NFPA® 302

Fire Protection Standard for Pleasure and Commercial Motor Craft

2015 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA® 302

Fire Protection Standard for

Pleasure and Commercial Motor Craft

2015 Edition

This edition of NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, was prepared by the Technical Committee on Motor Craft. It was issued by the Standards Council on April 29, 2014, with an effective date of May 19, 2014, and supersedes all previous editions.

This edition of NFPA 302 was approved as an American National Standard on May 19, 2014.

Origin and Development of NFPA 302

This *Fire Protection Standard for Pleasure and Commercial Motor Craft* represents the cumulative result of over 75 years of attention to fire safety of boats by the NFPA. The first edition of this standard was adopted by the Association in 1937. Successive editions were adopted in 1939, 1948, 1950, 1951, 1952, 1953, 1954, 1955, 1957, 1960, 1964, 1966, 1968, 1972, 1980, 1984, 1989, 1994, and 1998. Prior to 1937, the information was contained in Appendix D of NFPA 301, *Fire Prevention Regulations for the Construction and Maintenance of Vessels*.

The 2004 edition of NFPA 302 contained a first-time requirement in the industry for smoke detectors on pleasure boats. The chapters on fire protection equipment and electrical systems were updated based on the latest technologies. NFPA 302 was completely revised for the 2004 edition to comply with the latest edition of the *Manual of Style for NFPA Technical Committee Documents*.

The 2010 edition included provisions for the mitigation of carbon monoxide hazards that include but are not limited to revised ventilation requirements and installation of carbon monoxide detection devices on certain vessels. New requirements addressing the fire hazard of portable heaters and dehumidifiers were added. Requirements that address electrical systems were updated. The 2010 edition offered guidance information for the installation of fire detection equipment in the engine rooms of commercial vessels that are 12 meters or more in length.

Following the withdrawal of NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, the Technical Committee on Motor Craft has incorporated ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, into the 2015 edition of NFPA 302 as the primary test method to be used for assessing the flame spread index. This latest edition of the standard introduces a requirement to limit as far as practicable the number of elbows and other restrictions in the exhaust systems of gasoline-fueled engines to help minimize the production of carbon monoxide (CO). The standard also identifies the test method to be used for determining the flame resistance properties of fabrics used in the construction of motor craft in accordance with NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*. The provisions to protect boats from lightning in Chapter 10 of NFPA 780, *Standard for the Installation of Lightning Protection Systems*, are now referenced by NFPA 302. Annex E, Extinguisher Inspection and Maintenance Information from NFPA Standards, has been updated with extracts from NFPA 10, *Standard for Portable Fire Extinguishers*; NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; and NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*.

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Committee Scope: This Committee shall have primary responsibility for documents on fire prevention and protection of motor craft and to encourage their use by designers, builders, and owners.

Contents

NFPA 302

Fire Protection Standard for

Pleasure and Commercial Motor Craft

2015 Edition

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard shall establish minimum requirements for the prevention of fire and explosion, for mitigation of carbon monoxide hazards, and for life safety in case of fire, on boats specified in Section 1.3.

1.1.2 This standard shall establish minimum requirements for the following:

(1) Elimination of ignition sources
(2) Ventilation of accommodation spaces, fuel tank compartments (if separate from machinery spaces), and machinery spaces
(3) Use of combustible materials
(4) Fire-extinguishing equipment and fire exits
(5) Control of fire-extinguishing agents in machinery spaces
(6) Mitigation of carbon monoxide hazards from all sources

1.2 Purpose.

1.2.1 The purpose of this standard shall be to minimize the loss of life and property due to fires, explosions, and carbon monoxide aboard pleasure and commercial vessels.

1.2.2 The intent of this standard shall be to make motor craft as free from the hazards of fire and carbon monoxide as practicable.

1.2.3 The requirements of this standard shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire, explosion, and carbon monoxide and reflect the conditions and the state of the art at the time the standard was issued.

1.3 Application.

1.3.1 This standard shall apply to the following boats of less than 300 gross tons that are used for pleasure or commercial purposes:

(1) Boats that use engines for propulsion
(2) Boats that use engines for generating power
(3) Boats that use cooking, heating, or auxiliary appliances
(4) Boats that have permanently installed ignition source(s)
(5) Boats that have permanently installed electrical systems

1.3.2 This standard shall not apply to personal watercraft.

1.3.3 No requirement of this standard shall be construed as reducing applicable federal regulations.

1.4 Retroactivity. It is not intended that the provisions of this standard be applied to boats constructed or equipment installed prior to the effective date of the standard.

1.5 Equivalency. Nothing in this standard shall prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety in place of those required by the standard, provided that technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency.

1.6* Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter unit, which falls outside of but is recognized by SI, is used commonly in international fire protection. These units are listed in Table 1.6 with their conversion factors.

Table 1.6 Unit Conversion Factors

Name of Unit	Unit Symbol	Conversion Factor
Millimeter	mm	1 in. = 25.4 mm
Meter	m	1 in. = 0.0254 m
Square centimeter	cm^2	1 $in.^2$ = 6.452 cm^2
Square meter	m^2	1 ft^2 = 0.093 m^2
Cubic centimeter	cm^3	1 $in.^3$ = 16.39 cm^3
Cubic meter	m^3	1 ft^3 = 0.0283 m^3
Gram	g	1 oz = 28.35 g
Liter	L	1 gal = 3.785 L
Kilopascal	kPa gauge	1 psi = 6.89 kPa gauge
Bar	bar	14.50 psi = 1 bar
Cubic meters per minute	m^3/min	1 cfm = 0.0283 m^3/min

1.6.1 If a value for a required measurement in this standard is followed by an equivalent value in metric units, the first stated value shall be regarded as the requirement, and the equivalent value that follows shall be approximate.

1.6.2 The metric unit value shall be the requirement for motor craft under the jurisdiction of Canadian authorities.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard 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,* 2013 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2011 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2009 edition.

NFPA 52, *Vehicular Gaseous Fuel Systems Code,* 2013 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards,* 2011 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2010 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2012 edition.

NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems,* 2010 edition.

2.3 Other Publications.

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

ABYC A-24, *Carbon Monoxide Detection Systems*, 2007.

ABYC A-28, *Galvanic Isolators*, 2008.

ABYC A-31, *Battery Chargers and Inverters*, 2010.

ABYC E-11, *AC and DC Electrical Systems on Boats*, 2012.

ABYC TE-4, *Lighting Protection*, 2006.

ABYC TH-23, *Design, Construction, and Testing of Boats in Consideration of Carbon Monoxide*, 2012.

2.3.2 AMCA Publications. Air Movement and Control Association International, Inc., 30 West University Drive, Arlington Heights, IL 60004-1893.

AMCA/ANSI 210, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*, 2007.

2.3.3 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z21.57, *Recreational Vehicle Cooking Gas Appliances*, 2010.

2.3.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A463/A463M, *Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process*,2010.

ASTM A653/A653M, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*, 2011.

ASTM B96/B96M, *Specification for Copper-Silicon Alloy Plate, Sheet, Strip, and Rolled Bar for General Purposes and Pressure Vessels*, 2011.

ASTM B122/B122 M, *Standard Specification for Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy (Nickel Silver), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar*, 2011.

ASTM B127, *Standard Specification for Nickel-Copper Alloy (UNS N05500) Plate, Sheet, and Strip*, 2009.

ASTM B152/B152 M, *Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar*, 2009.

ASTM D471, *Standard Test Method for Rubber Property-Effect of Liquids*, 2012.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2013.

2.3.5 NEMA Publications. National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

NEMA/ANSI WD-6, *Wiring Devices — Dimensional Requirements*, 2008.

NEMA/ANSI 250-6, *Enclosures for Electrical Equipment (1000 Volts Maximum)*, 2008.

2.3.6 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J378, *Recommended Practice for Marine Propulsion System Wiring*, 2011.

SAE J1127, *Standard for Low Voltage Battery Cable*, 2010.

SAE J1128, *Standard for Low Voltage Primary Cable*, 2010.

SAE J1171, *External Ignition Protection of Marine Electrical Devices*, 2011.

SAE J1928, *Devices Providing Backfire Flame Control for Gasoline Engines in Marine Applications*, 2012.

SAE J2006, *Standard on Marine Exhaust Hose*, 2003.

SAE J2031, *Standard for High Tension Ignition Cable*, 2012.

2.3.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 21, *Standard for Safety LP Gas-Hose*, 2007, Revised 2010.

ANSI/UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*, 2010, Revised 2012.

ANSI/UL 103, *Standard for Safety Factory-Built Chimneys for Residential Type and Building Heating Appliances*, 2010, Revised 2012.

ANSI/UL 217, *Standard for Safety for Single and Multiple Station Smoke Alarms*, 2006, Revised 2012.

ANSI/UL 248, *Series of Standards for Safety for Low Voltage Fuses*, 2011.

ANSI/UL 310, *Standard for Safety for Electrical Quick-Connect Terminals*, 2009.

