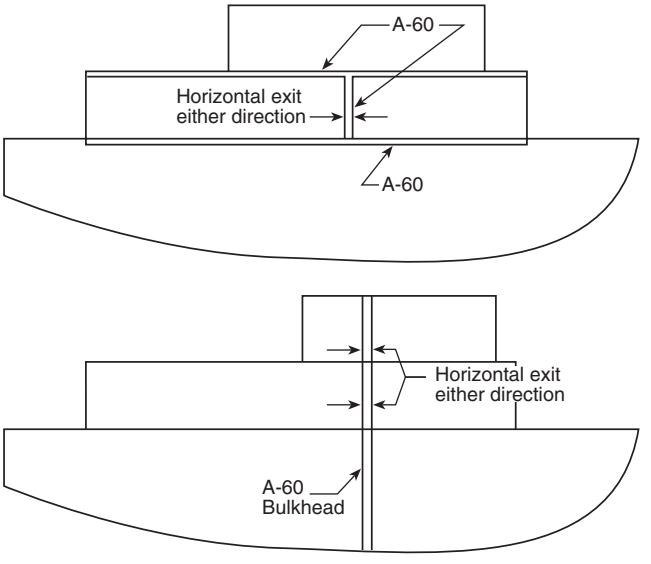


FIGURE A.3.3.22.1 Horizontal Exit.

A.3.3.30 Fire-Rated Glazing. The glass could be or could not be wire reinforced.

A.3.3.41 Major Modification. Replacement in kind of structural material for hull and superstructure, replacement of a vessel's piping or electrical systems, and replacement of vessel propulsion systems does not constitute cause for determination of major modification. Where a part of a vessel or an occupancy is changed or replaced and that does not constitute a major modification, the requirements of this document should apply only to the portion of the vessel that was modified. The authority having jurisdiction should encourage owners to enhance the fire protection features of existing vessels without imposing new requirements via the major modification clause.

A.3.3.43 Means of Egress. A means of egress comprises the vertical and horizontal travel and includes intervening room spaces or open decks, doorways, passageways, mezzanines, galleries, ramps, stairs, enclosures, lobbies, and escalators.

Means of egress is intended to be synonymous with means of escape.

A.3.3.50 Photoluminescent. The released light is normally visible for a limited time if the ambient light sources are removed or partially obscured.

A.3.3.54 Structural Fire Protection. Additional items considered are joiner–work details and penetrations of structural elements. Structural, or fire, insulation refers to insulation employed as a part of the structural fire protection system.

A.3.3.55 Survival Craft. The term includes lifeboats, liferafts, buoyant apparatus, and lifefloats.

A.3.3.57 Trunk. Trunks are also designed for access to and egress from ship spaces, and as escape routes. Trunks penetrating fire-rated bulkheads and decks should not destroy the structural and fire resistance integrity of the affected division.

A.3.4.1 Electrical and Control Space. See 6.1.5 or Chapter 13.

A.3.4.2 Engineering and Machinery Space. See 6.1.6 or Chapter 14.

A.3.4.3 Manned Space. Manned spaces are normally occupied by crew or others.

A.3.4.5 Restricted Access Space. Examples of restricted access spaces are cargo holds, fuel tanks, and cargo tanks.

A.3.4.7 Unmanned Space. Unmanned spaces are not normally occupied, while a vessel is underway or in port. However, they are at times occupied, and the occasional manning of the space can correspond to maintenance, inspection, response to abnormal condition alarms, or other situations.

A.3.4.8 Vehicle Space. Examples of vehicle spaces are open vehicle decks, enclosed decks, and RO/RO spaces.

A.3.5.4 Design Specification. Design specifications include both hardware and human factors, such as the conditions produced by maintenance and training. For purposes of performance-based design, the design specifications of interest are those that affect the ability of the building to meet the stated goals and objectives. [***5000,*** 2006]

A.3.5.6 Exposure Fire. An exposure fire usually refers to a fire that starts outside a building, such as a wildlands fire or vehicle fire, and that, consequently, exposes the building to a fire.

A.3.5.7 Fire Model. Due to the complex nature of the principles involved, models are often packaged as computer software. Any relevant input data, assumptions, and limitations needed to properly implement the model will be attached to the fire models.

A.3.5.8 Fire Scenario. A fire scenario defines the conditions under which a proposed design is expected to meet the fire safety goals. Factors typically include fuel characteristics, ignition sources, ventilation, building characteristics, and occupant locations and characteristics. The term *fire scenario* includes more than the characteristics of the fire itself but excludes design specifications and any characteristics that do not vary from one fire to another; the latter are called assumptions. The term is used here to mean only those specifications required to calculate the fire's development and effects, but,

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in other contexts, the term might be used to mean both the initial specifications and the subsequent development and effects (i.e., a complete description of fire from conditions prior to ignition to conditions following extinguishment).

A.3.3.5.9 Fuel Load. Fuel load includes interior finish and trim. [***5000***, 2006]

A.3.3.5.13 Performance Criteria. Performance criteria are stated in engineering terms. Engineering terms include temperatures, radiant heat flux, and levels of exposure to fire products. Performance criteria provide threshold values used to evaluate a proposed design.

A.3.3.5.14 Proposed Design. The design team might develop a number of trial designs that will be evaluated to determine whether they meet the performance criteria. One of the trial designs will be selected from those that meet the performance criteria for submission to the authority having jurisdiction as the proposed design. The proposed design is not necessarily limited to fire protection systems and building features. It also includes any component of the proposed design that is installed, established, or maintained for the purpose of life safety, without which the proposed design could fail to achieve specified performance criteria. Therefore, the proposed design often includes emergency procedures and organizational structures that are needed to meet the performance criteria specified for the proposed design.

A.4.1 The following are secondary benefits that could be met in applying this code:

(1) Prevent pollution of the marine environment from fuels, lubricants, cargo, and extinguishing agents
(2) Avoid obstruction of maritime commerce

A.5.1.1 Chapter 5 provides requirements for the evaluation of a performance-based life safety design. The evaluation process is summarized in Figure A.5.1.1.

Code Criteria. On the left side of Figure A.5.1.1 is input from the Code. The fundamental requirements have been stated in Section 4.1 and Section 4.2. Section 5.2 specifies the performance criteria that are to be used to determine whether the objectives have been met.

Input. At the top of Figure A.5.1.1 is the input necessary to evaluate a life safety design. The design specifications are to include certain retained prescriptive requirements, as specified in Section 5.3. All assumptions about the life safety design and the response of the vessel and its occupants to a fire are to be clearly stated as indicated in Section 5.4. Scenarios are used to assess the adequacy of the design. Eight sets of initiating events are specified for which the ensuing outcomes are to be satisfactory.

Performance Assessment. Appropriate methods for assessing performance are to be used per Section 5.6. Safety factors are to be applied to account for uncertainties in the assessment, as stated in Section 5.7. If the resulting predicted outcome of the scenarios is bounded by the performance criteria, the objectives have been met, and the life safety design is considered to be in compliance with this Code. Although not part of this Code, a design that fails to comply can be changed and reassessed, as indicated on the right side of Figure A.5.1.1.

Documentation. The approval and acceptance of a life safety design are dependent on the quality of the documentation of the process. Section 5.8 specifies a minimum set of documentation that is to accompany a submission.

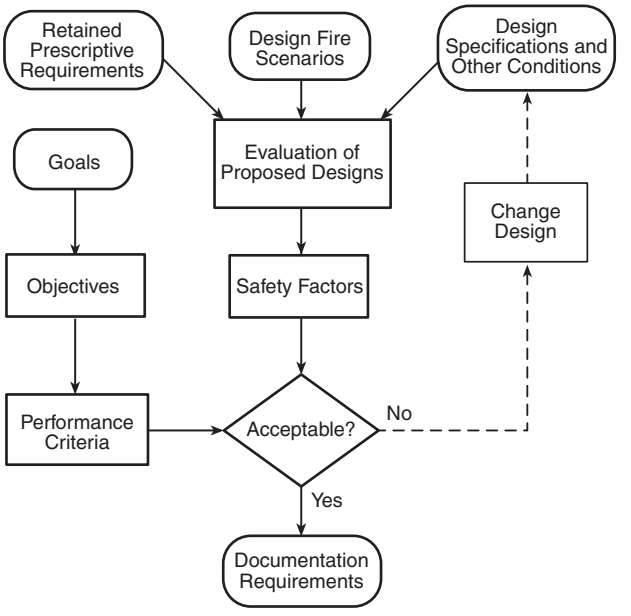


FIGURE A.5.1.1 Performance-Based *Life Safety Code* Compliance Process.

The performance option of this Code establishes acceptable levels of risk to occupants of vessels as addressed in Section 1.1. While the performance option of this Code does contain goals, objectives, and performance criteria necessary to provide an acceptable level of risk to occupants, it does not describe how to meet the goals, objectives, and performance criteria. Design and engineering are needed to develop solutions that meet the provisions of Chapter 5. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* provides a framework for these assessments. Other useful references include the *Australian Fire Engineering Guidelines* and the *British Standard Firesafety Engineering in Buildings.*

A.5.1.4 A third-party reviewer is a person or group of persons chosen by the authority having jurisdiction to review proposed performance-based designs. *The SFPE Guidelines for Peer Review in the Fire Protection Design Process* provides a method for the initiation, scope, conduct, and report of a peer review of a fire protection engineering design.

A.5.1.6 For guidance on reviewing performance-based designs, see the *SFPE Enforcer's Guide to Performance-Based Design Review.* Additional guidance on reviewing designs in which fire risk assessment is used can be found in NFPA 551, *Guide for the Evaluation of Fire Risk Assessments.*

A.5.1.7 Continued compliance with the goals and objectives of the Code involves many factors. The vessel construction — including openings, interior finish, and structural fire protection — and the vessel and fire protection systems need to retain at least the same level of performance as is provided for the original design parameters. The use and occupancy should not change to the degree that assumptions made about the occupant characteristics, combustibility of furnishings, and existence of trained crew are no longer valid. In addition, actions provided by other personnel, such as emergency responders, should not be diminished below the documented assumed levels. Also, actions needed to maintain reliability of systems at the anticipated level need to meet the initial design criteria.

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A.5.2.2 One of the methods that follow can be used to avoid exposing occupants to untenable conditions.

Method 1. The design team can set detailed performance criteria that ensure that occupants are not incapacitated by fire effects. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* describes a process of establishing tenability limits.

The guide references D. A. Purser, "Toxicity Assessment of Combustion Products," Chapter 2/6, *SFPE Handbook of Fire Protection Engineering*, which describes a fractional effective dose (FED) calculation approach, which is also contained in NFPA 269, *Standard Test Method for Developing Toxic Potency Data for Use in Fire Hazard Modeling*. FED addresses the effects of carbon monoxide, hydrogen cyanide, carbon dioxide, hydrogen chloride, hydrogen bromide, and anoxia. It is possible to use the test data, combined with laboratory experience, to estimate the FED value that leads to the survival of virtually all people. This value is about 0.8.

There is a relationship between exposures leading to death and those leading to incapacitation. Kaplan (*Journal of Fire Sciences*) found that rodent susceptibility is similar to that of humans and that for the narcotic gases, CO and HCN, incapacitation is estimated to occur at one-third to one-half of the lethal exposure. A set of very large statistical studies on human lethality associated with carbon monoxide involving almost 5000 fatalities (Hirschler et al., "Carbon Monoxide and Human Lethality: Fire and Non-Fire Studies") showed that the vast majority of fire deaths are attributable to carbon monoxide poisoning, which results in lethality at levels as low as 25 percent carboxyhemoglobin (much lower than previously believed) without requiring the effect of additional toxicants. This work was also confirmed by Gann (*Fire and Materials*), who also found that carbon monoxide dominates the lethality of fire smoke, since most fire deaths occur remote from the fire room, in fires that have proceeded past flashover. Thus, if an FED value of 0.8 were used for a nonlethal exposure, an FED of 0.3 would be reasonable for a nonincapacitating exposure.

If the authority having jurisdiction or the design professional is concerned with potential toxic fire effects, other than those addressed by the FED procedure as documented, the calculation procedure can be expanded by adding additional terms to the FED equation, with each term expressed as a ratio. The numerator of the ratio is the cumulative exposure to that fire effect, measured as an integral of the product of instantaneous exposure (concentration for toxic products) and time. The denominator of the ratio is the quantity of cumulative exposure for which FED equals the chosen threshold value (that is, 0.8 or 0.3) based on that fire effect alone. A complete analysis of tenability requires consideration of tenability criteria for thermal effects (convected heat and radiated heat) and smoke obscuration, as well as those for smoke toxicity, and an example of the application of such criteria is shown in ASTM E 2280, *Standard Guide for Fire Hazard Assessment of the Effect of Upholstered Seating Furniture Within Patient Rooms of Health Care Facilities*.

For vessels where an unusually large fraction of the occupants are especially vulnerable, the calculation procedure for the smoke toxicity incapacitating criterion should be modified to use FED values lower than 0.8 or 0.3.

Method 2. For each design fire scenario and the design specifications, conditions, and assumptions, the design team can demonstrate that each room or area will be fully evacuated before the smoke and toxic gas layer in that room descends to a level lower than 6 ft (1830 mm) above the floor. The timing of such an evacuation means that no occupant is exposed to fire effects. Such an evacuation requires calculation of the locations, movement, and behavior of occupants, because fire effects and occupants are separated by moving the occupants. A level of 60 in. (1525 mm) is often used in calculations, but, at that level, a large fraction of the population would not be able to stand, walk, or run normally and still avoid inhalation of toxic gases. They would have to bend over or otherwise move their heads closer to the floor level.

Method 3. For each design fire scenario and the design specifications and assumptions, the design team can demonstrate that the smoke and toxic gas layer will not descend to a level lower than 6 ft (1830 mm) above the floor in any occupied room. The advantage of this procedure is that it conservatively ensures that no occupant is exposed to fire effects, regardless of where occupants are located or where they move. This eliminates the need for calculations regarding occupants, including those for their behavior, movement locations, pre-fire characteristics, and reactions to fire effects. This procedure is even more conservative and simpler than the procedure in Method 2, because it does not allow fire effects in occupied rooms to develop to a point where people could be affected at any time during the fire.