ANSI/UL 474 *Standard for Safety for Dehumidifiers*, 2009, Revised 2012.

ANSI/UL 489, *Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*, 2009, Revised 2011.

ANSI/UL 498, *Standard for Safety for Attachment Plugs and Receptacles*, 2010.

ANSI/UL 817, *Standard for Safety for Cord Sets and Power-Supply Cords*, 2001, Revised 2011.

ANSI/UL 858, *Standard for Safety for Household Electric Ranges*, 2005, Revised 2012.

ANSI/UL 943, *Standard for Safety for Ground-Fault Circuit-Interrupters*, 2006, Revised 2012.

ANSI/UL 1059, *Standard for Safety for Terminal Blocks*, 2001, Revised 2011.

ANSI/UL 1077, *Standard for Safety for Supplementary Protectors for Use in Electrical Equipment*, 2005, Revised 2010.

UL 1128, *Standard for Safety for Marine Blowers*, 1997.

UL 1129, *Standard for Safety for Wet Exhaust Component for Marine Engines*, 1999.

UL 1426, *Standard for Safety for Electrical Cables for Boats*, 2010.

UL 1500, *Standard for Safety for Ignition-Protection Test for Marine Products*, 1997, Revised 2007.

ANSI/UL 4248, *Series of Standards for Safety for Fuseholders*, 2011.

2.3.8 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 33, Code of Federal Regulations, Part 183, "Boats and Associated Equipment."

2.3.9 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2012 edition.

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

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

3.2.5 Shall. Indicates a mandatory requirement.

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

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

3.3 General Definitions.

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

3.3.2 Accommodation Space. Space designed for living purposes.

3.3.3 Battery Cold Cranking Rating. The discharge load in amperes that a battery at 0°F (−17.8°C) can deliver for 30 seconds while maintaining a voltage of 1.2 volts per cell or higher.

3.3.4 Battery Reserve Capacity. The number of minutes for which a new, fully charged battery at 80°F (26.7°C) can be continuously discharged at 25 amperes while maintaining a voltage of 1.75 volts per cell or higher (10.5 volts for a 12-volt battery or 5.25 volts for a 6-volt battery).

3.3.5* Bonding Conductor. A normally non-current-carrying conductor that is intended to carry leakage current from either the ac or the dc system.

3.3.6 Butane. See 3.3.27, Liquefied Petroleum Gas (LPG).

3.3.7 Candela (cd). A unit of measure used in measuring the effective intensity of a flashing light.

3.3.8* Clean Agent. Electrically nonconducting, volatile, or gaseous fire extinguishant that does not leave a residue upon evaporation. The word *agent* as used in this document means clean agent unless otherwise indicated. [**2001,** 2012]

3.3.9* Compressed Natural Gas (CNG). A natural lighter-than-air gas compressed for use as a fuel that consists principally of methane in gaseous form plus naturally occurring mixtures of hydrocarbon gases.

3.3.10 Double Insulation System. An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and so arranged that they are not simultaneously subjected to the same deteriorating influences (temperature, contaminants, and the like).

3.3.11* Engine Exhaust System. The means by which products of combustion are conducted from the engine exhaust manifold to an outboard terminus.

3.3.12 Engine Negative Terminal. The point on the engine at which the negative battery cable is connected.

3.3.13 Flammable Hydrocarbon Mixture. A mixture of gasoline vapor and air, or propane plus air, between the lower explosive limit (LEL) and upper explosive limit (UEL).

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

3.3.15* Galvanically Compatible Metals. Metals that are related closely to each other in the galvanic series.

3.3.16 Gross Ton. A measure of internal volume equal to 100 ft^3.

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

3.3.18 Grounded Conductor.

3.3.18.1 ***Alternating Current (ac) Grounded Conductor.*** A current-carrying conductor that is intentionally maintained at ground potential.

3.3.18.2 ***Direct Current (dc) Grounded Conductor.*** A current-carrying conductor connected to the side of the power source that is intentionally maintained at boat ground potential.

3.3.19* Ground-Fault Circuit-Interrupter (GFCI). A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. [**70:**100]

3.3.20 Ground-Fault Protector (GFP). A device intended to protect equipment by interrupting the electric current to the load when a fault current to ground exceeds a predetermined value that is less than that required to operate the overcurrent protection device of that supply circuit.

3.3.21 Grounding Conductor.

3.3.21.1 ***Alternating Current (ac) Grounding Conductor (green or green with yellow stripe).*** A conductor, not normally carrying current, used to connect the metallic non-current carrying parts of electrical equipment to the ac system and engine negative terminal, or its bus, and to the shore ac grounding conductor through the shore power cable.

3.3.21.2 ***Direct Current (dc) Grounding Conductor.*** A normally non-current-carrying conductor used to connect metallic non-current-carrying parts of a direct current device to the engine negative terminal or its bus for the purpose of minimizing stray current corrosion.

3.3.22* Halocarbon Agent. An agent that contains as primary components one or more organic compounds containing one or more of the elements fluorine, chlorine, bromine, or iodine.

3.3.23* Halogenated Agent. Bromochlorodifluoromethane (Halon 1211), bromotrifluoromethane (Halon 1301), and mixtures of Halon 1211 and Halon 1301.

3.3.24* Ignition Protection. The design and construction of a device such that, under the designed operating conditions, the device does not initiate ignition when surrounded by a flammable hydrocarbon mixture if an ignition source causes an internal explosion, the device is incapable of releasing sufficient electrical or thermal energy to ignite a hydrocarbon mixture, and the source of ignition is hermetically sealed.

3.3.25 Ignition Source. Any item or substance capable of an energy release of a type and magnitude sufficient to ignite any flammable mixture of gases or vapors that could occur onboard the vessel.

3.3.26 Inboard Engine. Any internal combustion engine other than an outboard engine permanently mounted within the hull.

3.3.27* Liquefied Petroleum Gas (LPG). Terms "liquefied petroleum gas," "LP-Gas," and "LPG" that are synonymous and include any product composed predominantly of any of the following gaseous hydrocarbons: propane, propylene, butane, isobutane, butylenes, or a mixture thereof.

3.3.28 Machinery Space. Spaces that contain permanently installed engines for mechanical or electrical power or propulsion.

3.3.29 Motor Craft. Any boat that is propelled by other than wind or human power.

3.3.30 Open to the Atmosphere. A space or compartment that has at least 15 $in.^2$ of net open area directly exposed to the atmosphere for each cubic foot of net compartment volume ($0.34\ m^2/m^3$).

3.3.31 Overcurrent Protection Device. A device, such as a fuse or circuit breaker, designed to interrupt the circuit when the current flow exceeds a predetermined value.

3.3.32* Panelboard. An assembly of devices for the purpose of controlling or distributing, or both, electrical power on a boat.

3.3.33* Permanently Installed. Securely fastened so that tools must be used for removal.

3.3.34 Personal Watercraft. A vessel less than 13 ft (4 m) in length that uses an internal combustion engine powering a water jet pump as its primary source of propulsion and is designed to be operated by a person or persons sitting, standing, or kneeling on rather than within the confines of the hull.

3.3.35 Pigtail. An external conductor that originates within an electrical component or appliance installed by the manufacturer.

3.3.36* Polarized System (ac). A system in which the grounded (white) and ungrounded conductors are connected identically in relation to all terminals or fixture leads on all devices in the circuit, including the shore power connections.

3.3.37 Polarized System (dc). A system in which the grounded (negative) and ungrounded (positive) conductors are connected identically in relation to all terminals or leads on all devices in the circuit.

3.3.38 Propane. See 3.3.27, Liquefied Petroleum Gas (LPG).

3.3.39 Readily Accessible. Capable of being reached quickly and safely for effective use under emergency conditions without the aid of tools.

3.3.40 Self-Limiting. A device with a maximum output restricted to a specified value by its magnetic and electrical characteristics.

3.3.41* Sheath. A material used as a continuous protective covering around one or more insulated conductors.

3.3.42 Shore Power Inlet. A reverse service-type fitting designed for mounting on a boat that requires a female connector on the shore power cable in order to make the electrical connection.

3.3.43 Transformer.

3.3.43.1 ***Isolation Transformer.*** A transformer installed in the shore power supply circuit of a boat to isolate electrically all ac system conductors, including the ac grounding conductor (green, or green with yellow stripe) on the boat, from the ac system conductors of the shore power supply.

3.3.43.2 ***Polarization Transformer.*** An isolated winding transformer ("dry-type" encapsulated lighting transformer) installed in the shore power supply circuit of a boat to isolate electrically the normally current-carrying ac system conductors, but not the ac grounding conductor (green, or green with yellow stripe), from the normally current-carrying conductors of the shore power supply.

3.3.44 Trip-Free Circuit Breaker. A resettable overcurrent protection device designed so that the means of resetting cannot override the current interrupting mechanism.

3.3.45* Ventilation. The changing of air within a compartment by natural or powered means.

3.3.46 Watertight. So constructed that water does not enter the enclosure under test conditions specified in NEMA/ANSI 250-6, *Enclosures for Electrical Equipment (1000 Volts Maximum).*

3.3.47* Weatherproof. Constructed or protected so that exposure to the weather does not interfere with successful operation.

Chapter 4 Hull

4.1 General Arrangement.

4.1.1 The hull shall be arranged so that all compartments are accessible and all escape hatches are unobstructed and readily accessible.

4.1.1.1 Every boat having enclosed accommodation spaces shall have a readily accessible and unobstructed means of egress.

4.1.1.2 Every boat having enclosed accommodation spaces shall have a second accessible means of egress if it is possible for one exit to be blocked by a fire in a galley or machinery area.

4.1.1.3 The means of egress in 4.1.1.1 and 4.1.1.2 shall provide for minimum clear opening dimensions of 14 in. × 18 in. (36.8 cm × 47 cm) (rectangular); or 18 in. (45.7 cm) diameter (circular); or 270 $in.^2$ (1741 cm^2) with a minimum dimension of 14½ in. (36.8 cm) (oval).

4.1.1.4 Any hatch that is required for egress shall have a means of being operated from the inside and a means of being operated from the outside when not secured from the inside.

4.1.1.5 All hinged hatches shall have a means or method to support the hatch in an open position.

4.1.2* Bulkheads or enclosures shall be installed between machinery spaces and accommodation spaces.

4.1.2.1 Openings such as crevices, holes, joints, and penetrations for wiring, cable, and hose, etc., in bulkheads or decks between accommodation compartment(s) that are adjacent to or above a compartment(s) that contains a gasoline engine shall be constructed to minimize the flow of gas or vapors from the machinery space by means such as, but not limited to, flexible compounds.

4.1.3 Bulkheads or enclosures required in 4.1.2 shall be continuous, except for necessary penetrations, to minimize the escape of fire-extinguishing agents discharged into the machinery space.

4.1.4 The requirements of 4.1.4 shall apply to boats other than boats using diesel fuel only.

4.1.4.1 Bilges of spaces containing fuel lines and fuel line fittings shall be separated from bilges of accommodation spaces and other enclosed spaces containing sources of ignition by bulkheads that shall not permit more than 0.25 fl oz (7.4 ml) of leakage per hour when the liquid in the bilge is at a height of 12 in. (30 cm) or one-third the maximum height of the bulkhead, whichever is less.

4.1.4.2 Above heights of 12 in. (30 cm) or one-third the maximum height, the bulkhead shall be permitted to have openings for the passage of conductors, piping, ventilation ducts, mechanical equipment, doors, hatches, and access panels, provided that the maximum annular space around each item is not greater than ¼ in. (6.4 mm).

4.1.5 Machinery spaces shall be readily accessible.

4.1.6 Thermal and Acoustical Insulation.

4.1.6.1 Materials used for thermal and acoustical insulation in any compartment or enclosure containing an internal combustion engine or heater shall have a flame spread index of 75 or less, when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials.*

4.1.6.2 Material shall be labeled or listed as having been tested to meet the requirements of ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials.*

4.1.6.3 Materials used for thermal and acoustical insulation shall not disintegrate in the presence of hydrocarbon vapor.

4.1.6.4 Materials used for thermal and acoustical insulation shall be designed and installed such that hydrocarbon vapors cannot accumulate within the material and thereby reduce its flame spread rate.

4.2 Spaces Open to the Atmosphere.

4.2.1 Spaces Connected to Spaces Open to the Atmosphere.

4.2.1.1 Compartments or spaces connecting with engine or portable fuel tank spaces that are open to the atmosphere shall require ventilation if the connecting space has an open area of less than 15 $in.^2/ft^3$ (0.34 m^2/m^3) of its net volume.

4.2.1.2 The open area in 4.2.1.1 shall be open either to the atmosphere or to another open space, provided that, for the combined net volumes of the connecting spaces, there is a total area open to the atmosphere of at least 15 $in.^2/ft^3$ (0.34 m^2/m^3).

4.2.2 Long, narrow spaces formed by side panels or accommodation floors shall have openings at both ends or along the sides if they are to be considered open to the atmosphere.

4.3* Natural Ventilation.

4.3.1 Each compartment not open to the atmosphere shall be provided with a natural ventilation system where such a compartment contains any of the following:

(1) Permanently installed gasoline engine
(2) Portable fuel tank that vents into the compartment
(3) Gasoline tank and an electrical component without ignition protection

4.3.2* Space under a motor well in outboard boats not open to the atmosphere, that is large enough to accommodate a 6 gal (23 L) portable fuel tank but is not intended for such usage, shall be labeled to prohibit its use for fuel storage.

4.3.3 Each natural ventilation system shall be constructed with at least one intake and one exhaust opening that shall be located on the boat's exterior surface.

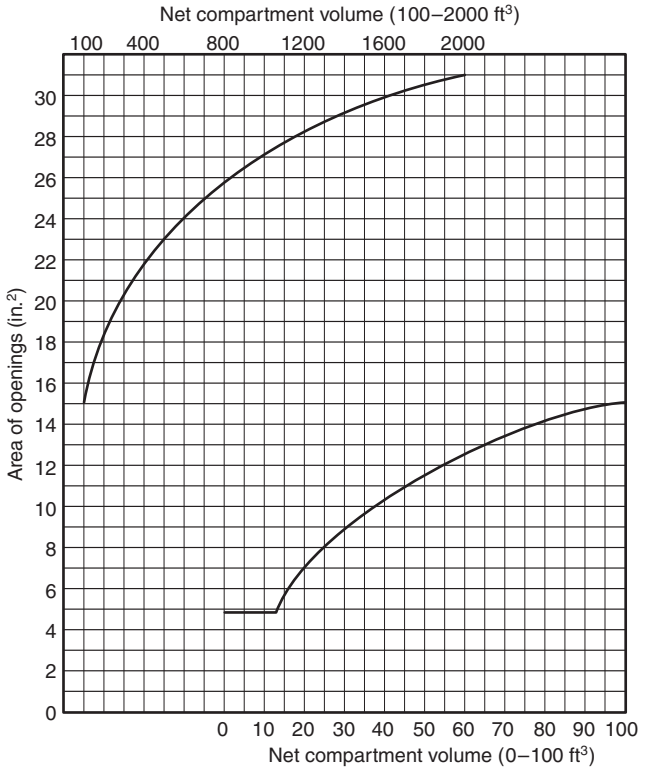
4.3.4* Each compartment requiring natural ventilation shall be equipped with an exhaust duct(s) originating in the lower third of the compartment, with the duct opening permanently fixed above the normal accumulation of bilge water.

4.3.5 If the compartment requiring natural ventilation is an engine compartment, the exhaust duct(s) shall be located as near below the engine(s) as practicable.

4.3.6 An exhaust duct fitted with a cowl or its equivalent shall face aft.

4.3.7 Air intake openings inside a compartment shall be separated from exhaust duct openings inside the compartment by at least 24 in. (610 cm), compartment dimensions permitting.

4.3.8 The minimum aggregate internal cross-sectional area of intake ducts or openings shall be as shown in Figure 4.3.8.



Notes:
The values in Figure 4.3.8 are based on the following equation: $A = 5 \log_e \left(\frac{V}{5}\right)$

Engine room ventilation in accordance with this chart might not be adequate for combustion air requirements IAW Section 4.6.1.

FIGURE 4.3.8 Area of Openings.

4.3.9 The minimum aggregate internal cross-sectional area of exhaust ducts or openings shall be calculated in the same manner as for intakes. *(See 4.3.8.)*

4.3.10* Duct size shall be based on nominal diameters and shall be at least 2½ in. (64 mm) in diameter.

4.3.11* Duct openings shall be of at least equivalent cross-sectional area of the duct.

4.3.12 The minimum cross-sectional area of terminal fittings for flexible ventilation ducts shall be not less than 80 percent of the required internal cross-sectional area of the flexible ventilation duct.

4.4 Connecting Compartments or Spaces by a Natural Ventilation System.

4.4.1 A natural ventilation system shall be provided for each compartment in a boat, except those open to the atmosphere, that contains any of the following:

(1) Permanently installed gasoline engine
(2) Permanently installed fuel tank and an electrical component without ignition protection
(3) Portable fuel tank
(4) Nonmetallic fuel tank that has an aggregate permeability rate exceeding 0.04 oz (1.2 g) of fuel loss in 24 hours per cubic foot of net compartment volume using reference fuel "C" at 104°F ± 36°F (40°C ± 2°C) from ASTM D 471, *Standard Test Method for Rubber Property-Effect of Liquids*
(5) If no tank described in 4.4.1(4) is present, openings between the compartment and a compartment that requires ventilation where the aggregate area of such openings exceeds 2 percent of the area between the compartments

4.4.2 Each required supply opening shall be located on the exterior surface of the boat.

4.4.3 An accommodation compartment located above a compartment requiring ventilation that is separated from the compartment requiring ventilation by a deck or other enclosure shall not be considered a connecting compartment.