Method 4. For each design fire scenario and the design specifications and assumptions, the design team can demonstrate that no fire effects will reach any occupied room. The advantage of this procedure is that it eliminates the need for calculations regarding occupants, including those for their behavior, movement, locations, pre-fire characteristics, and reactions to fire effects. A further advantage is that it also eliminates the need for some of the modeling of fire effects, because it is not necessary to model the filling of rooms, only the spread of fire effects to those rooms. This procedure is even more conservative and simpler than the procedures in Methods 2 and 3, because it does not allow any fire effects in occupied rooms.

A.5.3.1 This requirement applies both to systems and features required by this Code that reference applicable standards and to any additional systems or features included in the design at the discretion of the design team. The referenced standards are hereby expected to state maintenance, testing, and other requirements needed to provide positive assurance of an acceptable level of reliability. The referenced standards themselves might be prescriptive- or performance-based.

A.5.4.1 The design specifications and other conditions form the input to evaluation of proposed designs *(see Section 5.6)*. Where a specification or condition is not known, a reasonable estimation is permitted. However, the design team must take steps to ensure that the estimation is valid during the life of the vessel. Any estimations need to be documented. *(See Section 5.8.)*

A.5.4.4 Systems addressed by this requirement include automatic fire suppression systems and fire alarm systems. Performance issues that need to be documented might include response time indexes, discharge densities, and distribution patterns. Calculations should not include an unlimited supply of extinguishing agent if only a limited supply will be provided in the actual vessel.

A.5.4.5.1 Examples of design features that might be incorporated to modify expected occupant characteristics include training, use of staff to assist with notification and movement, or type of notification appliance used.

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A.5.4.5.2 The four basic characteristics — sensibility, reactivity, mobility, and susceptibility — make up a minimum, exhaustive set of mutually exclusive performance characteristics of people onboard vessels that can affect a fire safety system's ability to meet life safety objectives. The characteristics are briefly described as follows:

(1) Sensibility to physical cues, which is the ability to sense the sounding of an alarm and can also include discernment and discrimination of visual and olfactory cues in addition to auditory emanations from the fire itself
(2) Reactivity, which is the ability to interpret cues correctly and take appropriate action and can be a function of cognitive capacity, speed of instinctive reaction, or group dynamics. There might be a need to consider reliability or likelihood of a wrong decision, as in situations where familiarity with the vessel influences wayfinding
(3) Mobility (speed of movement), which is determined by individual capabilities, as well as crowding phenomena, such as arching at doorways and vessel movements
(4) Susceptibility to products of combustion, which includes metabolism, lung capacity, pulmonary disease, allergies, or other physical limitations that affect survivability in a fire environment

In application, as with the use of computer evacuation models, assumptions can address a larger number of factors that are components of the basic performance characteristics, including the following:

(1) Alertness — awake or asleep, can depend on time of day
(2) Responsiveness — ability to sense cues and react
(3) Commitment — degree to which occupant is committed to an activity underway before the alarm
(4) Focal point — point at which an occupant's attention is focused; for example, to front of classroom, stage, or server in business environment
(5) Physical and mental capabilities — can affect ability to sense, respond, and react to cues; might be related to age or disability
(6) Role — can determine whether occupant will lead or follow others
(7) Familiarity — can depend on time spent on vessels or participation in emergency training
(8) Social affiliation — extent to which an occupant will act and react as an individual or as a member of a group
(9) Condition over the course of the fire — effects, both physiological and psychological, of the fire and its combustion products on each occupant

For a more detailed explanation of occupant characteristics, see the *SFPE Engineering Guide to Human Behavior in Fire*. Occupant characteristics that are discussed in the guide include the following:

(1) Population numbers and density
(2) Alone or with others
(3) Familiarity with the vessel
(4) Distribution and activities
(5) Alertness
(6) Physical and cognitive ability
(7) Social affiliation
(8) Role and responsibility
(9) Location
(10) Commitment
(11) Focal point
(12) Occupant condition
(13) Gender
(14) Culture
(15) Age

A.5.4.5.4 The number of people expected to be contained in a room or area should be based on the occupant load factor specified in 10.1.4.1 or other approved sources.

A.5.4.5.5 For example, crew characteristics such as number, location, and frequency of training should be considered.

A.5.4.7 Design proposals need to state explicitly any design specifications or estimations regarding vessel fire safety plans, inspection programs, or other ongoing programs whose performance is necessary for the vessel, when occupied and operational, to meet the stated goals and objectives. Programs of interest include any maintenance, training, labeling, or certification programs required to ensure operational status or reliability in systems or features.

A.5.4.9 The design elements required to be excluded by 5.4.9 include those regarding the interrelations among the performance of vessel elements and systems, occupant behavior, or emergency response actions that conflict with each other. For each fire scenario, care needs to be taken to ensure that conflicts in actions do not occur. Typical conflicts could include the following:

(1) Assuming a fire door will remain closed during the fire to contain smoke while this same door is used by occupants during egress from the area
(2) Assuming fire boats will arrive immediately from a distant location to provide water to international shore connections and similar situations

For example, an assumption that compartmentation blocking the passage of fire and smoke will be maintained at the door to a stairwell cannot be paired with an assumption that evacuation through that door will extend over many minutes.

A.5.4.10 The provisions required by 5.4.10 to be documented include those that are in excess of basic requirements covered by referenced codes and standards, typical design requirements, and operating procedures. It includes provisions such as the following:

(1) More frequent periodic testing and maintenance to increase the reliability of fire protection systems
(2) Redundant systems to increase reliability
(3) On-site guard service to enhance detection of fires and aid in fire response procedures
(4) Staff training
(5) Availability and performance of emergency response personnel
(6) Other factors

A.5.5 Design fire scenarios define the challenge a vessel is expected to withstand. Design fire scenarios capture and limit value judgments on the type and severity of the fire challenge to which a proposed fire safety system needs to respond. The system includes any and all aspects of the proposed design that are intended to mitigate the effects of a fire, such as egress system, automatic detection and suppression, barriers, crew training, and placement of manual extinguishers.

Design fire scenarios come from two sources: those that are specified in 5.5.3.1 through 5.5.3.8, and those that are developed by the design team based on the unique characteristics of the vessel as required by 5.5.2. In most, if not all, cases, more

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than one design fire scenario will be developed to meet the requirements of 5.5.2.

Once the set of design fire scenarios is established, both those specified by 5.5.3.1 through 5.5.3.8 and those that are developed as required by 5.5.2, they need to be quantified into a format that can be used for the evaluation of proposed designs. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process and identifies tools and references that can be used at each step of this process.

A.5.5.2 The protection systems and features used to meet the challenge of the design fire scenario should be typical of and consistent with those used for other similar areas of the vessel. They should not be designed to be more effective in the area addressed than in similar areas not included and that are, therefore, not explicitly evaluated.

A.5.5.3 It is desirable to consider a wide variety of different fire scenarios to evaluate the complete life safety capabilities of the vessel. Fire scenarios should not be limited to a single or a couple of worst-case fire scenarios.

The descriptive terms used to indicate the rate of fire growth for the scenarios are intended to be generic. Use of t-squared fires is not required for any scenario.

A.5.5.3.1 An example of Design Fire Scenario 1 for an accommodation occupancy involves a passenger cabin with two beds, with a fire initially involving one bed and the door to the corridor open. This is a cursory example in that much of the explicitly required information indicated in 5.5.3.1 can be determined from the information provided in the example. Note that it is usually necessary to consider more than one scenario to capture the features and conditions typical of an occupancy.

A.5.5.3.2 Design Fire Scenario 2 examples include a fire involving ignition of 100-proof alcohol for a restaurant dessert flambé station near the main means of egress from the restaurant that extends to other fuel configurations to cause an ultrafast fire. The means of egress chosen is the doorway with the largest egress capacity among doorways normally used in the ordinary operation of the restaurant. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the vessel.

A.5.5.3.3 An example of Design Fire Scenario 3 is a fire in a storage locker adjacent to the largest public space on the vessel. The contents of the room of fire origin are specified to provide the largest fuel load and the most rapid growth in fire severity consistent with the normal use of the locker. The adjacent public space is assumed to be filled to capacity with occupants. Occupants are assumed to be somewhat impaired in whatever form is most consistent with the intended use of the vessel. At ignition, doors from both rooms are assumed to be open. Depending on the design, doorways connect the two rooms or they connect via a common hallway or corridor.

A.5.5.3.4 An example of Design Fire Scenario 4 is a fire originating in a concealed bulkhead or ceiling space adjacent to a large, occupied public space. Ignition involves concealed combustibles, including wire or cable insulation. The adjacent public space is assumed to be occupied to capacity. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the vessel.

A.5.5.3.5 An example of Design Fire Scenario 5 is a cigarette fire in a trash can. The trash can is close enough to room contents to ignite more substantial fuel sources but is not close enough to any occupant to create an intimate-with-ignition situation. If the intended use of the vessel involves the potential for some occupants to be incapable of movement at any time, the room of origin is chosen as the type of room likely to have such occupants, filled to capacity with occupants in that condition. If the intended use of the property does not involve the potential for some occupants to be incapable of movement, the room of origin is chosen to be a public space characteristic of the use of the vessel, and the trash can is placed so that it is shielded by furniture from suppression systems. At ignition, doors are assumed to be open throughout the vessel.

A.5.5.3.6 An example of Design Fire Scenario 6 is a fire originating in the largest fuel load of combustibles possible in normal operation in the largest public space, the main galley, or machinery space. The configuration, type, and geometry of the combustibles are chosen so as to produce the most rapid and severe fire growth or smoke generation consistent with normal operations. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be closed throughout the vessel.

A.5.5.3.7 An example of Design Fire Scenario 7 is an exposure fire. The initiating fire is the closest and most severe fire possible consistent with the placement and type of adjacent vessels and shoreside properties. The baseline occupant characteristics for the property are assumed.

This category includes wildlands fires, urban interface fires, and exterior wood shingle problems, where applicable.

A.5.5.3.8 Design Fire Scenario 8 addresses a set of conditions with a typical fire originating in the vessel with any one passive or active fire protection system or feature being ineffective. Examples include unprotected openings between decks or between A-class bulkheads, failure of rated fire doors to close automatically, shutoff of sprinkler system water supply, nonoperative fire alarm system, inoperable smoke management system, or automatic smoke dampers blocked open. This scenario should represent a reasonable challenge to the other vessel features provided by the design and presumed to be available.

The concept of a fire originating in ordinary combustibles is intentionally selected for this scenario. This fire, although presenting a realistic challenge to the vessel and the associated systems, does not represent the worst-case scenario or the most challenging fire. Examples include the following:

(1) Fire originating in ordinary combustibles in an accommodation area under the following conditions:
   (a) Crew is assumed not to close any doors upon detection of fire.
   (b) The baseline occupant characteristics are assumed, and the rooms off the corridor are assumed to be filled to capacity.
   (c) At ignition, doors to rooms are not equipped with self-closing devices and are assumed to be open throughout the smoke compartment.
(2) Fire originating in ordinary combustibles in a large public space under the following conditions:
   (a) The automatic sprinklers are assumed to be out of operation.
   (b) The baseline occupant characteristics are assumed, and the room of origin is assumed to be filled to capacity.
   (c) At ignition, doors are assumed to be closed throughout the vessel.

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(3) Fire originating in ordinary combustibles in an unoccupied storage room adjacent to a large public space under the following conditions:
   (a) The automatic detection systems are assumed to be out of operation.
   (b) The baseline occupant characteristics are assumed, the room of origin is assumed to be unoccupied, and the public space is assumed to be filled to capacity.
   (c) At ignition, doors are assumed to be closed throughout the vessel.

A.5.5.3.8(3) The exemption is applied to each active or passive fire protection system individually and requires two different types of information to be developed by analysis and approved by the authority having jurisdiction. System reliability is to be analyzed and accepted. Design performance in the absence of the system is also to be analyzed and accepted, but acceptable performance does not require fully meeting the stated goals and objectives. It might not be possible to meet fully the goals and objectives if a key system is unavailable, and yet no system is totally reliable. The authority having jurisdiction will determine which level of performance, possibly short of the stated goals and objectives, is acceptable, given the very low probability (i.e., the system's unreliability probability) that the system will not be available.

A.5.6 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process for evaluating whether trial designs meet the performance criteria during the design fire scenarios. Additional information on reviewing the evaluation of a performance-based design can be found in the *SFPE Enforcer's Guide to Performance-Based Design Review*.

The procedures described in Sections 5.2 and 5.4 identify required design fire scenarios among the design fire scenarios within which a proposed fire safety design is required to perform and the associated untenable conditions that are to be avoided in order to maintain life safety. Section 5.6 discusses methods that form the link from the scenarios and criteria to the goals and objectives.

Assessment methods are used to demonstrate that the proposed design will achieve the stated goals and objectives, by providing information indicating that the performance criteria of Section 5.2 can be adequately met. Assessment methods are permitted to be either tests or modeling.

Tests. Test results can be directly used to assess a fire safety design when they accurately represent the scenarios developed by using Section 5.4 and provide output data matching the performance criteria in Section 5.2. Because the performance criteria for this Code are stated in terms of human exposure to lethal fire effects, no test will suffice. However, tests will be needed to produce data for use in models and other calculation methods.

Standardized Tests. Standardized tests are conducted on various systems and components to determine whether they meet some predetermined, typically prescriptive criteria. Results are given on a pass/fail basis — the test specimen either does or does not meet the pre-established criteria. The actual performance of the test specimen is not usually recorded.

Scale. Tests can be either small, intermediate, or full scale. Small-scale tests are used to test activation of detection and suppression devices and the flammability and toxicity of materials. Usually, the item to be tested is placed within the testing device or apparatus. Intermediate-scale tests can be used to determine the adequacy of system components — for example, doors and windows — as opposed to entire systems. The difference between small- and intermediate-scale tests is usually one of definition provided by those conducting the test. Full-scale tests are typically used to test structural components or entire systems. The difference between intermediate- and large-scale tests is also subject to the definition of those performing the test. Full-scale tests are intended to most closely depict performance of the test subject as installed in the field; that is, full-scale tests most closely represent real-world performance.

Full-scale evacuations can provide information on how the evacuation of a vessel is likely to occur for an existing vessel with a given population without subjecting occupants to the real physical or psychological effects of a fire.

Data Uses. The data obtained from standardized tests have three uses for verification purposes. First, the test results can be used instead of a model. This use is typically the role of full-scale test results. Second, the test results can be used as a basis for validating the model. The model predictions match well with the test results. Therefore, the model can be used in situations similar to the test scenario. Third, the test results can be used as input to models. This is typically the use of small-scale tests, specifically flammability tests.

Start-Up Test. Start-up test results can be used to demonstrate that the fire safety system performs as designed. The system design might be based on modeling. If the start-up test indicates a deficiency, the system needs to be adjusted and retested until it can be demonstrated that the design can meet the performance criteria. Typically, start-up tests apply only to the installation to which they are designed.

Experimental Data. Experimental data from nonstandardized tests can be used when the specified scenario and the experimental setup are similar. Typically, experimental data are applicable to a greater variety of scenarios than are standardized test results.

Human and Organizational Performance Tests. Certain tests determine whether inputs used to determine human performance criteria remain valid during the occupancy of a vessel. Tests of human and organizational performance might include any of the following:

(1) Measuring evacuation times during fire drills
(2) Querying emergency response team members to determine whether they know required procedures
(3) Conducting field tests to ensure that emergency response team members can execute tasks within predetermined time and accuracy limits

Design proposals should include descriptions of any tests needed to determine whether stated goals, objectives, and performance criteria are being met.

Modeling. Models can be used to predict the performance criteria for a given scenario. Because of the limitations on using only tests for this purpose, models are expected to be used in most, if not all, performance-based design assessments.

The effects of fire and its toxic products on the occupants can be modeled, as can the movement and behavior of occupants during the fire. The term *evacuation model* is used to describe models that predict the location and movements of occupants, and the term *tenability model* is used to describe models that predict the effects on occupants of specified levels of exposure to fire effects.

Types of Fire Models. Fire models are used to predict fire-related performance criteria. Fire models can be either probabilistic or deterministic. Several types of deterministic models

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are available: computational fluid dynamics (CFD) or field models, zone models, purpose-built models, and hand calculations. Probabilistic fire models are also available but are less likely to be used for this purpose.

Probabilistic fire models use the probabilities as well as the severity of various events as the basis of evaluation. Some probabilistic models incorporate deterministic models but are not required to do so. Probabilistic models attempt to predict the likelihood or probability that events or severity associated with an unwanted fire will occur, or they predict the "expected loss," which can be thought of as the probability-weighted average severity across all possible scenarios. Probabilistic models can be manifested as fault or event trees or other system models that use frequency or probability data as input. These models tend to be manifested as computer software, but are not required to do so. Furthermore, the discussion that follows under "Sources of Models" can also be applied to probabilistic models, although it concentrates on deterministic models.

CFD models can provide more accurate predictions than other deterministic models, because they divide a given space into many smaller volumes. However, since they are still models, they are not absolute in their depiction of reality. In addition, they are much more expensive to use, because they are computationally intensive. Because of their expense, complexity, and intensive computational needs, CFD models require much greater scrutiny than do zone models.

It is much easier to assess the sensitivity of different parameters with zone models, because they generally run much faster and the output is much easier to interpret. Prediction of fire growth and spread has a large number of variables associated with it.

Purpose-built models (also known as stand-alone models) are similar to zone models in their ease of use. However, purpose-built models do not provide a comprehensive model. Instead, they predict the value of one variable of interest. For example, such a model can predict the conditions of a ceiling jet at a specified location under a ceiling, but a zone model would "transport" those conditions throughout the enclosure.

Purpose-built models might or might not be manifested as computer software. Models that are not in the form of software are referred to as hand calculations. Purpose-built models are, therefore, simple enough that the data management capabilities of a computer are not necessary. Many of the calculations are found in the *SFPE Handbook of Fire Protection Engineering*.

Types of Evacuation Models. Three categories of evacuation models can be considered: single-parameter estimation methods, movement models, and behavioral simulation models.

Single-parameter estimations are generally used for simple estimates of movement time. They are usually based on equations derived from observations of movement in nonemergency situations. They can be hand calculations or simple computer models. Examples include calculation methods for flow times based on widths of exit paths and travel times based on travel distances. Sources for these methods include the *SFPE Handbook of Fire Protection Engineering* and the *NFPA Fire Protection Handbook*.

Movement models generally handle large numbers of people in a network flow similar to water in pipes or ball bearings in chutes. They tend to optimize occupant behavior, resulting in predicted evacuation times that can be unrealistic and far from conservative. However, they can be useful in an overall assessment of a design, especially in early evaluation stages where an unacceptable result with this sort of model indicates that the design has failed to achieve the life safety objectives.

Behavioral simulation models take into consideration more of the variables related to occupant movement and behavior. Occupants are treated as individuals and can have characteristics assigned to them uniquely, allowing a more realistic simulation of the design under consideration. However, given the limited availability of data for the development of these models, for their verification by their authors, or for input when using them, their predictive reliability is questionable.

Tenability Models. In general, tenability models will be needed only to automate calculations for the time-of-exposure effect equations referenced in A.5.2.2.

Other Models. Models can be used to describe combustion (as noted, most fire models only characterize fire effects), automatic system performance, and other elements of the calculation. There are few models in common use for these purposes, so they are not further described here.

Sources of Models. Compendia of computer fire models are found in the *SFPE Computer Software Directory* and in "An Updated International Survey of Computer Models for Fire and Smoke," in the *Journal of Fire Protection Engineering*, 13 (2). Within these references are models that were developed by the Building and Fire Research Laboratory of the National Institute of Standards and Technology, which can be downloaded from the Internet at http://www.bfrl.nist.gov/864/fmabs.html. Evacuation models in all three categories are discussed in the *SFPE Handbook of Fire Protection Engineering* and the *NFPA Fire Protection Handbook*.

Validation. Models undergo limited validation. Most can be considered demonstrated only for the experimental results they were based on or the limited set of scenarios to which the model developers compared the model's output, or a combination of both.

The Society of Fire Protection Engineers has a task group that independently evaluates computer models. In January 1998, they finished their first evaluation and had chosen a second model for evaluation. Until more models can be independently evaluated, the model user has to rely on the available documentation and previous experience for guidance regarding the appropriate use of a given model.

The design professional should present the proposal, and the authority having jurisdiction, when deciding whether to approve a proposal, should consider the strength of the evidence presented for the validity, accuracy, relevance, and precision of the proposed methods. An element in establishing the strength of scientific evidence is the extent of external review and acceptance of the evidence by peers of the authors of that evidence.

Models have limitations; most are not user friendly, and experienced users are able to construct more reasonable models and better interpret output than are novices. For these reasons, the third-party review and equivalency sections are provided. The intent is not to discourage the use of models, only to indicate that they should be used with caution by those who are well versed in their nuances.

Input Data. The first step in using a model is to develop the input data. The heat release rate curve specified by the user is the driving force of a fire effects model. If this curve is incorrectly defined, the subsequent results are not usable. In addition to the smoldering and growth phases that will be specified as part of the scenario definition, two additional phases are needed to complete the input heat release rate curve — steady burning and burnout.

Steady burning is characterized by its duration, which is a function of the total amount of fuel available to be burned. In determining the duration of this phase, the designer needs to

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consider how much fuel has been assumed to be consumed in the smoldering and growth phases and how much is assumed to be consumed in the burnout phase that follows. Depending on the assumptions made regarding the amount of fuel consumed during burnout, the time at which this phase starts is likely to be easy to determine.

The preceding discussion assumes that the burning objects are solid (e.g., tables and chairs). If liquid or gaseous fuels are involved, the shape of the curve will be different. For example, smoldering is not relevant for burning liquids or gases, and the growth period is very short, typically measured in seconds. Peak heat release rate can depend primarily on the rate of release, on the leak rate (gases and liquid sprays), or on the extent of spill (pooled liquids). The steady burning phase is once again dependent on the amount of fuel available to burn. Like the growth phase, the burnout phase is typically short (e.g., closing a valve), although it is conceivable that longer times might be appropriate, depending on the extinguishment scenario.

Material properties are usually needed for all fuel items, both initial and secondary, and for the enclosure surfaces of involved rooms or spaces.

For all fires of consequence, it is reasonable to assume that the fire receives adequate ventilation. If there is insufficient oxygen, the fire will not be sustained. An overabundance of oxygen is only a concern in special cases (e.g., hermetically sealed spaces) when a fire might not occur due to dilution of the fuel (i.e., a flammable mixture is not produced). Therefore, given that the scenarios of interest will occur in nonhermetically sealed enclosures, it is reasonable to assume that adequate ventilation is available and that, if a fire starts, it will continue to burn until it either runs out of fuel or is extinguished by other means. The only variable that might need to be assumed is the total vent width.

Maximum fire extent is affected by two geometric aspects: burning object proximity to walls and overall enclosure dimensions.

The room dimensions affect the time required for a room to flashover. For a given amount and type of fuel, under the same ventilation conditions, a small room will flash over before a large room. In a large room with a small amount of fuel, a fire will behave as if it is burning outside — that is, adequate oxygen for burning and no concentration of heat exist. If the fuel package is unchanged but the dimensions of the room are decreased, the room will begin to have an affect on the fire, assuming adequate ventilation. The presence of the relatively smaller enclosure results in the buildup of a hot layer of smoke and other products of combustion under the ceiling. This buildup, in turn, feeds more heat back to the seat of the fire, which results in an increase in the pyrolysis rate of the fuel and, thus, increases the amount of heat energy released by the fire. The room enclosure surfaces themselves also contribute to this radiation feedback effect.

Probabilistic data are expressed as either a frequency (units of inverse time) or a probability (unitless, but applicable to a stated period of time). An example of the former is the expected number of failures per year and the range of the latter is between zero and one, inclusive. Probabilities can be either objective or subjective. Subjective probabilities express a degree of belief that an event will occur. Objective probabilities are based on historical data and can be expressed as a reliability of an item, such as a component or a system.

A.5.6.3.3 Procedures used to develop required input data need to preserve the intended conservatism of all scenarios and assumptions. Conservatism is only one means to address the uncertainty inherent in calculations and does not eliminate the need to consider safety factors, sensitivity analysis, and other methods of dealing with uncertainty. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process for identifying and treating uncertainty.

A.5.6.4 An assessment method translates input data, which might include test specifications, parameters, or variables for modeling, or other data, into output data, which are measured against the performance criteria. Computer fire models should be evaluated for their predictive capability in accordance with ASTM E 1355, *Standard Guide for Evaluating the Predictive Capability of Fire Models.*

A.5.7 The assessment of precision required in 5.8.2 will require a sensitivity and uncertainty analysis, which can be translated into safety factors.

Sensitivity Analysis. The first run a model user makes should be labeled as the base case, using the nominal values of the various input parameters. However, the model user should not rely on a single run as the basis for any performance-based fire safety system design. Ideally, each variable or parameter that the model user made to develop the nominal input data should have multiple runs associated with it, as should combinations of key variables and parameters. Thus, a sensitivity analysis should be conducted that provides the model user with data that indicate how the effects of a real fire might vary and how the response of the proposed fire safety design might also vary.

The interpretation of a model's predictions can be a difficult exercise if the model user does not have knowledge of fire dynamics or human behavior.

Reasonableness Check. The model user should first try to determine whether the predictions actually make sense; that is, whether they do not upset intuition or preconceived expectations. Most likely, if the results do not pass this test, an input error has been committed.

Sometimes the predictions appear to be reasonable but are, in fact, incorrect. For example, a model can predict higher temperatures farther from the fire than closer to it. The values themselves might be reasonable, for example, they are not hotter than the fire, but they do not "flow" down the energy as expected.

A margin of safety can be developed using the results of the sensitivity analysis in conjunction with the performance criteria to provide the possible range of time during which a condition is estimated to occur.

Safety factors and margin of safety are two concepts used to quantify the amount of uncertainty in engineering analyses. Safety factors are used to provide a margin of safety and represent, or address, the gap in knowledge between the theoretically perfect model — reality — and the engineering models that can only partially represent reality.

Safety factors can be applied either to the predicted level of a physical condition or to the time at which the condition is predicted to occur. Thus, a physical or a temporal safety factor, or both, can be applied to any predicted condition. A predicted condition (i.e., a parameter's value) and the time at which it occurs are best represented as distributions. Ideally, a computer fire model predicts the expected or nominal value of the distribution. Safety factors are intended to represent the spread of the distributions.

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Given the uncertainty associated with data acquisition and reduction, and the limitations of computer modeling, any condition predicted by a computer model can be thought of as an expected or nominal value within a broader range. For example, an upper layer temperature of 600°C (1112°F) is predicted at a given time. If the modeled scenario is then tested (i.e., full-scale experiment based on the computer model's input data), the actual temperature at that given time could be 640°C or 585°C (1185°F or 1085°F). Therefore, the temperature should be reported as 600°C + 40°C/–15°C (1112°F + 75°F/–25°F) or a range of 585°C to 640°C (1085°F to 1185°F).

Ideally, predictions are reported as a nominal value, a percentage, or an absolute value. As an example, an upper layer temperature prediction could be reported as "600°C (1112°F), 30°C (55°F)" or "600°C (1112°F), 5 percent." In this case, the physical safety factor is 0.05 (i.e., the amount by which the nominal value should be degraded and enhanced). Given the state-of-the-art of computer fire modeling, this is a very low safety factor. Physical safety factors tend to be on the order of tens of percent. A safety factor of 50 percent is not unheard of.

Part of the problem in establishing safety factors is that it is difficult to state the percentage or range that is appropriate. These values can be obtained when the computer model predictions are compared to test data. However, using computer fire models in a design mode does not facilitate this comparison, due to the following:

(1) The room being analyzed has not been built yet.
(2) Test scenarios do not necessarily depict the intended design.