4.5 Powered Ventilation System.

4.5.1 Each compartment not open to the atmosphere that has a permanently installed internal combustion engine with a cranking motor and a fixed fire extinguishing system shall be ventilated by an exhaust blower to remove any by-products of combustion or remaining extinguishing agent after the discharge of a fixed fire extinguishing system.

4.5.2 Blowers.

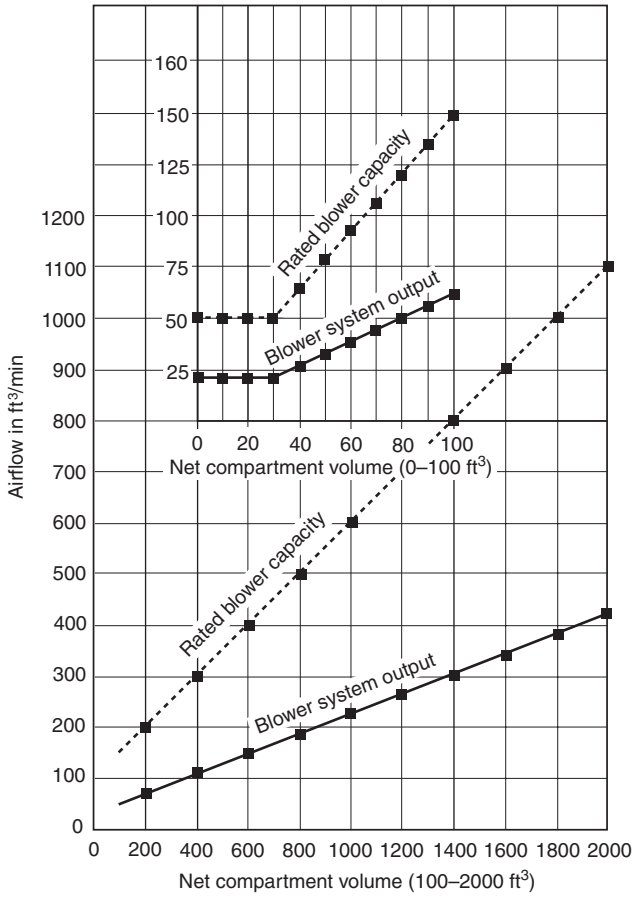
4.5.2.1 Blowers shall be designed for continuous operation at 120 percent of nominal voltage.

4.5.2.2* Blowers shall meet the external ignition protection requirements of UL 1128, *Standard for Safety for Marine Blowers*, or UL 1500, *Standard for Safety for Ignition-Protection Test for Marine Products.*

4.5.2.3 Blowers shall be rated for airflow in cubic feet per minute, at nominal voltage, in accordance with Figure 12 of AMCA/ANSI 210, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*, or UL 1128, *Standard for Safety Marine Blowers. (See Figure 4.5.3.1.)*

4.5.3 Installation of Powered Ventilation.

4.5.3.1 Blower(s) capacity shall be selected in accordance with the blower capacity curve in Figure 4.5.3.1.



Note: The blower capacity curve is included for informational purposes and represents the average relationship of capacity to performance.

FIGURE 4.5.3.1 Minimum Blower Capacity and System Performance.

4.5.3.2 More than one blower shall be permitted to be installed to meet the requirements of 4.5.3.1.

4.5.3.2.1 Each blower shall be separately circuited and protected internally at the equipment or by branch-circuit overcurrent devices suitable for motor current.

4.5.3.3 As installed, the blower system(s) shall exhaust air from the boat at a rate in accordance with the system performance curve (blower system output) in Figure 4.5.3.1 when the engine is not operating and the blower is operating at the electrical system's nominal voltage.

4.5.3.4 Blowers that are not submersible blower motors shall be mounted above the normal level of accumulated bilge water.

4.5.3.5 Blowers shall be installed with ducts having intake openings that meet the following criteria:

(1) They shall be permanently secured.
(2) They shall be located in the lower third of the compartment.
(3) They shall be located above the normal level of accumulated bilge water with the boat at rest.
(4) They shall be located as near below the engine(s) that they serve as practicable.

4.5.3.6 Electrical wiring shall be installed in accordance with Chapter 9 or Chapter 10.

4.5.3.7 Warning Label.

4.5.3.7.1 Each boat that requires a powered ventilation system shall display a warning label located in plain view of the operator and located as close as practicable to each ignition switch (including auxiliary equipment).

4.5.3.7.2 The warning label required by 4.5.3.7.1 shall contain at a minimum the following informational elements:

WARNING
Gasoline vapors can explode, resulting in injury or death.
Before starting engine:
(1) Check engine compartment bilge for gasoline or vapors.
(2) Operate blower for 4 minutes.
(3) Verify blower operation.

4.6 Arrangements of Openings.

4.6.1 Ventilation openings shall be located to prevent the entrance of water in amounts that could impair the stability or handling of the vessel or that could cause machinery malfunction under normal operating conditions.

4.6.2 External openings of intakes and exhausts shall be located to minimize the re-entry of exhausted fumes.

4.6.2.1 On boats with accommodation compartments there shall be no engine ventilation system openings in aft-facing surfaces at the stern.

Exception: Where testing in accordance with ABYC TH-23, Design, Construction, and Testing of Boats in Consideration of Carbon Monoxide, indicates that machinery or tank compartments connected to these openings do not have sustained accumulated levels of carbon monoxide (CO) in excess of 125 ppm.

4.6.3* Fuel Vapors.

4.6.3.1 External openings of intakes and exhausts shall be located and oriented to prevent entry of fuel vapors.

4.6.3.2 The location of intake and exhaust ventilation openings shall be no less than 15 in. (38 cm) from the fuel fill and fuel vent fittings, as measured in a straight line or across any intervening surface(s).

4.6.4 Ventilation openings shall be unobstructed by side curtains, cockpit enclosures, dodgers, and other weather enclosures.

4.7* Combustion Air. Ventilating provisions and openings to the machinery space provided for supplying combustion air shall accommodate at least the sum of the maximum air requirements specified by the engine manufacturer(s) for each propulsion and auxiliary engine(s) in that space.

Chapter 5 Engines

5.1 Exposed Engine Surface Temperatures.

5.1.1 Exposed engine surfaces, except the surfaces addressed in 5.1.2, shall not exceed 200°F (94°C) under normal operating conditions.

5.1.2 The requirements of 5.1.1 shall not apply to short branch connections between liquid-cooled exhaust manifolds and cylinder head exhaust ports or to hot spots on intake manifolds.

5.1.3 An audible or visual device shall be installed to warn of engine temperatures that exceed 200°F (94°C).

5.2 Diaphragm-Type Gasoline Pumps.

5.2.1 Gasoline engine fuel pumps of the diaphragm type shall be designed so that fuel shall not be released to the engine space if a primary diaphragm failure occurs.

5.2.2 Gasoline engine fuel pumps of the diaphragm type shall be provided with a means to determine that a diaphragm failure has occurred without dismantling the fuel pump.

5.3* Marine Carburetors.

5.3.1 Marine carburetors shall not leak more than 0.17 fl oz (5 ml) of fuel in 30 seconds under either of the following conditions:

(1) When the float valve is open, the carburetor is at half throttle, and the engine is cranked without having been started
(2) When the fuel pump is delivering the maximum pressure specified by its manufacturer

5.3.2 Each updraft and horizontal draft carburetor shall have a device that performs the following functions:

(1) Collects and holds fuel that flows out of the carburetor venturi section toward the air intake
(2) Prevents collected fuel from being carried out of the carburetor assembly by the shock wave of a backfire or by reverse airflow
(3) Returns collected fuel to the engine induction system after the engine starts

5.3.3* Spark ignition engine air intakes shall be fitted with one of the following means of backfire flame control:

(1) Backfire flame control approved by the U.S. Coast Guard and bearing a U.S. Coast Guard approval number
(2) Backfire flame control meeting the requirements of SAE J1928, *Devices Providing Backfire Flame Control for Gasoline Engines in Marine Applications*
(3) An engine-air and fuel induction system that provides adequate protection from propagation of backfire flame to the atmosphere equivalent to that provided by an acceptable backfire flame arrester and includes a reed valve assembly

5.4 Electrical Components. Electrical components for engines shall comply with the applicable provisions of Chapter 9 and Chapter 10.

5.5 Air-Cooled Engines.

5.5.1 Permanently installed air-cooled engines with self-contained fuel systems shall be located only on open decks or on cabin tops.

5.5.2 Any housing over engines addressed in 5.5.1 shall be open whenever the engine is operating.

5.5.3 Enclosed Air-Cooled Engines.

5.5.3.1 Factory-installed engine air-cooling shrouding shall be constructed and mounted for enclosed air-cooled engines to trap all engine-cooling air and lead it to a point from which it can be discharged outside the hull or engine box by means of ducting.