A sensitivity analysis should be performed, based on the assumptions that affect the condition of interest. A base case that uses all nominal values for input parameters should be developed. The input parameters should be varied over reasonable ranges, and the variation in predicted output should be noted. This output variation can then become the basis for physical safety factors.

The temporal safety factor addresses the issue of when a condition is predicted and is a function of the rate at which processes are expected to occur. If a condition is predicted to occur 2 minutes after the start of the fire, this prediction can be used as a nominal value. A process similar to that already described for physical safety factors can also be employed to develop temporal safety factors. In such a case, however, the rates (e.g., of heat release and toxic product generation) will be varied instead of the absolute values (e.g., material properties).

The margin of safety can be thought of as a reflection of societal values and can be imposed by the authority having jurisdiction for that purpose. Because the time for which a condition is predicted will most likely be the focus of the authority having jurisdiction (e.g., the model predicts that occupants will have 5 minutes to safely evacuate), the margin of safety will be characterized by temporal aspects and tacitly applied to the physical margin of safety.

Escaping the harmful effects of fire (or mitigating them) is, effectively, a race against time. When assessing fire safety system designs based on computer model predictions, the choice of an acceptable time is important. When an authority having jurisdiction is faced with the predicted time of untenability, a decision needs to be made regarding whether sufficient time is available to ensure the safety of the occupants. The authority having jurisdiction is assessing the margin of safety. Is there sufficient time to get everyone out safely? If the authority having jurisdiction feels that the predicted egress time is too close to the time of untenability, the authority having jurisdiction can impose an additional period of time that the designer will have to incorporate into the system design. In other words, the authority having jurisdiction can impose a greater margin of safety than that originally proposed by the designer.

A.5.8.1 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* describes the documentation that should be provided for a performance-based design.

Proper documentation of a performance-based design is critical to design acceptance and construction. Proper documentation will also ensure that all parties involved understand the factors necessary for the implementation, maintenance, and continuity of the fire protection design. If attention to details is maintained in the documentation, there should be little dispute during approval, construction, start-up, and use.

Poor documentation could result in rejection of an otherwise good design, poor implementation of the design, inadequate system maintenance and reliability, and an incomplete record for future changes or for testing the design forensically.

A.5.8.2 The sources, methodologies, and data used in performance-based designs should be based on technical references that are widely accepted and used by the appropriate professions and professional groups. This acceptance is often based on documents that are developed, reviewed, and validated under one of the following processes:

(1) Standards developed under an open consensus process conducted by recognized professional societies, codes or standards organizations, or governmental bodies
(2) Technical references that are subject to a peer review process and published in widely recognized peer-reviewed journals, conference reports, or other publications
(3) Resource publications that are widely recognized technical sources of information, such as the *SFPE Handbook of Fire Protection Engineering*

The following factors are helpful in determining the acceptability of the individual method or source:

(1) Extent of general acceptance in the relevant professional community, including peer-reviewed publication, widespread citation in the technical literature, and adoption by or within a consensus document
(2) Extent of documentation of the method, including the analytical method itself, assumptions, scope, limitations, data sources, and data reduction methods
(3) Extent of validation and analysis of uncertainties, including comparison of the overall method with experimental data to estimate error rates, as well as analysis of the uncertainties of input data, uncertainties and limitations in the analytical method, and uncertainties in the associated performance criteria
(4) Extent to which the method is based on sound scientific principles
(5) Extent to which the proposed application is within the stated scope and limitations of the supporting information, including the range of applicability for which there is documented validation, and considering factors such as spatial dimensions, occupant characteristics, and ambient conditions, which can limit valid applications

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In many cases, a method will be built from, and will include, numerous component analyses. Such component analyses should be evaluated using the same acceptability factors that are applied to the overall method, as outlined in items (1) through (5).

A method to address a specific fire safety issue, within documented limitations or validation regimes, might not exist. In such a case, sources and calculation methods can be used outside of their limitations, provided that the design team recognizes the limitations and addresses the resulting implications.

The technical references and methodologies to be used in a performance-based design should be closely evaluated by the design team and the authority having jurisdiction, and possibly by a third-party reviewer. The strength of the technical justification should be judged using criteria in items (1) through (5). This justification can be strengthened by the presence of data obtained from fire testing.

A.5.8.11 Documentation for modeling should conform to ASTM E 1472, *Standard Guide for Documenting Computer Software for Fire Models*, although most, if not all, models were originally developed before this standard was promulgated. Information regarding the use of the model DETACT-QS can be found in the *SFPE Engineering Guide — Evaluation of the Computer Fire Model DETACT-QS*.

A.6.1.3.1 Medical, health care, and child care occupancies are occupied by persons who are mostly incapable of self-preservation because of age or physical disability.

A.6.1.6.1 If the engineering and machinery control space is located in and not isolated from the engine room, it is treated as part of the engine room.

The following are examples of engineering and machinery spaces:

(1) Spaces containing pipes, hose, or processing equipment handling pressurized flammable or combustible liquids or gases, including fuel oil
(2) Lubrication oil, hydraulic oil, or ammonia
(3) Internal combustion engines
(4) Boiler rooms
(5) Motor rooms
(6) Incinerator rooms

A.6.1.13 For example, for a cargo vessel that also carries more than twelve passengers, Chapter 21 would apply to areas carrying passengers, and Chapter 20 would apply to areas that support carrying cargo.

A.7.1.5 Headroom on stairs is the vertical distance above a plane parallel to and tangent with the most forward projection of the stair tread.

A.7.2.1.2 Figure A.7.2.1.2 illustrates clear door width.

A.7.2.1.4.3 Figure A.7.2.1.4.3 illustrates the requirements for door swing into a corridor. Doors that swing within a recessed pocket of the corridor so as not to protrude into the required corridor width provide the best arrangement for clear passage through an exit access corridor. Doors that swing 180 degrees to come to rest against a bulkhead and do not extend into more than 15 cm (5.9 in.) of required corridor width provide an acceptable arrangement. A door swinging 90 degrees to come to rest in the path of travel is considered as not encroaching excessively on the exit access corridor width if not more than 15 cm (5.9 in.) of the required width of the corridor remains obstructed. Any door swinging into the corridor must leave unobstructed during its entire swing at least one half of the required corridor width (a).

A.7.2.2.2.1 Stair design should avoid a rise with a 1-to-1 ratio.

A.7.2.2.2.3 Figure A.7.2.2.2.3(a) through Figure A.7.2.2.2.3(e) illustrate stair tread slopes and depths.

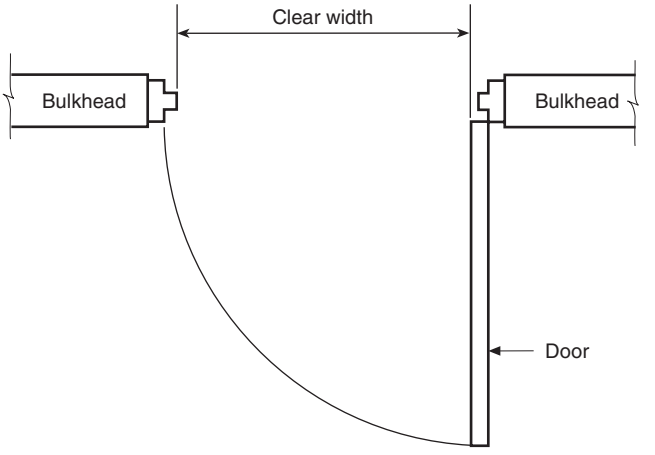


FIGURE A.7.2.1.2 Clear Door Width.

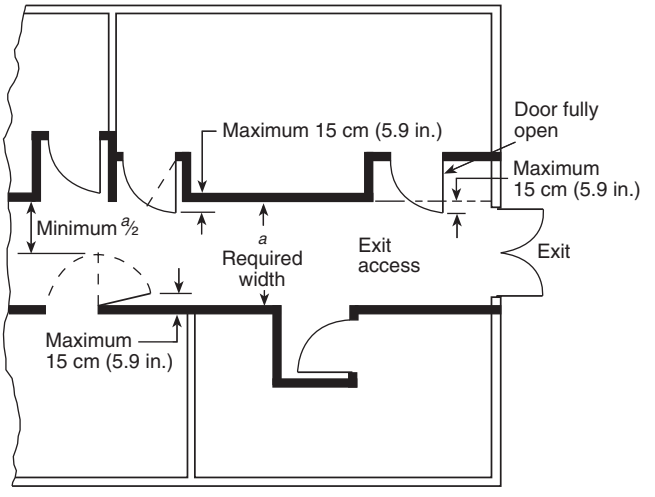


FIGURE A.7.2.1.4.3 Door Swing into a Corridor.

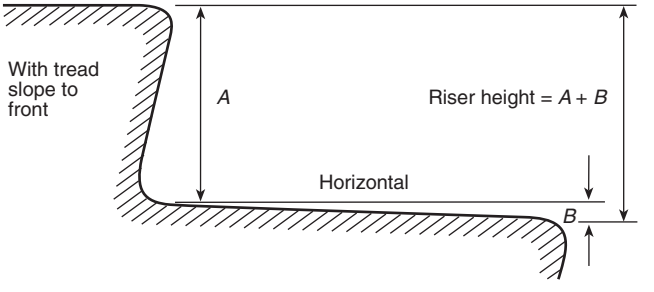


FIGURE A.7.2.2.2.3(a) Riser Measurement with Tread Slope to Front.

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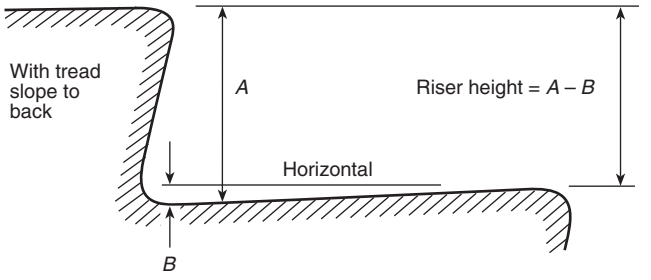


FIGURE A.7.2.2.2.3(b) Riser Measurement with Tread Slope to Back.

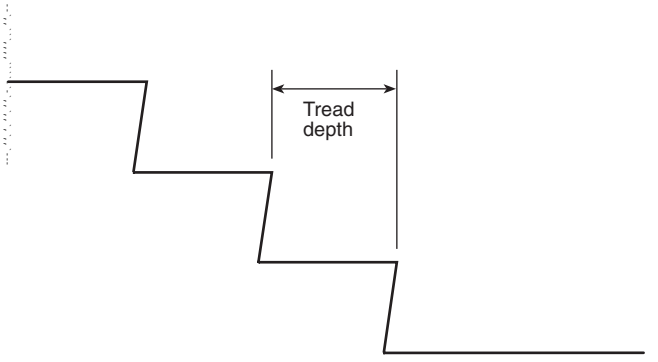


FIGURE A.7.2.2.2.3(c) Tread Depth.

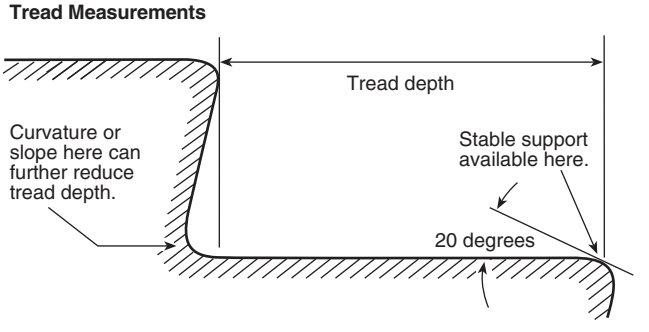


FIGURE A.7.2.2.2.3(d) Tread Measurement with Stable Support at Leading Edge.

A.7.2.2.4.5 Figure A.7.2.2.4.5 illustrates handrails on stairs.

A.7.2.2.6.2 Figure A.7.2.2.6.2 illustrates outside stair protection. The fire resistance rating for the bulkhead of the 10 ft (3 m) extension is a minimum of 1 hour.

A.7.2.6 An exit passageway serves as a horizontal means of exit travel that is protected from fire in a manner similar to an enclosed interior exit stair. Where it is desired to offset exit stairs in a vessel with multiple decks, an exit passageway can be used to preserve the continuity of the protected exit by connecting the bottom of one stair to the top of another stair. One possible use of an exit passageway is to satisfy the requirement of 7.7.2.

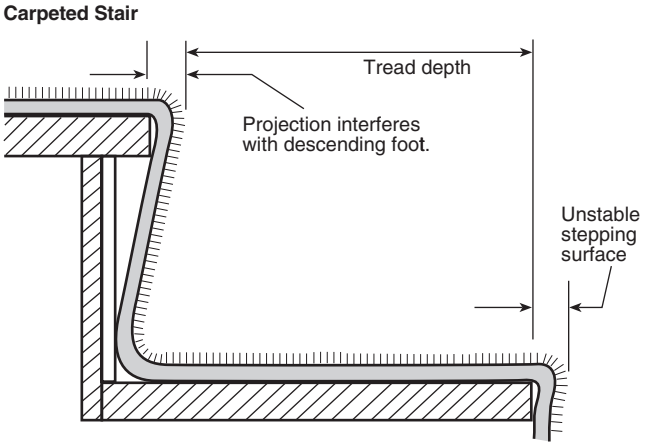
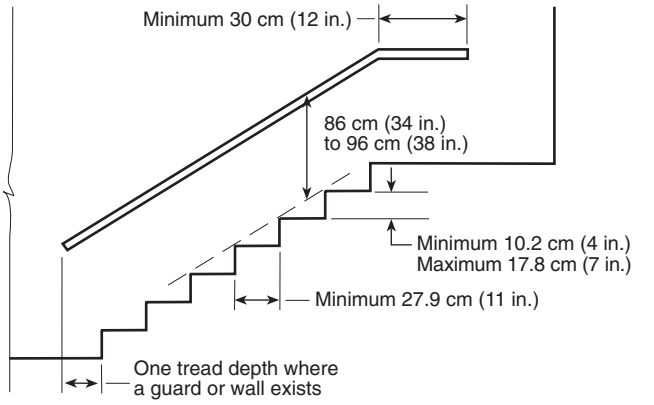


FIGURE A.7.2.2.2.3(e) Tread Measurement with Unstable Stepping Surface at Leading Edge.



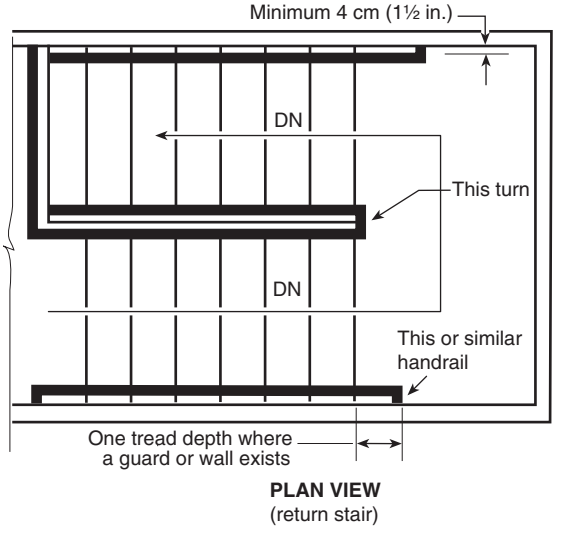


FIGURE A.7.2.2.4.5 Handrail Details.

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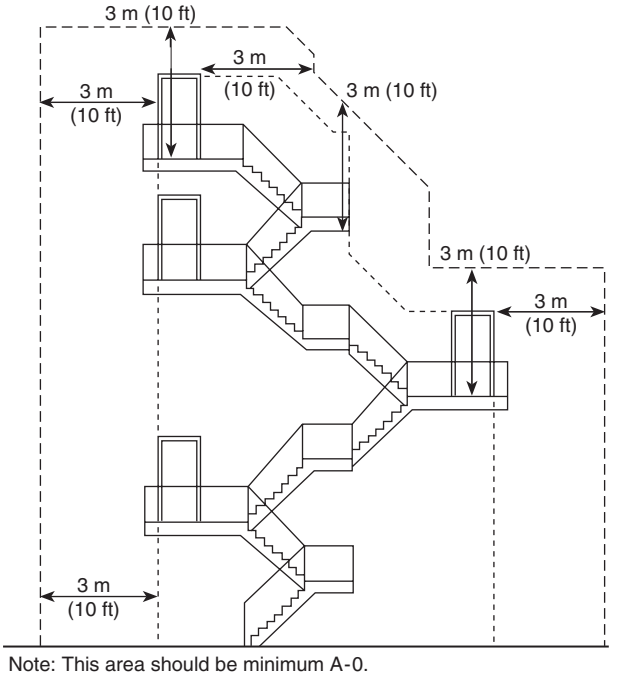


FIGURE A.7.2.2.6.2 Protection of Outside Stairs.

A.7.2.9 Alternating tread devices are illustrated in Figure A.7.2.9.

A.7.2.10.4 Reliable two-way communication systems are intended to include the following:

(1) Two-way telephone communication systems as described in *NFPA 72, National Fire Alarm Code*
(2) Sound-powered phones
(3) Two-way public address systems
(4) Hand-held radios suitable for the intended shipboard application
(5) Where handheld radios require repeaters, the repeaters should be powered from the emergency power source.

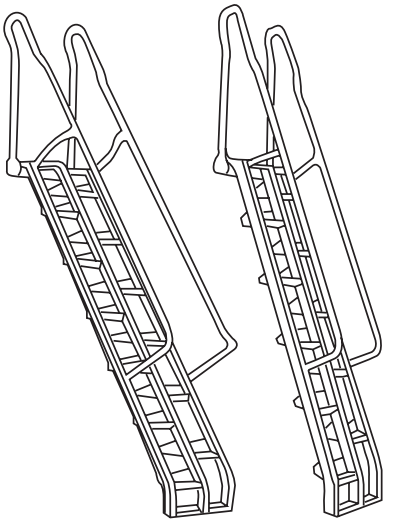


FIGURE A.7.2.9 Alternating Tread Devices.

A.7.2.10.6.4 The option in 7.2.10.6.4 would require 75 L/min·m^2 width of glazing, and is based on ordinary glass, which is assumed to have no integrity. The option in 7.2.10.6.3 recognizes that the windows have inherent integrity, so the sprinklers could be spaced in accordance with their listing.

A.7.2.11 See Figure A.7.2.11(a) and Figure A.7.2.11(b) for a description of aisles and aisle accessways.

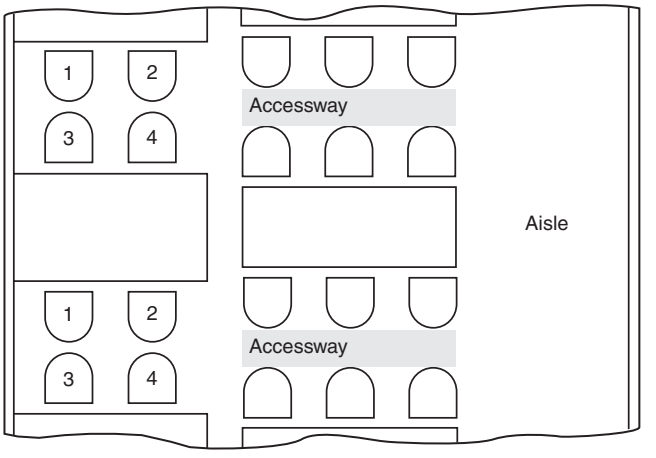


FIGURE A.7.2.11(a) Aisle Accessways Between Rows of Theater-Style Seating.

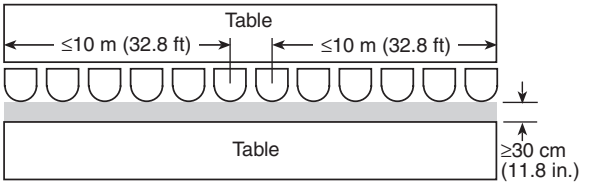


FIGURE A.7.2.11(b) Aisle Accessway Width ≥ 30 cm (11.8 in.).

A.7.5.1.5 Figure A.7.5.1.5(a) through Figure A.7.5.1.5(e) illustrate various arrangements of means of egress.

A.7.5.1.7 Figure A.7.5.1.7 illustrates scissor stairs.

Two entwined stairways sharing the same enclosing bulkheads are called scissor stairs. To be considered separate exits, the stairs should be completely separated from each other. In effect, each stair's enclosure should consist of a fire resistance–rated tube entwined around the other, much like the form of a helix. This results in space and cost savings by permitting the stairs to share the common enclosing bulkheads between them and the remainder of the vessel. With this arrangement, two independent escape paths are created, similar to those provided by two independent stair enclosures positioned some distance from each other. Note the continuity of all bulkheads, providing a complete separation at all points. The arrows designate the direction of egress travel.

A.7.6.4 The intent of this paragraph is that where an exterior stair is unprotected, it is to be considered part of the exit access.

A.7.8.1.3 This illumination criterion applies to unobscured (i.e., smokefree) environments.

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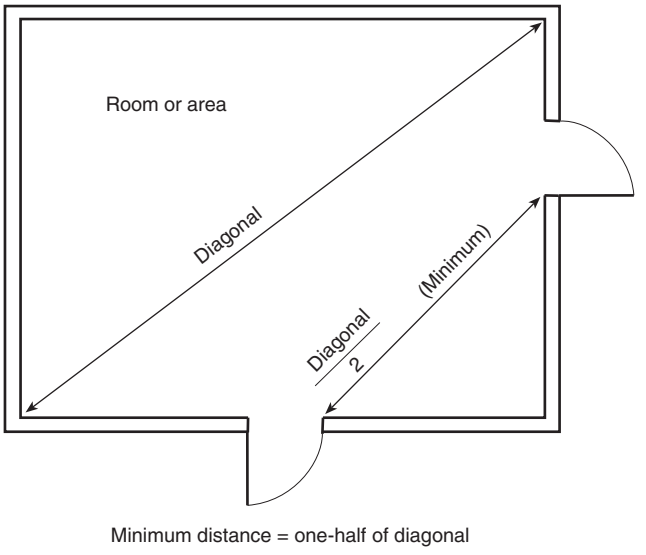


FIGURE A.7.5.1.5(a) Remoteness and Half-Diagonal Rule.

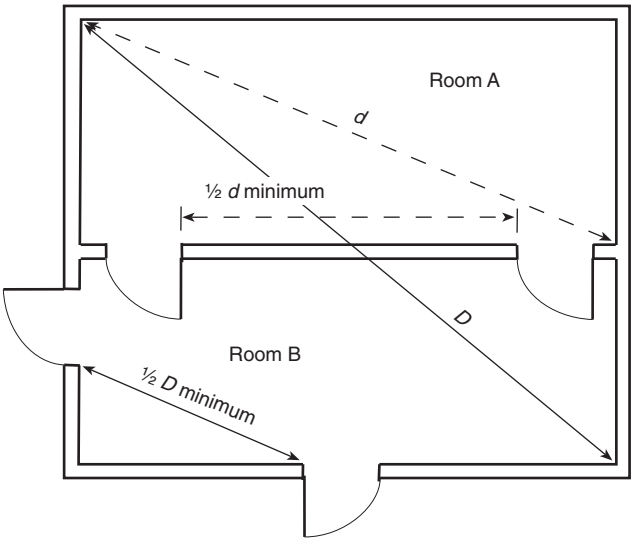


FIGURE A.7.5.1.5(b) Communicating Openings, Whether Protected or Not, Between the Stair Enclosures.

A.8.2.2 The following materials are considered inherently noncombustible and should not be required to be tested or listed for noncombustibility:

(1) Sheet or block glass, clay, ceramics, or uncoated glass fiber
(2) All metals except magnesium or magnesium alloys
(3) Portland cement, gypsum, concrete with aggregates of only sand, gravel, vermiculite, silica, perlite, or pumice
(4) Woven or knitted glass fabric containing no treatments other than 2.5 percent lubricant by mass

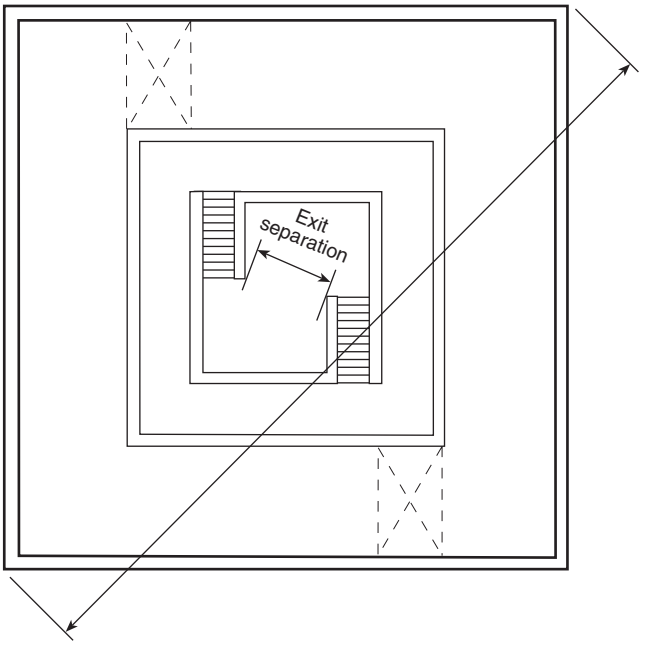


FIGURE A.7.5.1.5(c) Exit Separation and Diagonal Measurement of Area Served.

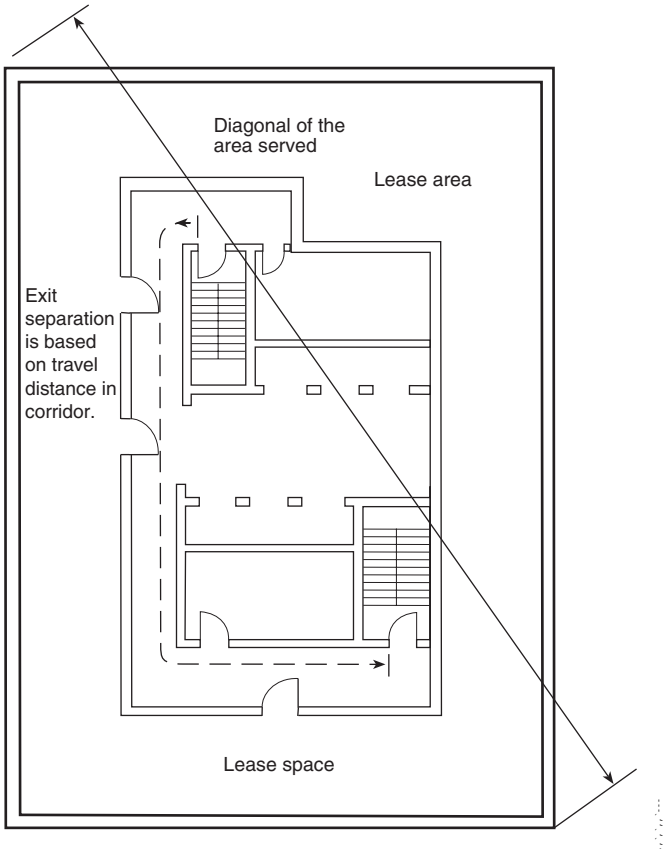


FIGURE A.7.5.1.5(d) Exit Separation Measured Along Corridor Path.