5.5.3.2 Duct Material.

5.5.3.2.1 Ducts for engine-cooling air shall have a flame spread index of 75 or less, when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

5.5.3.2.2 Material used for ducts for engine-cooling air shall be labeled or listed as having been tested to meet the requirements of ASTM E 84, *Standard Test Method of Test of for Surface Burning Characteristics of Building Materials*.

5.5.3.3 Engine-cooling air shall not be used as a direct source for heating accommodation spaces.

5.6 Portable Gasoline Tanks. Portable gasoline engines with integral fuel tanks or portable gasoline fuel tanks shall be stowed securely in an open or ventilated space in accordance with Sections 4.2 and 9.8 so that fuel or vapors cannot reach interior spaces.

5.7 Automatic Shutdown. Nonpropulsion engines intended for automatic operation shall be equipped with an automatic shutdown device actuated by low oil pressure, excessive engine overheat, and excess heat from exhaust pipe or exhaust gas ducting.

5.8* High-Tension Cable. High-tension cable assemblies shall conform to SAE J2031, *Standard for High Tension Ignition Cable*.

5.9* Distributors. Ignition distributors shall conform to UL 1500, *Standard for Safety Ignition-Protection Test for Marine Products*.

Chapter 6 Engine Exhaust Systems

6.1 General Requirements.

6.1.1 Exhaust systems shall comply with the following:

(1) They shall be gastight to hull interiors.
(2) All connections shall be accessible.
(3) They shall be supported to minimize failure from vibration, shock, expansion, and contraction.
(4) They shall have no threaded fittings into nonmetallic exhaust system components.
(5) They shall have no discharge from other devices into the exhaust other than from engine-cooling water.

6.1.1.1 In addition to the requirements of 6.1.1, exhaust systems on gasoline engines shall be designed and installed to reduce the production of carbon monoxide by providing the minimum restrictions to exhaust gas flow practicable.

6.1.2 Wherever personnel or combustibles can come in contact with hot surfaces, effective protection shall be provided by water-jacketing, lagging, or shielding, or by guards or engine enclosures.

6.1.3 Exhaust Supports.

6.1.3.1 For wet exhaust systems, hangers, brackets, or other means used to support metallic exhaust systems shall be noncombustible within 6 ft (1.8 m) of the engine connection(s).

6.1.3.2 For dry exhaust systems, hangers, brackets, or other means used to support metallic exhaust systems shall be noncombustible.

6.1.4 Except for outboard engines, a means to indicate loss of exhaust-cooling water shall be provided so that it is effective at all helm positions.

6.1.5 Non-propulsion engines shall be permitted to use an automatic shutdown device to meet the requirements of 6.1.4.

6.1.6 A separate exhaust system shall be provided for each engine.

6.2 Materials.

6.2.1 Materials used in engine exhaust systems, except in components addressed in 6.2.3 and 6.2.4, shall be resistant to fuels, heat, water, corrosion, and the products of combustion.

6.2.2 Nonmetallic exhaust system components, except for those components addressed in 6.2.3 and 6.2.4, shall meet the requirements of UL 1129, *Standard for Safety Wet Exhaust Components for Marine Engines*, or SAE J2006, *Standard on Marine Exhaust Hose*, and shall be so marked.

6.2.3 The requirements of 6.2.1 and 6.2.2 shall not apply to components furnished as part of an original equipment manufactured (OEM) engine assembly.

6.2.4 The requirements of 6.2.1 and 6.2.2 shall not apply to components of stern-drive and jet-drive installations where exhaust is discharged through the drive system.

6.2.5 Copper shall not be used in contact with dry diesel exhaust gases or within six pipe diameters downstream from the point of water entry in water-cooled exhaust systems.

6.2.6 As installed, nonmetallic exhaust system components shall retain watertight integrity for 2 minutes after a total loss of cooling water, with the engine operating at full power.

6.3 Hose Connections. Except for single-clamped hose furnished for specific use as part of an OEM engine assembly, hose connections shall be double clamped.

6.4 Temperature Protection. The exhaust turbine side of non-water-jacketed turbochargers and unjacketed, single-wall, dry exhaust components shall be installed so that the temperature of adjacent combustible surfaces shall not exceed 200°F (94°C).

Chapter 7 Fuel Systems

7.1 General Requirements.

7.1.1 Scope.

7.1.1.1 The requirements of this chapter shall apply to the design, construction, choice of materials, and installation of permanently installed fuel systems, except compressed gas, that run from the fuel fill opening to the connections at each engine or at auxiliary equipment.

7.1.1.2 The requirements of this chapter shall apply to all tanks that are permanently installed.

7.1.2 Any tanks with a capacity of more than 7 gal (27 L) shall be permanently installed.

7.1.3 Fuel systems shall be liquidtight and vaportight with respect to hull interiors.

7.1.4 Individual system components and the system as a whole shall be designed and installed to withstand the stresses of and exposure to marine service including pressure, vibration, shock, movement, grease, lubricating oil, bilge solvents, high aromatic fuels, and corrosive environments.

7.1.5 Exposure Fire Protection.

7.1.5.1 As installed in the boat, all individual components of the fuel system, except for the components identified in 7.1.5.2 and 7.1.5.3, shall be capable of withstanding a 2½-minute exposure to free-burning fuel without a failure that results in leakage of liquid or vapor.

7.1.5.2 Fuel distribution lines on boats shall not be required to comply with 7.1.5.1 if a break at any point in the line will cause a discharge of not more than 5.0 fl oz (150 ml) of fuel within 2½ minutes. *(See 7.5.1.5.)*

7.1.5.3 Self-draining fuel tank vent hose located outside the engine compartment shall not be required to comply with 7.1.5.1.

7.1.6 To ground static electricity, the resistance between ground and each metallic or metallic-plated component of the fuel fill system and fuel tank that is in contact with fuel shall be less than 1 ohm.

7.1.7 Pressurized fuel tanks shall not be used.

7.2 Fuel Tank Materials.

7.2.1 Hull Integration.

7.2.1.1 Gasoline Tanks. Gasoline fuel tanks shall not be integral with the hull structure.

7.2.1.2 Diesel Tanks.

7.2.1.2.1 Diesel tanks shall be permitted to be integral with the hull structure.

7.2.1.2.2 If cored composite construction is used where the tank is integral with the hull structure, the core material shall not deteriorate due to contact with diesel fuel and shall not permit diesel fuel to migrate.

7.2.2 Corrosion Resistance.

7.2.2.1 Materials for fuel tanks shall be corrosion resistant.

7.2.2.2 Materials shall meet the specifications of Table 7.2.2.2.

7.2.2.3 The following shall apply to steel tanks used for fuel:

(1) Unless constructed of aluminized steel, they shall be galvanized inside and outside by the hot-dip process for other than diesel fuel tanks.
(2) Unless constructed of aluminized steel, they shall be galvanized on the outside only by the hot-dip process for diesel fuel tanks.
(3) They shall not be constructed of terneplate steel.

7.2.2.4 Aluminized steel tanks with a wall thickness of less than 0.0785 in. (2 mm) shall be installed only above the cockpit floor or above the deck if no clearly defined cockpit exists.

7.2.2.5 Stainless Steel Diesel Fuel Tanks.

7.2.2.5.1 Stainless steel diesel fuel tanks, except those identified in 7.2.2.5.2, shall have a wall thickness of not less than 0.0747 in. (14 gauge).

7.2.2.5.2 Stainless steel fuel tanks that are both less than 20 gal (76 L) capacity and of cylindrical construction with domed heads shall require a wall thickness of not less than 0.031 in. (22 gauge).

7.2.2.5.3* Stainless steel tanks shall be supported to avoid crevice and pitting corrosion from entrapment of moisture by means of welded brackets of like material or other support material permanently bonded to the tank surface with impermeable nonhygroscopic adhesive.

7.2.3 Nonmetallic materials meeting the applicable requirements of Chapter 4 and Chapter 7 shall be permitted to be used for tanks. *[See 4.4.1(4).]*

Table 7.2.2.2 Metallic Fuel Tank Material and Fabrication Requirements for Corrosion Resistance

Material[a]	Specification	Minimum Nominal Sheet Thickness	Gauge
Nickel-copper	ASTM B127, Class A	0.031 in. (0.79 mm)	22 U.S. Std.
Copper-nickel	ASTM B122	0.045 in. (1.14 mm)	17 AWG
Copper	ASTM B152, Type E.T.P.	0.057 in. (1.45 mm)	15 AWG
Copper-silicon	ASTM B96/B96M, Types A, B, and G	0.050 in. (1.27 mm)	16 AWG
Steel sheet	ASTM A653/A653M	0.0747 in. (1.90 mm)	14 Mfrs.
Aluminized steel	ASTM A463	0.0478 in. (1.21 mm)	18 Mfrs.
Aluminum	Alloy 5052, 5083, or 5086	0.090 in. (2.29 mm)	—
Stainless steel	316L or 317L	0.0747 in. (1.90 mm)	14 Mfrs.
		0.031 in. (0.79 mm)[b]	22 U.S. Std.[b]

[a]See American Welding Society recommendations for welding processes.
[b]Only cylindrical stainless steel tanks with domed heads and a capacity of less than 20 gal (76 L) are permitted.