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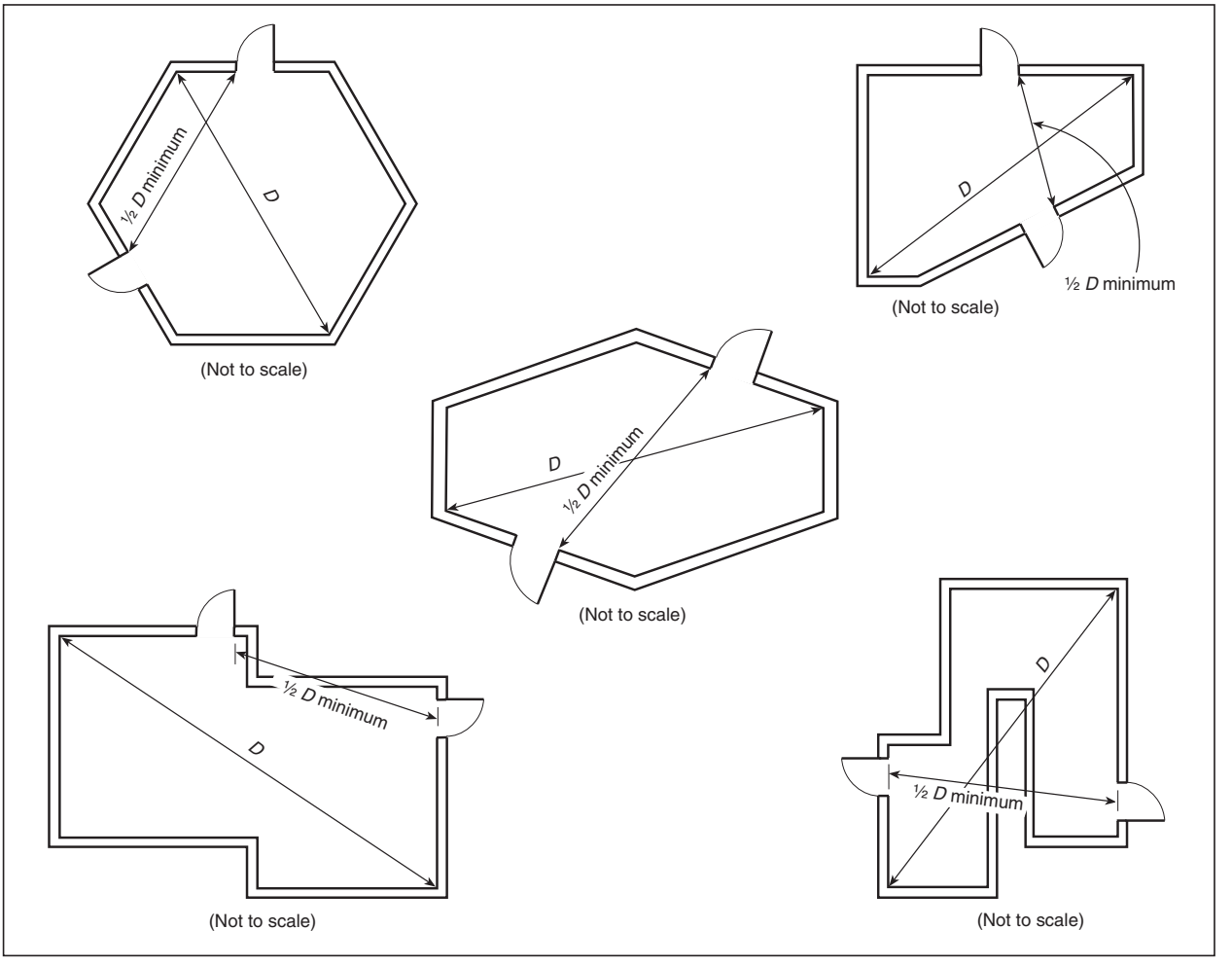


FIGURE A.7.5.1.5(e) Diagonal Measurement for Unusually Shaped Areas.

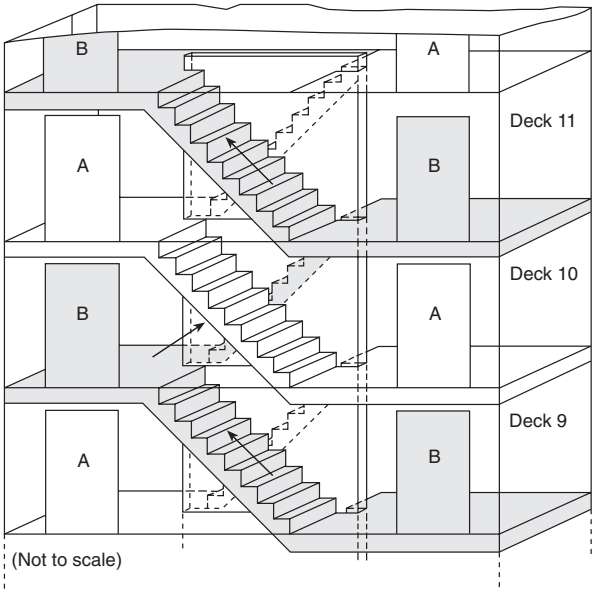


FIGURE A.7.5.1.7 Scissor Stairs.

A.8.2.4.3.3(2) To maintain the smoketight qualities of the division, all penetrations should be protected as with penetrations of A-Class divisions. The penetrations need not be rated as A or B Class, but should be sealed. In most cases, C'-Class construction will involve bolting or overlapping parts or the addition of firestop sealants around fittings and penetrations.

A.8.2.4.7 An example of an acceptable protective device can be a steel shutter operated by a fusible link.

A.8.2.5.4 Figure A.8.2.5.4 illustrates shafts of various heights.

A.8.2.7.1.2(2) The 14 m (45.9 ft) separation requirement applies in both the longitudinal and transverse directions.

A.8.3.3 Paint meeting the requirements of 8.3.3.1 or 8.3.3.2 is considered an acceptable interior finish.

A.8.3.4 Figure A.8.3.4 illustrates the deck overlay requirement.

A.8.4.2 ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture Items*, is technically equivalent to California TB 133, *Flammability Test Procedure for Seating Furniture for Use in Public Occupancies.*

A.8.4.3.2 ASTM E 1590, *Standard Test Method of Fire Testing of Mattresses*, is technically equivalent to California TB 129, *Flammability Test Procedure for Mattresses for Use in Public Buildings.*

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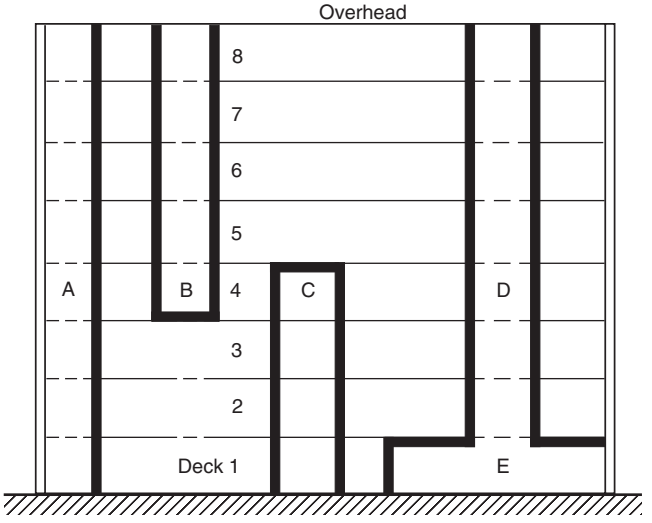


FIGURE A.8.2.5.4 Shafts Not Running Full Height of the Vessel Capped by Decks or Overheads.

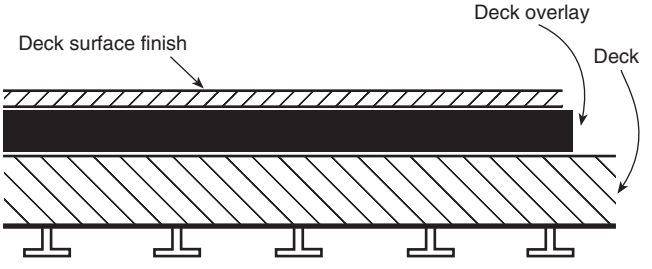


FIGURE A.8.3.4 Deck Overlay Details.

A.8.4.5 This requirement does not apply to textiles that are used as interior finish.

A.8.4.6 Stacking chairs should comply with ASTM E 1822, *Standard Method for Fire Testing of Stacked Chairs*, with a maximum rate of heat release of 500 kW, when a stack of five chairs is tested.

A.8.4.7 Nonmetallic or plastic rubbish containers should be limited in their combustibility and should be tested for heat release with the cone calorimeter, ASTM E 1354, *Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, or NFPA 271, *Standard Method of Test for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*. Cone calorimeter tests on plastic materials should be conducted in the horizontal orientation and at a thickness of 6 mm. The value of 300 kW/m^2 for peak rate of heat release of the rubbish container material corresponds to the value that Douglas fir wood emits under the same conditions. Rubbish containers are often manufactured of polyethylene [effective heat of combustion ca. 19,000 BTU/lb (45 MJ/kg)], which releases much more heat in a fire than the typical contents of the container, much of which is paper [effective heat of combustion ca. 6,400 BTU/lb (15 MJ/kg)].

A.8.5.2.3 For further information, see NFPA 75, *Standard for the Protection of Information Technology Equipment*.

A.9.1 Chapter 9 specifies fire detection, alarm, and communication systems, as well as fire protection systems and equipment required for merchant vessels. Wherever possible, reference has been made to the appropriate NFPA codes and standards, provided they address marine applications. Otherwise, reference has been made to the appropriate SOLAS or CFR regulation. When the appropriate NFPA code or standard is revised to address the specific marine application, references to SOLAS and CFR regulations will be deleted.

A.9.2.2 Guidance for the installation of automatic foam–water sprinkler systems can be found by using the applicable chapters of NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, in combination with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*.

A.9.2.16.2 The fire-fighting equipment contemplated by this requirement includes nozzles, eductors, fog applicators, and so forth.

A.9.2.16.7 This water delivery can be accomplished either by remote starting of one of the main fire pumps from the navigating bridge, engineering operating station, or fire control station, if any, or permanent pressurization of the fire main system by one of the main fire pumps, except where machinery space is continuously attended.

A.9.3.2.5.1 *Self-Contained Breathing Apparatus (SCBA) Compressor and Refill Station.* High-pressure [310.3 bar (4500 psi)] SCBA provide additional breathing time over the low-pressure units and/or afford the user weight savings. On larger vessels, the operator very likely will need high-pressure units to meet the entrance and exit time demands placed on the fire fighters.

Where SCBA recharge systems are installed onboard a vessel or where SCBAs can be readily recharged at a suitable recharge facility shoreside, shipboard fire-fighting evaluations should emphasize the actual donning and use of SCBAs, consumption of SCBA air, and recharging of the cylinders. During training, to prevent exhausting all readily accessible and fully charged breathing apparatus, thereby reducing a ship's actual fire-fighting readiness, a ship should maintain at least 75 percent of the ship's total units in a fully charged and ready state. Following completion of the training, priority should be placed on getting the ship back to 100 percent breathing apparatus capability.

NFPA, ANSI, OSHA, and the Compressed Gas Association (CGA) provide additional maintenance, sizing, quality standards, and air–test criteria for breathing air quality–recharge equipment. Although the CGA requires a minimum air quality of Grade D for such equipment, SCBA recharge systems should meet at least CGA Grade-E air quality with less than 25 ppm water vapor. Grade-D air is acceptable, but requiring Grade-E air provides an air quality margin for the operator. The water–vapor limit is required to eliminate water vapor condensing and freezing in the SCBA regulator when the SCBA is used in cold weather. Compressor air samples should be taken on a quarterly basis in accordance with manufacturers' procedures and should be provided to a qualified air test laboratory to check for proper air quality. Additional air analysis is required following major overhaul modifications or extensive repairs to the breathing air system.

Routine maintenance of the SCBA compressor recharge system is essential to ensure proper operation of the equipment and to ensure that proper air quality is maintained. Special attention should be given to the condition, level, and type of lubricating

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oil; purification cartridge shelf life or usable life; condition of air quality monitoring equipment; and drainage of the condensate reservoir. Only lubrication oils specifically approved for the compressor should be used. Operation of the compressor in high ambient air conditions [32.2°C (90°F)] decreases performance and accelerates wear and should be avoided. Consult the manufacturers' technical manual for maintenance and overhaul practices and periodicity. An active servicing program should be implemented to prevent excessive oil carry-over and carbon dioxide (CO_2) generation.

A.9.4.1 Vessel ventilation systems are used to supply fresh or conditioned air to vessel spaces, and exhaust heated and contaminated air from those or other spaces. Ventilation systems are also installed to prevent the buildup of explosive or noxious vapors.

A.9.4.2.2.1(1) Use of this method could require the provision of a spool piece for added strength.

A.9.4.8 The preferred smoke-removal systems are dedicated, independent exhaust systems capable of removing smoke from specific spaces. Consideration should be given to the design concepts of NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, and NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*. The system should be designed to allow operation at a remote location either at the main fire-control station or at the bridge while maintaining local operation. Sizing of a smoke-extraction system is based on the entire free-air volume within the protected space(s) being exhausted in a minimum of 10 minutes or less. Other ventilation systems can be used to provide this capability, provided safeguards are installed to ensure the smoke-removal performance as noted above. When the vessel's existing ventilation fans are used to remove smoke, the following criteria are to be met:

(1) System controls are provided to allow for rapid operation.
(2) Special features and location operations are clearly marked.
(3) Smoke is exhausted directly to the weather.
(4) Smoke-removal capacity is equal to dedicated system.

A.9.6 Certain electrical equipment is required to be listed by Underwriters Laboratory Inc. (UL), Factory Mutual Research Corporation (FMRC), Canadian Standards Association (CSA), or another independent laboratory recognized by the authority having jurisdiction. IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms*, describes recommendations for performance and construction requirement of marine shipboard cables for use in IEEE 45, *Recommended Practice for Electrical Installations on Shipboard*, installations.

A.10.1.2.1 These limits do not include an assumed fire load due to personal items, which is assumed to constitute an additional 12.5 kg/m^2 (2.5 lb/ft^2).

A.10.1.4.1 For a space with mixed occupancies where several load factor criteria apply, the load factor for the entire space can be determined by using each criterion separately.

A.10.3.4.3 Consideration should be given to the installation of special-purpose smoke detectors within ventilation ducting.

Certain shoreside standards require the installation of smoke detectors in ventilation ducting. It is not the intent of this committee to require those detectors. However, if designers choose to install them, 10.3.4.3 requires that they be listed.

A.11.2 Many of the requirements in Section 11.2 apply to egress components or spaces that are outside of the medical, health care, or child care occupancy, but serve the medical, health care, or child care space. For example, corridors might not be fitted within a health care occupancy, but the requirements in Section 11.2 apply to the corridors that serve the health care spaces.

A.12.1.2 The high-risk service subclassification is not intended to apply to chafing dishes or warming trays used in buffet food service applications.

A.13.3.3 Examples of low fire risk include rooms containing only gaseous extinguishing agent storage, distribution panels, and sprinkler control.

A.14.2.2.2 Passenger vessels complying with recent SOLAS provisions will be fitted with semi-watertight doors in some areas immediately above the margin line.

A.14.3.2.5 Fire-extinguishing systems can utilize compressed gas, electric pumps, diesel pumps, or other means to convey the fire-extinguishing agent to the protected space. When electric pumps are used, they can be provided with power from the ship's service generators. These generators, their wiring, or associated switchgear will likely be disabled by a fire or by fuel and lube oil shutdowns associated with a fire. Therefore, primary sources of electrical or shaft power from within the protected space are inherently unreliable. Compressed gas stored within the protected space is subject to fire impingement. In order to ensure that a machinery space fire does not expand and become a major loss-of-life incident or major marine environmental disaster, redundant sources of power from outside the machinery space are required.

A.14.3.5 EEBDs should be accessible along egress routes and watch stations (control stations, lower engine room, generator flat, etc.).

A.14.5.2 Openings between machinery spaces or machinery space casings have traditionally been an avenue for smoke or fire to spread into the vessel. Of particular note are cases where openings allowed smoke to fill passenger stairs and, in one case (in 1995), doors between the engine casing and the deck with officers' quarters allowed smoke to endanger the lives of, and hamper the response of, ship officers responsible for mitigation of the fire incident.

A.14.6 The requirements of Section 14.6 are not intended to be comprehensive with respect to machinery space design, but are intended to address only major machinery-space fire risks. Other documents, such as 46 CFR 50, Subchapter F, "Marine Engineering," should be consulted.

A.14.6.3 Splash guard design guidance can be found in ASTM F 1138, *Standard Specification for Spray Shields for Mechanical Joints*.

A.14.6.3(3) Splash guards should be required around all takedown joints (flanges, unions, etc.), valve bonnets, and other areas where leakage can occur.

A.14.6.4 Fuel injectors operate at high pressure and are capable of creating atomized fuel sprays if they rupture.

A.14.10 Incinerator spaces present a variety of hazards, including possible combinations of oil-fired burners, gas-fired burners, trash fires, and deep-seated fires.

A.16.3.2.2 Deck-foam systems should provide the following minimum performance:

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(1) Extinguish deck spill fires and maintain a foam blanket after the fire while the hot metal cools
(2) Control or suppress cargo manifold fires
(3) Suppress or control tank fires involving a portion of the cargo area, assuming that the top of the tank(s) within the design area is open to weather and the trajectory of the foam is not obstructed
(4) Provide protection for the crew while arrangements are being made to abandon ship
(5) During lightering operations, protect the exposed vessel from fires on an adjacent ship while preparations are made to get the exposed vessel underway
(6) Be robust and arranged to withstand the effects of weather, vibration, corrosion, strain, and impact

The deck-foam system is not intended to provide extinguishment or suppression, or to control casualties resulting from explosions or collisions.

A.16.4 *Refrigerated Cargo Holds.* Insulation has been shown to contribute to fire incidents unless properly protected or unless the insulation exhibits adequate fire performance. For this reason, insulation installed inside cargo holds should be either noncombustible and tested as a composite system in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, to the following criteria: (1) a flame spread index not exceeding 25; (2) a smoke-developed index not exceeding 50; and (3) no flaming drips; or noncombustible and tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, to the following criteria: (1) a flame spread index not exceeding 75; (2) a smoke-developed index not exceeding 450; and (3) insulation protected by an approved thermal barrier [13 mm (0.51 in.) gypsum wallboard or equivalent] affording 15 minutes of protection.

A.17.1.2 The requirements for the same separation differ from those found in other chapters. The separation criterion considered here is directional as would come into play with aluminum construction.

A.17.1.3 There are no fire-rating requirements for windows facing open decks other than for those windows facing embarkation areas, areas of refuge, and exterior ways of exit access.

A.18.1 The intent of the chapter is to apply only to helicopter decks designed for routine use. It is not intended to apply to open deck areas, which would only be used in emergency situations. These emergency applications need not comply with the provisions of Chapter 18. The requirements of Section 18.1 apply only to fire protection of helicopter facilities. Federal or international requirements should be consulted for requirements regarding approach, lighting, sizing, strength, and so forth.

A.18.3.1 The criteria of 18.3.1 also apply to aircraft fueling stations.

A.18.3.3 See A.7.2.10.4 for a description of reliable communication systems.

A.19.1.1.3 Such exemption should be given only for specific routes where it is determined that such an exemption would not result in unsafe navigation under any possible conditions.

A.20.1.2 For vessels that engage in international voyages, additional documents can be applicable. Examples include the following:

(1) *International Code for the Construction and Equipment of Ships Carrying Chemicals in Bulk (IBC)*
(2) *Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH)*
(3) *International Gas Carrier Code (IGC)*
(4) *Gas Carrier Code*
(5) *International Safety Guide of Oil Tankers and Terminals (ISGOTT)* (5th Edition)

Compliance with all of these documents might not be necessary; their respective scope statements should be consulted.

A.20.3.3 The requirements for A-60 protection indicate that the boundary should be protected to A-60 from the exterior.

A.20.4.1.1 Where cofferdams, cargo pumprooms, oil fuel bunker tanks, or ballast tanks can be isolated from accommodation spaces and an equivalent standard can demonstrate that a single failure of a deck or bulkhead would not permit the entry of gas or fumes from the cargo tanks into the accommodation spaces, this requirement can be waived by allowing accommodation spaces to be positioned forward of cargo tanks, slop tanks, and spaces that isolate cargo or slop tanks from machinery spaces.

A.20.4.2 This isolation can be accomplished by provision of a permanent continuous coaming of at least 0.3 m (0.98 ft) height extending from side to side. Special consideration should be given to the arrangements associated with stern loading.

A.21.1.3.4 The Group V passenger vessel grouping is based on identifying a vessel type that would be used as an IMO Category-A Craft (IMO *International Code of Safety for High Speed Craft*, 1.4.10). This separate classification allows for the high-speed nature and limited route of operation of the craft, and the lightweight construction that can be combustible [fiberglass, fiber-reinforced plastic (FRP), composite] or combinations of combustible and noncombustible construction. Classification as a Group V passenger vessel would be at the discretion of the designer.

A.21.2.5.2 Normally accessible areas can include accommodation spaces; medical, health care, and child care spaces; and service spaces.

A.21.3.1.1.5 This sizing requires a draft stop extending down below the ceiling into the lower space 46 cm (18 in.) deep surrounding the opening and automatic sprinklers fitted at not more than 1.8 m (6 ft) intervals around the perimeter.

A.21.3.1.2.11 This provision is necessary to allow passengers to escape and survival craft parties the ability to travel to their stations without having to go through a smoke-filled atrium.

A.21.3.3.2 It is expected that load distribution should be achieved through passive protection means. For aluminum construction, this can be achieved by applying insulation per SNAME Technical Bulletin No. 2-21.

A.21.13.2.2.2.3 Consideration should be given to providing connections and adapters that are compatible with the local shoreside fire department. *(See also 9.2.16.9.)*

A.21.14 It is recognized that it is challenging for combustible construction to meet specific requirements in the IMO *HSC Code*. An equivalent level of safety can be provided by the addition of safety features to a vessel on a case-by-case basis. Typical of these additional safety features would be adding active fire protection systems, providing system redundancy, adding life-saving equipment, reducing fire loading, and similar added safety features. The methodology of Chapter 5 should be followed.

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A fundamental difference between means of egress for Group III passenger vessels and Group I, II, III, and IV passenger vessels is that safe refuge is not required for passengers. Egress is considered to be directly into life-saving appliances.

A.21.15.2 A fundamental difference between means of egress for Group IV passenger vessels and Group I, II, and III passenger vessels is that safe refuge is not required for passengers. Egress is considered to be directly into life-saving appliances.

A.21.15.13.1.1 See A.9.4.1.

Annex B Ventilation Guidelines

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Design Guidelines. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) design guidelines and *The Society of Naval Architects and Marine Engineers (SNAME) Technical and Research Bulletin No. 4-16* should be used as a guide when designing vessel heating, ventilation, and air-conditioning (HVAC) systems in terms of heating, cooling, dehumidification, and other design requirements. ASTM F 1005, *Standard Practice for HVAC Duct Shapes; Identification and Description of Design Configuration*, should be used as guidance when determining HVAC duct shapes, identification, description, and related criteria.

The following information is ventilation guidance for various spaces.

B.1.1 Spaces with Dedicated Exhaust. Independent exhaust-duct runs are generally required for spaces containing toxic, noxious, or potentially explosive fumes — such as battery rooms, paint lockers, film rooms, and toilets — or where a high fire hazard exists, such as the galley. Where dedicated exhaust runs are required, they should lead directly to the weather. Weather exhaust terminals for this ducting should be located to prevent the possibility of recirculating exhausted air back into the vessel. Where common exhaust ducting is considered, the design of the exhaust system should consider the spaces being served and the possibility of contaminated air migrating back into those spaces due to failure of any required exhaust fans.

B.1.2 Medical Spaces. Ventilating systems servicing medical spaces should be installed in accordance with NFPA 99, *Standard for Health Care Facilities.*

B.1.3 Incinerator Space. The ventilation system for an incinerator space should be a permanent, positive-pressure type and the pressure in the space should be kept greater than the operating pressure of the incinerator. The ventilation system for an incinerator blower space should be a permanent, positive-pressure type and be independent of all other ventilation systems. It should provide a pressure greater than the pressure within the incinerator and provide at least 20 air changes per hour based on the gross volume of the incinerator blower space.

B.1.4 Battery Storage Areas.

B.1.4.1 Battery rooms are to be ventilated to avoid accumulation of flammable gas. Natural ventilation can be employed if ducts are run directly from the top of the battery room to weather. If natural ventilation is impractical, mechanical exhaust ventilation is to be provided with fan intake at the top of the room. Openings for air intake are to be provided near the floor. Fans are to be of the nonsparking type and capable of completely changing the air in the battery room in not more than 2 minutes. The fan should be interlocked with the charging system and should always operate during charging.

B.1.4.2 Where battery lockers are installed, they are to be ventilated, if practical, similar to a battery room, by a duct leading from the top of the locker to open air or to an exhaust ventilation duct leading to the weather. The duct should terminate not less than 0.9 m (3 ft) above the top of the locker in machinery spaces and similar well-ventilated compartments. Louvers or their equivalent are to be provided near the bottom of the room or locker for entrance of air. Deck boxes are to be provided with a duct from the top of the box terminating at least 1.2 m (4 ft) above in a gooseneck or other device to prevent entrance of water. Holes for air inlet are to be provided on at least two opposite sides of the box. The entire deck box, including openings, is to be weathertight. Small battery boxes require only openings near the top to permit escape of gas.

B.1.5 Compartments Containing Gasoline [or Fuel Having a Flash Point of 43.3°C (110°F) or Lower], Machinery, or Fuel Tanks.

B.1.5.1 Such spaces should maintain a negative pressure by means of a natural supply and mechanical exhaust ventilation system. Where mechanical exhaust systems are required, design of the system should assure that adequate air changes are provided per minimum requirements per Table B.1.5.1.

Table B.1.5.1 Ventilation Requirements

Size of Spaces		Air Changes per Minute
m^3	ft^3	
<14.2	<500	2
14.2–28.3	501–1000	3
28.3–42.5	1001–1500	4
>42.5	>1500	5

B.1.5.2 Electrical equipment within such spaces should be explosionproof and nonsparking as appropriate for such equipment in accordance with 46 CFR 111 "Electric Systems — General Requirements." Purged and pressurized systems in accordance with NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, can also be used where explosionproof installations are required. *(See Section 9.6 for Electrical Power Systems.)* Exhaust blower motors should be installed exterior to the ducting. Exhaust blower switches should be located outside of such spaces and interlocked with engine ignition switches to allow a minimum of one complete space air change prior to engine starting, where applicable. A red warning sign should be posted at the switch, stating the same. Ventilation ducting should conform to the following minimum criteria:

(1) Maintain air velocity in ducting less than 610 m/min (2000 ft/min)
(2) Have dimensions not greater than twice that of any other system duct
(3) Meet B-Class boundary construction requirements as a minimum
(4) Be constructed of nonferrous or galvanized ferrous metal and be gastight from end to end

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(5) Be as direct as possible to prevent air pockets
(6) Be securely supported
(7) Be provided with cowls or scoops having a free area not less than twice the required duct size and, accounting for any screens at the entrance, have no dampers and be open at all times

B.1.5.3 Where engines and fuel tanks are not in closed compartments, at least one ventilation duct should be installed in the fore part of the vessel and one in the aft part of the vessel whereby both ducts should have cowls or scoops. Supply and exhaust duct openings should not be located where the natural flow of air is unduly obstructed or adjacent to possible sources of vapor ignition, nor should they be so located that exhaust air could be taken into the supply vents.

B.1.6 HAZMAT Stores. Ventilation requirements for the stowage of hazardous materials (HAZMAT) stores is covered under 46 CFR 147, Subchapter N, "Dangerous Cargoes."

B.1.7 Machinery Spaces. Mechanical ventilating systems for machinery spaces should be in accordance with SOLAS II-2, Regulation 15.