7.3 Fuel Tank Design and Construction.

7.3.1 The following shall apply to fuel tanks other than diesel fuel tanks:

(1) The bottom, sides, and ends shall not have openings.
(2) Openings for fill, vent, and feed pipes and level gauges, if installed, shall be at or above the topmost surface of tanks.
(3) Clean-out plates shall not be installed.
(4) Plates used for fittings shall be secured in such a manner that they cannot be used for clean-out purposes.

7.3.2 Tanks shall be constructed so that, when installed, exterior surfaces shall not trap water.

7.3.3 Threaded fittings shall conform to Table 7.3.3.

Table 7.3.3 Minimum Thread Engagement

Thread Engagement (in.)	Minimum Length of IPS (in.)
¼	⅜
⅜	⅜
½	½
¾	9⁄16
1	⅝
1¼	⅝
1½	⅝
2	11⁄16

For SI units, 1 in. = 2.5 cm.

7.3.4 Fuel tanks with a capacity of 25 gal (95 L) or greater shall not leak when subjected to the pressure impulse test requirement of 33 CFR 183.586.

7.3.5 Fuel tanks with a capacity of less than 25 gal (95 L) shall not leak when subjected to the shock test requirement of 33 CFR 183.584.

7.3.6 Fuel tanks with a capacity of 200 gal (760 L) or more shall not leak when subjected to the slosh test requirement of 33 CFR 183.588.

7.3.7 All metal tanks and the metal fitting plates of nonmetallic fuel tanks shall be provided with a bonding terminal suitable for the attachment of a No. 8 AWG bonding conductor.

7.3.8 Indentations for labeling or other identification shall not weaken the fuel tank.

7.3.9 Fuel tanks shall be marked or identified permanently with the following information in a location that is visible and readable for inspection after installation:

(1) Manufacturer's name or logo and address
(2) Month (or lot or serial number) and year of manufacture
(3) Capacity in U.S. gallons (capacity also shall be permitted to be expressed in liters)
(4) Construction material and thickness
(5) Fuel for which tank is intended
(6) Maximum test pressure
(7) Model number, if applicable
(8) Statement on tanks other than diesel tanks that reads, "This tank has been tested under 33 CFR 183.510(a)."
(9) Statement that reads, "Must be installed aft of the half-length of the boat," if the tank has been tested under 33 CFR 183.584, at less than 25 G vertical accelerations

7.3.10 Fuel tank(s) shall be tested by the manufacturer or builder for fuel tightness at 3.0 psi (21 kPa gauge) or 1½ times the maximum static head to which the tank(s) can be subjected during service as specified by the boat manufacturer, whichever is greater.

7.3.11 The design of the pickup tube shall preclude damage to the tank bottom as the tank flexes while in service.

7.3.12 The use of gauge glasses shall be restricted to day tanks and service tanks of diesel fuel systems.

7.4 Fuel Tank Installation.

7.4.1 Fuel tank connections and fittings shall be accessible.

7.4.2 Fuel tanks, other than diesel fuel tanks integral with the hull, shall be installed in such a manner that means for maintenance or replacement is provided or indicated so that it can be accomplished without compromising the structural integrity of the vessel.

7.4.3 Fuel tanks shall be installed in a manner that prevents permanent deformation.

7.4.4 Fuel tanks shall be installed in a manner that provides immobilization to the extent practicable.

7.4.5 Nonmetallic fuel tanks that expand dimensionally after exposure to fuel shall comply with the following:

(1) They shall be installed in accordance with the fuel tank manufacturer's instructions.
(2) The fuel tank manufacturer's instructions shall indicate the installation clearances required for the tank in diagram form.
(3) They shall be provided with a warning label that contains at a minimum the following informational elements:

CAUTION
To prevent hull and tank damage due to expansion of the tank while in service, installation shall be in accordance with the manufacturer's instructions.

7.4.6 Contact between metallic fuel tanks and other structures shall be limited to necessary structural supports and shall permit free circulation of air.

7.4.7 Abrasive surfaces and absorbent surfaces of tank supports and braces shall be insulated effectively from contact with tank surfaces by a nonabrasive and nonabsorbent material.

7.4.8 Aluminized steel tanks of thicknesses less than 0.0785 in. (2 mm) shall be installed above the cockpit deck or above deck if there is no clearly defined cockpit.

7.4.9 Nonferrous and nonmetallic fuel tanks shall be permitted to be foamed in place if they comply with the requirements of 33 CFR 183.516. *(See 7.4.5.)*

7.4.10 Fuel tanks shall not be installed above the engine and shall not be installed above sources of ignition.

7.4.11 Fuel tank(s) shall not support a deck, a bulkhead, or other structure.

7.5 Fuel Lines, Fittings, and Related Accessories.

7.5.1 General.

7.5.1.1 For the purposes of Section 7.5, fuel lines shall mean all pipes, tubing, or hose that conduct fuel from the deck fill plate to the engine connection.

7.5.1.2 For the purposes of Section 7.5, related accessories shall include any attachments to fuel lines such as valves, filters, strainers, pumps, and connecting fittings.

7.5.1.3 All fuel tank fittings shall be galvanically compatible with the fuel tank material.

7.5.1.4 Copper-bearing fittings shall be isolated from aluminum tanks by a galvanic barrier including, but not limited to, a 300 series stainless steel fitting.

7.5.1.5 Flexible nonmetallic fuel hose shall be one of the following:

(1) USCG Type A-1 or A-1-15 or Type A-2 hose where 2½-minutes minimum fire resistance is required
(2) USCG Type A-1 or A-1-15, Type A-2, Type B-1 or B-1-15, or Type B-2 hose where 2½-minutes minimum fire resistance is not required *(see 7.1.5)*

7.5.1.6 Fuel lines, connections, and accessories shall be accessible.

7.5.1.7* Plastic Components.

7.5.1.7.1 Plastic pipe and plastic fittings shall not be used in fuel distribution lines, vent lines, and fill lines unless permitted by 7.5.1.7.2 or 7.5.1.7.3. *(See 7.1.5.)*

7.5.1.7.2 Components of deck fill fittings, vent fillings, carburetor fittings, fuel pump fittings, and fuel filter fittings shall be permitted to be of plastic.

7.5.1.7.3 Engineering-grade plastics, such as glass-reinforced nylons, shall be permitted to be used in fuel distribution lines, vent lines, and fill lines.

7.5.1.8 Fuel lines shall be secured against movement or vibration by the use of noncombustible clips or straps without rough surfaces or sharp edges.

7.5.1.9 Clips and straps used to hold fuel lines in position to maintain anti-siphon protection shall be capable of withstanding a 2½-minute fire test.

7.5.1.10 Gasoline-resistant sealing compound or tape shall be used in making up threaded pipe connections.

7.5.1.11 Where making flared tubing connections, the following criteria shall be met:

(1) Tubing shall be cut squarely and flared by tools designed for that purpose.
(2) Tubing shall be deburred prior to being flared.
(3) Copper tubing shall be annealed prior to being flared.

7.5.1.12 Outlets.

7.5.1.12.1 Outlets for drawing fuel from the system are prohibited unless permitted by 7.5.1.12.2.

7.5.1.12.2 Filter bowl plugs provided for the purpose of servicing only shall be permitted.

7.5.1.13 Manually Operated Valves.

7.5.1.13.1 Manually operated multiposition valves shall be required to indicate only their open and closed positions.

7.5.1.13.2 Manually operated stop valves shall be designed with positive stops in the open and closed positions.

7.5.2 Installation of Fill and Vent Pipes.

7.5.2.1 Fuel tank fill and vent pipes shall be located in the following manner:

(1) To prevent the escape of liquid and vapor overflow to the inside of the hull
(2) To provide protection from the flow of vapors escaping into the hull

7.5.2.2 No liquid fuel shall enter the boat from the fill due to an overflow rate of 5 gpm (19 L/min) for 5 seconds when the boat is in its static floating position.

7.5.2.3 The vent pipe shall terminate at least 15 in. (38 cm) from any hull opening.

7.5.2.4* The vent shall be installed to minimize the intake of water without resisting the release of vapor.

7.5.2.5 Overflow from the vent at a rate of 2 gpm (7.7 L/min) shall not enter the boat.

7.5.2.6 The inside diameter of the fill pipe system shall be no less than 1¼ in. (3.2 cm) and shall have a hose diameter of no less than 1½ in. (3.8 cm).

7.5.2.7 The fuel fill shall be self-draining from the fuel fill inlet to the tank connection.

7.5.2.8 The fuel fill plate shall be identified by a permanent marking indicating the type of fuel.

7.5.2.9* Bonding wire ends shall not be clamped between the fill pipes and the flexible tubing. *(See 7.1.6.)*

7.5.2.10 No blow-back of fuel through the fill fitting shall occur while filling at a rate of 9 gpm (35 L/min) and to a level of one-quarter to three-quarters of the capacity indicated by the tank label.

7.5.2.11 As installed in the boat, the vent pipe connection shall be at the highest point of the tank under conditions of normal trim.

7.5.2.12 The inside diameter at any location in the vent line system shall be not less than 7⁄16 in. (11 mm).

7.5.2.13 The fittings at the hull vent line opening shall be corrosion resistant.

7.5.2.14 Each fuel tank vent system shall have a flame arrester that can be cleaned unless one of the following conditions is met:

(1) The vent system itself is a flame arrester.
(2) Metallic vent lines are used and serve as effective flame arresters.

7.5.2.15 Hose Clamps.

7.5.2.15.1 If a nonmetallic hose is used in the fill pipe system, it shall be secured tightly with a minimum of two corrosion-resistant metal clamps of ½ in. (12.7 mm) minimum width at each end of the hose.

7.5.2.15.2 Clamps depending solely on spring tension shall not be used to meet the requirements of 7.5.2.15.1.

7.5.3* Installation of Fuel Feed Lines and Accessories.

7.5.3.1* Electric fuel supply pumps, other than priming pumps in outboard motor fuel systems, shall operate only under the following conditions:

(1) The engine is operating.
(2) The cranking motor is energized.
(3) The supply pump is operated by a momentary switch for priming and is located either on or within 12 in. (30 cm) of the engine.

7.5.3.2 Hose installed on the pressure side of an electric fuel supply pump shall be USCG Type A-1 or A-1-15.

7.5.3.3 Fuel lines shall be run with as few connections as practicable.

7.5.3.4 Fuel lines that run over dry sections of the engine exhaust system shall be metallic and shall contain no joints, fittings, or components other than at the point of termination.

7.5.3.5 Gasoline fuel distribution systems shall be provided with anti-siphon protection by at least one of the following methods:

(1) All parts of fuel distribution and return lines are installed above the level of the tank top from the tank to the carburetor inlet or its equivalent (e.g., throttle body, port fuel injection).
(2) All parts of fuel distribution and return lines are installed above the level of the tank top from the tank to a location where fuel leakage cannot enter the boat when the boat is in a static floating position.
(3) An anti-siphon device is installed at the tank withdrawal fitting, or along the line, with a rated siphon protection head and flow rate greater than required for the installation.
(4) An electrically operated valve is installed at the tank fitting, or along the line, that is to be energized open only when the engine ignition switch is on and the engine is running, with a momentary-type override permitted to be used for starting.
(5)*A manual shutoff valve is installed directly at the fuel tank connection, arranged to be readily accessible for operation from outside the compartment if the fuel tank top is located below the level of the carburetor inlet, the fuel line is rigid metal or USCG Type A-1 or A-1-15 hose, and the length of the fuel line from the tank outlet to the engine inlet is no more than 12 ft (3.6 m).
(6) A manual shutoff valve shall be installed directly at the fuel tank connection, arranged to be readily accessible for operation from outside the compartment if the fuel tank top is located below the level of the carburetor inlet, the fuel line is rigid metal or USCG Type A-1 or A-1-15 hose, a manual shutoff valve is installed at the fuel inlet connection to the engine, and the length of the fuel line from the tank outlet to the engine inlet is more than 12 ft (3.6 m).

7.5.3.6 Systems Without Anti-Siphon Protection.

7.5.3.6.1* A readily accessible manual shutoff valve shall be installed on all fuel tanks directly at the tank connection where the fuel system is without anti-siphon protection.

7.5.3.6.2 If the fuel tank is located in a machinery space, a remotely operated means of closing the valve required in 7.5.3.6.1, without opening machinery spaces, shall be provided.

7.5.3.7 A flexible section, meeting the requirements of 7.5.1.5, shall be installed to separate the part of the fuel feed line secured to the hull members from the part of the fuel feed line secured to the engine.

7.5.3.8 The fixed fuel line shall be fastened to structures within 4 in. (10 cm) of the connection to the flexible section to secure against vibration and movement.

Chapter 8 Cooking, Heating, and Auxiliary Appliances

8.1* General.

8.1.1 Instructions.

8.1.1.1 Printed instructions for proper installation, operation (including refueling, where applicable), and maintenance shall be provided with each appliance.

8.1.1.2 The instructions required in 8.1.1.1 shall include the following information:

(1) The hazards associated with appliance air consumption
(2) Installer information regarding the proper display of a warning label

8.1.2 Appliances using gasoline in liquid or solid form for priming or fuel shall be prohibited.

8.1.3* The design and installation of appliances shall address the air consumption of the appliances and the venting of exhaust products.

8.1.4 An appliance shall be mounted in accordance with the manufacturer's instructions.

8.1.5 Appliances shall be fastened securely when in use or stored.

8.1.6 A burner system shall meet the following criteria:

(1) It shall be capable of operation without creating a fire hazard during periods of boat pitch and roll at angles up to 30 degrees from horizontal in any direction sustained for 15 seconds.
(2) It shall be capable of continuous operation at angles of heel up to 30 degrees.

8.1.7 Label.

8.1.7.1 A durable and permanently legible label shall be provided detailing the proper operation and any unique hazards of the appliance.

8.1.7.2 The label required in 8.1.7.1 shall be mounted in plain view of the appliance operator.

8.1.8 Appliance operating controls shall be located to reduce the likelihood of injury from burners or elements while in use.

8.1.9 Glow Plugs and Pilot Lights.

8.1.9.1 Appliances with automatic igniter glow plugs or continuously lighted pilot lights for burner ignition shall be prohibited unless permitted by 8.1.9.2 or 8.1.9.3.

8.1.9.2 Automatic igniter glow plugs in appliances using sealed combustion chambers shall be permitted.

8.1.9.3 An oven control flame that operates only when the stove is in use shall be permitted.

8.1.10 Appliances shall be marked or identified permanently with the following information in a location visible after installation:

(1) Manufacturer's name or trademark
(2) Model number
(3) Serial number (if applicable)
(4) Fuel/energy used
(5) Maximum power consumption in kW when operating at capacity

8.2 Cooking Appliance Installation.

8.2.1 Exposed materials and finishes within 24 in. (61 cm) of heat-generating surfaces of appliances shall have a flame spread index of not more than 75 when tested in accordance with ASTM E84, *Standard Test Method of Test for Surface Burning Characteristics of Building Materials*.

8.2.2 Fabrics located above and within 39 in. (1 m) of a galley stove top, used for decorative or other purposes, shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

8.2.3 With the appliance installed, the temperature of vertical combustible surfaces below and surrounding heat-generating surfaces shall not rise more than 150°F (65°C) above the compartment's ambient temperature when using the temperature test of ANSI/UL 858, *Standard for Safety Household Electric Ranges*.

8.3 Coal, Charcoal, and Wood-Burning Appliances.

8.3.1 Appliances that burn solid fuel shall not be installed in gasoline-powered boats.

8.3.2 Installed stoves shall be mounted by one of the following methods:

(1) On a noncombustible base (preferably hollow tile)
(2) On legs providing a clearance of at least 5 in. (13 cm) between the stove bottom and the deck, and the deck insulated with a noncombustible material or sheathing

8.3.3 Stove Clearance.

8.3.3.1 The sides and backs of uninsulated stoves shall have a minimum clearance of 9 in. (23 cm) from the exposed materials and finishes, which shall meet the requirements of 8.2.1, or shall be separated by fire-resistant thermal insulation.

8.3.3.2 The sides and backs of insulated stoves shall have a minimum clearance from the exposed materials and finishes as specified by the manufacturer.

8.3.4 Smoke Pipe and Stack Clearance.

8.3.4.1 Single-wall smoke pipes and stacks on decks not equipped with water irons shall have a minimum clearance of 9 in. (23 cm) from combustible materials, including painted surfaces, or shall be separated by fire-resistant thermal insulation.

8.3.4.2 Listed and labeled double- or triple-wall smoke pipes and stacks on decks not equipped with water irons shall be installed with a minimum clearance from combustible materials, including painted surfaces, specified by the manufacturer.

8.3.5 Permanently installed solid-fuel burning appliances, other than solidified-alcohol galley stoves and exterior mounted grills, shall be equipped with a double- or triple-wall smoke pipe or stack that shall terminate above deck, and with smoke heads designed to minimize water entry, spark emission, and backdraft.

8.3.6 Where double- or triple-wall smoke pipe or stacks are installed, they shall meet the requirements of ANSI/UL 103, *Standard for Safety Factory-Built Chimneys for Residential Type and Building Heating Appliances*, and installed in accordance with the specifications of the manufacturer.

8.3.7 Charcoal stored on the boat shall be kept dry and stored in a closed, dry metal container.

8.4 Liquid Fuel Appliances Excluding Liquefied Petroleum Gas (LPG) Appliances.

8.4.1 Both pressure-fed and gravity-fed burners shall be permitted.

8.4.2 Fuel Tanks.

8.4.2.1 Fuel supply tanks shall be constructed of corrosion-resistant metal or of metal having a corrosion-resistant finish or coating.