B.1.8 Pump Rooms. Cargo oil or liquefied flammable gas (LFG) pump rooms are to have a mechanical ventilating system capable of providing at least 20 air changes per hour based on the gross volume of the pump room. The system is to have mechanical exhaust, natural or mechanical supply, and ducting near the deck of the compartment as required to effectively purge all areas of the pump room. Where forced supply ventilation is fitted, the system should be installed so as to avoid turbulence in the pump room. Fan motors are to be located outside the pump room and exterior to the ventilation ducts. Fans are to be of nonsparking construction. Provision is to be made for immediate shutdown of the fan motors upon release of the fire-extinguishing systems. Refer to 46 CFR, Subchapter D, "Tank Vessels," and ABS, *Rules for Building and Classing Steel Vessels*, Section 4/5.149.6 and Section 4/5.151.6, for additional requirements for cargo pump rooms.

B.1.9 Refrigeration Machinery Spaces. Refrigeration machinery spaces are to be effectively ventilated. Ammonia refrigerating machines are to be placed in compartments clear of the propelling machinery and so arranged that any leakage of ammonia fumes can escape to the open air.

B.1.10 Cargo Spaces. Cargo spaces can be broken down as outlined in B.1.10.1 through B.1.10.4.

B.1.10.1 Break Bulk. Those portions of the cargo hold suitable for carrying dry cargo, including hatch trunks and dry cargo deep tanks, should be mechanically ventilated with independent systems for each cargo hold. The supply air should be distributed from one end of the hold and exhausted at the opposite end, assuring uniform air distribution without dead-air pockets.

B.1.10.2 Refrigerated Cargo Spaces. Refrigerated cargo spaces should be provided with a mechanical fresh air supply system and natural foul air exhaust system. The fan should have 50 percent speed reduction with local and remote manual control. Manual volume-control dampers should be provided for each system in accessible locations.

B.1.10.3 RO/RO Cargo Spaces. The vent system for enclosed spaces intended for the carriage of motor vehicles with fuel in their tanks for self-propulsion is to be independent from all other vent systems and capable of being controlled from a position outside the space. Ten air changes per hour are required based on the empty volume of the space serviced unless the space is fitted with Class I, Division 1 equipment; then six air changes per hour should be sufficient. Fans are to be nonsparking; inlets for exhaust ducts are to be located within 450 mm (17.75 in.) above the vehicle deck. The outlet is to be located in a safe area near sources of ignition. Emergency shutdown arrangements are required to permit rapid shutdown and closure of the vent system in case of fire. Indication of loss-of-space ventilation should be provided on the navigation bridge.

B.1.10.4 Spaces Where Fueled Vehicles Operate or Spaces Specially Suited for Vehicles. Areas below the weather deck should be provided with continuous positive-pressure ventilation at each level on which vehicles are transported; the quantity of vent air should be at least 0.3 $m^3/min \cdot m^2$ of deck surface area (1 $ft^3/min \cdot ft^2$ of deck area); air stratification and pocketing should not be permitted; and an alarm should be installed in a normally manned space indicating loss-of-space ventilation. Spaces exposed to carbon monoxide or where other hazardous vapors from operating vehicles or other equipment could accumulate should have adequate ventilation to remove harmful vapors and maintain concentration levels less than the safe levels established for workers. Carbon monoxide concentrations in the holds and intermediate decks where persons are working should be maintained less than 50 ppm (0.005 percent) as a time-weighted average, and persons should be removed from the space if the concentration exceeds 75 ppm (0.0075 percent). When necessary, portable blowers of adequate size and location should be used.

B.1.11 Magazines and Ammunition Storage.

B.1.11.1 Magazine spaces are normally provided with blowout ventilation and cooled to limit temperature levels to 37°C (100°F). Dependent on the type of materials carried and space configurations, various ventilation-system requirements can apply.

B.1.11.2 Requirements for magazine and ammunition storage spaces should be in accordance with 46 CFR 146, "Transportation or Storage of Military Explosives on Board Vessels," and 46 CFR 194, "Handling, Use, and Control of Explosives and Other Hazardous Materials," applicable to weapons and explosives to be transported as cargo by auxiliary and amphibious ships, and with NAVSEA Technical Manual 0938-LP-018-0010, *Heating, Ventilation and Air Conditioning Design Criteria Manual for Surface Ships of the U.S. Navy*.

B.1.12 Laboratories. Ventilating systems in laboratories using chemicals should be installed in accordance with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*. Power ventilation units should have minimum characteristics in accordance with 46 CFR 194.15-5, "Chemicals in the Chemistry Laboratory."

B.1.13 Duct Keels. A mechanical ventilation system capable of providing at least 8 air changes per hour, based on the gross volume of the spaces, is to be provided. The system is to have mechanical exhaust, natural or mechanical supply, and ducting as required to effectively purge the space and all connecting access trunks.

B.1.14 Voids and Cofferdams. Voids and cofferdams on tank vessels should be equipped with a gooseneck ventilator and flame arrester.

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Annex C Sample Ordinance Adopting NFPA 301

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 The following sample ordinance is provided to assist a jurisdiction in the adoption of this *[code, standard]* and is not part of this *[code, standard]*.

ORDINANCE NO. _____

An ordinance of the *[jurisdiction]* adopting the *[year]* edition of NFPA *[document number]*, *[complete document title]*, and documents listed in Chapter 2 of that *[code, standard]*; prescribing regulations governing conditions hazardous to life and property from fire or explosion; providing for the issuance of permits and collection of fees; repealing Ordinance No. _____ of the *[jurisdiction]* and all other ordinances and parts of ordinances in conflict therewith; providing a penalty; providing a severability clause; and providing for publication; and providing an effective date.

BE IT ORDAINED BY THE *[governing body]* OF THE *[jurisdiction]*:

SECTION 1 That the *[complete document title]* and documents adopted by Chapter 2, three (3) copies of which are on file and are open to inspection by the public in the office of the *[jurisdiction's keeper of records]* of the *[jurisdiction]*, are hereby adopted and incorporated into this ordinance as fully as if set out at length herein, and from the date on which this ordinance shall take effect, the provisions thereof shall be controlling within the limits of the *[jurisdiction]*. The same are hereby adopted as the *[code, standard]* of the *[jurisdiction]* for the purpose of prescribing regulations governing conditions hazardous to life and property from fire or explosion and providing for issuance of permits and collection of fees.

SECTION 2 Any person who shall violate any provision of this code or standard hereby adopted or fail to comply therewith; or who shall violate or fail to comply with any order made thereunder; or who shall build in violation of any detailed statement of specifications or plans submitted and approved thereunder; or fail to operate in accordance with any certificate or permit issued thereunder; and from which no appeal has been taken; or who shall fail to comply with such an order as affirmed or modified by a court of competent jurisdiction, within the time fixed herein, shall severally for each and every such violation and noncompliance, respectively, be guilty of a misdemeanor, punishable by a fine of not less than $ _____ nor more than $_____ or by imprisonment for not less than _____ days nor more than _____ days or by both such fine and imprisonment. The imposition of one penalty for any violation shall not excuse the violation or permit it to continue; and all such persons shall be required to correct or remedy such violations or defects within a reasonable time; and when not otherwise specified the application of the above penalty shall not be held to prevent the enforced removal of prohibited conditions. Each day that prohibited conditions are maintained shall constitute a separate offense.

SECTION 3 Additions, insertions, and changes — that the *[year]* edition of NFPA *[document number]*, *[complete document title]* is amended and changed in the following respects:

List Amendments

SECTION 4 That ordinance No. _____ of *[jurisdiction]* entitled *[fill in the title of the ordinance or ordinances in effect at the present time]* and all other ordinances or parts of ordinances in conflict herewith are hereby repealed.

SECTION 5 That if any section, subsection, sentence, clause, or phrase of this ordinance is, for any reason, held to be invalid or unconstitutional, such decision shall not affect the validity or constitutionality of the remaining portions of this ordinance. The *[governing body]* hereby declares that it would have passed this ordinance, and each section, subsection, clause, or phrase hereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional.

SECTION 6 That the *[jurisdiction's keeper of records]* is hereby ordered and directed to cause this ordinance to be published.

[NOTE: An additional provision may be required to direct the number of times the ordinance is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.]

SECTION 7 That this ordinance and the rules, regulations, provisions, requirements, orders, and matters established and adopted hereby shall take effect and be in full force and effect *[time period]* from and after the date of its final passage and adoption.

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this code and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

D.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2005 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2007 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2007 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2004 edition.

NFPA 72®, *National Fire Alarm Code®*, 2007 edition.

NFPA 75, *Standard for the Protection of Information Technology Equipment*, 2003 edition.

NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, 2006 edition.

NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*, 2005 edition.

NFPA 99, *Standard for Health Care Facilities*, 2005 edition.

NFPA *101®*, *Life Safety Code®*, 2006 edition.

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, 2006 edition.

NFPA 269, *Standard Test Method for Developing Toxic Potency Data for Use in Fire Hazard Modeling*, 2007 edition.

NFPA 271, *Standard Method of Test for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2004 edition.

NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up*, 2006 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2003 edition.

NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2007 edition.

NFPA *Fire Protection Handbook*, 2003 edition.

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D.1.2 Other Publications.

D.1.2.1 ABS Publications. American Bureau of Shipping, ABS Plaza, 16855 Northchase Drive, Houston, TX 77060.

Rules for Building and Classing Steel Vessels, 2007.

D.1.2.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E 1354, *Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2004.

ASTM E 1355, *Standard Guide for Evaluating the Predictive Capability of Deterministic Fire Models*, 2005.

ASTM E 1472, *Standard Guide for Documenting Computer Software for Fire Models*, 2007.

ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, 2002.

ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses*, 2007.

ASTM E 1822, *Standard Method for Fire Testing of Stacked Chairs,* 2002.

ASTM E 2280, *Standard Guide for Fire Hazard Assessment of the Effect of Upholstered Seating Furniture Within Patient Rooms of Health Care Facilities*, 2003.

ASTM F 1005, *Standard Practice for HVAC Duct Shapes; Identification and Description of Design Configurations,* 2002.

ASTM F 1138, *Standard Specification for Spray Shields for Mechanical Joints*, 1998(2003).

D.1.2.3 California Department of Consumer Affairs Publications. Bureau of Home Furnishings and Thermal Insulation, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595.

Technical Bulletin CA TB 129, *Flammability Test Procedure for Mattresses for Use in Public Buildings*, 1992.

Technical Bulletin CA TB 133, *Flammability Test Procedure for Seating Furniture for Use in Public Occupancies*, 1991.

D.1.2.4 IEEE Publications. Institute of Electrical and Electronics Engineers, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE 45, *Recommended Practice for Electrical Installations on Shipboard*, 2002.

IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms.*

D.1.2.5 IMO Publications. International Maritime Organization, 4 Albert Embankment, London, SE1 TSR.

Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH), 2005.

Gas Carrier Code, 1983.

IMO International Code of Safety for High-Speed Craft (HSC Code), 2000.

International Code for the Construction and Equipment of Ships Carrying Chemicals in Bulk (IBC), 2006.

Chapter II-2, *International Convention for Safety of Life at Sea*, 1974 (consolidated edition 2004).

International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers, 1978, (as amended 1995).

International Gas Carrier Code (IGC), 1993.

D.1.2.6 NAVSEA Publications. Naval Sea Systems Command (NAVSEA), Washington, DC 20024.

NAVSEA Technical Manual 0938-LP-018-0010, *Heating, Ventilation and Air Conditioning Design Criteria Manual for Surface Ships of the U.S. Navy*, 1991.

D.1.2.7 SFPE Publications. Society of Fire Protection Engineers, 7315 Wisconsin Avenue, Suite 620E, Bethesda, MD 20814.

SFPE Computer Software Directory.

SFPE Enforcer's Guide to Performance-Based Design Review.

SFPE Engineering Guide — Evaluation of the Computer Fire Model DETACT-QS.

SFPE Engineering Guide to Human Behavior in Fire.

SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings, 2nd Edition.

SFPE Guidelines for Peer Review in the Fire Protection Design Process.

SFPE Handbook of Fire Protection Engineering.

D.1.2.8 SNAME Publications. Society of Naval Architects and Marine Engineers, 601 Pavonia Avenue, Jersey City, NJ 07306.

The Society of Naval Architects and Marine Engineers Technical and Research Bulletin, No. 2-21, 1974.

The Society of Naval Architects and Marine Engineers Technical and Research Bulletin, No. 4-16, 1980.

D.1.2.9 Transport Canada Publications. Transport Canada, 330 Sparks Street, Ottawa, ON K1A 0N5.

CSA 20/TP 4813, Canada Shipping Act 20, *Fire Detection and Extinguishing Equipment Regulations*, 1978.

D.1.2.10 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Federal Water Pollution Control Act, 1972.

Hazardous Material Transportation Control Act, 1970.

Title 46, Code of Federal Regulations, Parts D, 30B, 111, 146, 147, and 194, 2006.

D.1.2.11 Additional Publications.

Australian Fire Engineering Guidelines, Victoria Department of Human Services, 2001.

British Standard Firesafety Engineering in Buildings, British Standards Institution, London, U.K., 1997.

Carpenter, D., "An Updated International Survey of Computer Models for Fire and Smoke," *Journal of Fire Protection Engineering*, 13(2), 2003.

Gann, R. G., et al., "Fire Conditions for Smoke Toxicity Measurement," *Fire and Materials*, 18, 1994.

Hirschler, M. M., et al., *Carbon Monoxide and Human Lethality: Fire and Non-Fire Studies*, Elsevier, 1993.

International Safety Guide of Oil Tankers and Terminals (ISGOTT), 5th Edition, International Chamber of Shipping, London, UK, 2006. Kaplan, H. L., et al., "Acute Inhalation Toxicity of the Smoke Produced by Five Halogenated Polymers," *Journal of Fire Sciences*, 2, 1984.

D.2 Informational References. (Reserved)

D.3 References for Extracts in Informational Sections.

NFPA 5000®, Building Construction and Safety Code®, 2006 edition.

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- Report on Proposals (ROP) is published for public review and comment.

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3.3.78 Effective Ground-Fault Current Path. An intentionally constructed, permanent, low impedance electrically conductive path designed and intended to carry ~~underground~~ electric fault current ~~conditions~~ from the point of a ground fault on a wiring system to the electrical supply source.

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