8.4.2.2 Pressurized Tanks.

8.4.2.2.1 Appliances with pressurized liquid fuel tanks that are integral with an appliance shall comply with the following criteria:

(1) Tanks shall withstand an internal pressure of four times the relief valve setting or 100 psi (700 kPa gauge), whichever is greater.

(2) Tank shall be shielded or insulated so that, under continuous operation at maximum heat, the pressure in the tank shall not exceed 50 percent of the relief valve setting.
(3) The complete system shall be tested up to the pressure of the relief valve setting.

8.4.2.2.2 Pressure tanks not integral with an appliance shall comply with the following criteria:

(1) Tanks shall be able to withstand a test pressure of at least 100 psi (700 kPa gauge) or twice the appliance relief valve setting, whichever is greater.
(2) Tanks shall be secured rigidly in an accessible location that permits convenient filling and pump operation.

8.4.2.2.3 Pressurized fuel tanks shall be equipped with relief valves.

8.4.2.3 Gravity Tanks.

8.4.2.3.1 Gravity tanks installed in the compartment with the appliance shall be located or shielded so that, when installed and under continuous operation at maximum heat output, the fuel temperature shall not rise more than 25°F (14°C) above the compartment temperature.

8.4.2.3.2 Gravity tanks shall have a capacity no more than 2.1 gal (8 L), unless the tank meets the requirements of Section 7.2 and is capable of withstanding a pressure of 3 psi (21 kPa gauge).

8.4.2.3.3 Non-integral gravity tanks shall have provisions for filling and venting at a distance of at least 39 in. (1 m) from open flame unless separated by a vaportight partition or bulkhead.

8.4.2.3.4 Where appliances burning liquid fuels have remote gravity tanks, provisions shall be made to relieve any excess pressure in the fuel line between the tank shutoff valve and the burner valve.

8.4.2.4 A readily accessible shutoff valve, not integral with the appliance, shall be installed near gravity tanks and at or on all non-integral pressure tanks.

8.4.2.5 Where a valve is required by 8.4.2.4, the valve shall close against fuel flow and shall clearly indicate the closed and open positions.

8.4.2.6 Liquid fuel supply lines from non-integral tanks shall be installed as a continuous run from the shutoff valve at the tank to the appliance or to the flexible section located immediately before a gimbaled stove.

8.4.2.7 Flexible liquid fuel supply hose sections shall be compatible with the fuel used.

8.4.2.8* The fill openings for non-integral fuel tanks shall be identified to indicate the type of fuel to be used with the system, and the word "fuel" shall not be used alone.

8.4.2.9 Liquid-fuel priming pans or troughs shall be secured to the burner or generator so that their mutual function is maintained.

8.4.2.10 A liquidtight, nonflammable drip pan at least ¾ in. (19 mm) deep shall be provided below all burners and shall be readily accessible for cleaning.

8.4.2.11 Appliances with integral tanks supplying fuel by gravity or pressure shall display a permanently affixed, legible warning label that contains at a minimum the following informational elements:

CAUTION
Fire and explosion hazard; severe burns.
Before filling, turn off burners.

8.4.2.12 Unpressurized stoves with fuel held in absorbent matter and designed with a fuel container removed for filling shall display a permanently affixed, legible label that contains at a minimum the following informational elements:

CAUTION
Fire and explosion hazard; severe burns.
Before filling, turn off all stove burners.
Remove fuel container from stove.
Fill fuel container away from stove.
Follow filling instructions provided.

8.4.3 If solidified alcohol is used as stove fuel, the container shall be secured on a fixed base to prevent sliding or overturning due to a sudden roll of the vessel.

8.4.4 Stacks and stoves shall comply with the applicable requirements of Section 8.3.

8.4.5 Sealed Combustion Chamber Heaters.

8.4.5.1 Sealed combustion chamber heaters that burn fuel oil shall be permitted to be used if they are designed to provide complete separation of the combustion system from the atmosphere in the boat.

8.4.5.2 A combustion air inlet and flue gas outlet shall be provided as integral parts of the appliance.

8.4.6* Means shall be provided on stove-top cooking surfaces to prevent both deep and shallow cooking utensils from sliding across or off the stove.

8.4.7 Oven doors shall be provided with a means to prevent their unintentional opening due to the force of sliding food and utensils.

8.4.8 A permanent, legible label shall be affixed in a conspicuous location on or adjacent to fuel burning stoves or ranges and shall contain at a minimum the following informational elements:

CAUTION
Open-flame cooking appliances consume oxygen.
Lack of oxygen can cause asphyxiation
or death. Maintain open ventilation when
appliance is in use.
Do not use appliances for comfort heating.

8.4.9 Stove operating controls shall be located to be easily accessible and to minimize possible injury from burners or elements while in use.

8.4.10 The operation of controls shall not require reaching over or across burners or heated elements.

8.5* Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG) Systems for Permanently Installed Appliances.

8.5.1 The installation for use and storage of stoves with attached (integral) LPG containers of more than 8 oz (230 g) capacity weight of gas shall be prohibited in accommodation spaces in the boat interior.

8.5.2 LPG and CNG appliances, other than the appliances addressed in 8.5.3, shall be permanently installed.

8.5.3 Appliances employing integral butane cylinders containing no more than 8 oz (230 g) of fuel, and that comply with 8.5.14.9, shall not be required to be permanently installed.

8.5.4 Components of LPG systems subject to cylinder pressure shall have a rated working pressure of no less than 250 psi (1725 kPa gauge).

8.5.5 Components of CNG systems subject to cylinder pressure shall have a working pressure of no less than 133 percent of the maximum fill pressure of the cylinder.

8.5.6* Ignition Protection of Electrical Devices.

8.5.6.1 Electrical devices on boats equipped with LPG or CNG systems, which can function or cycle on and off automatically without the presence of a person and that are located below the main deck, shall be provided with ignition protection in accordance with UL 1500, *Standard for Safety Ignition-Protection Test for Marine Products*, if located in compartments other than those in 8.5.6.2 and 8.5.6.3, that contain LPG or CNG appliances, cylinders, fittings, valves, or regulators.

8.5.6.2 The requirements of 8.5.6.1 shall not apply to electrical devices in accommodation spaces.

8.5.6.3 The requirements of 8.5.6.1 shall not apply to electrical devices in open compartments having at least 15 in.^{2} (97 cm^2) of open area per cubic foot of net compartment volume exposed to the open atmosphere outside the craft.

8.5.7 Systems shall use cylinders of the vapor withdrawal type.

8.5.8 Cylinders designed or installed to admit LPG into any other part of the system shall be prohibited.

8.5.9 Labels.

8.5.9.1 With each LPG or CNG system installed on a boat, at least two labels in accordance with 8.1.1 and 8.1.7 shall be installed and include the following:

(1) The signal word "WARNING"
(2) The introductory statement "To Avoid Fire and Explosion"

8.5.9.2 Labels at appliances shall include the statement, "This system is designed for use with (insert LPG or CNG) only. Do not connect (insert LPG or CNG) to this system."

8.5.9.3 Labels at containers shall include the following instructions where no leak detection device is installed:

(1) Close container valves when the boat is unattended and in case of a leak or fire.
(2) Close all appliance valves before opening container valves.
(3) Always apply the source of ignition to the burner before opening the burner valve.
(4) Mark container locker "For storage of (insert LPG or CNG) containers only."
(5) Keep valves closed and plugged on empty or unconnected containers.
(6) Test the system for leakage whenever the system is used, when the system is serviced, or when the container is changed as follows:
    (a) With the appliance valves closed and all other valves open, note the pressure on the gauge.
    (b) Close the container valve.
    (c) Ensure that the pressure remains constant for at least 5 minutes.
    (d) If the pressure drops, locate the leakage by application of a soapy water solution at all connections.
    (e) Repeat the test for each container in multicontainer systems.
    (f) Never use flame or soap containing ammonia to check for leaks.

8.5.9.4 Labels at containers shall include the instructions of 8.5.9.3 modifying 8.5.9.3(6) as appropriate if a leak detection device is installed.

8.5.9.5 On boats that have gasoline engines, the labels shall also contain at a minimum the following informational elements:

CAUTION
Avoid fire or explosion. Open-flame appliances can ignite gasoline vapor, causing fire or explosion. Turn off all open-flame appliances while fueling.

8.5.9.6 The required warning labels shall be installed in plainly visible locations on the outside of each container enclosure and adjacent to each consuming appliance.

8.5.10 Containers.

8.5.10.1 Containers shall be constructed, tested, marked, maintained, requalified for continued service, and refilled in accordance with one of the following:

(1) U.S. Department of Transportation (DOT) regulations for containers in LPG or CNG service
(2) Equivalent specifications or regulations to those in 8.5.10.1(1) and acceptable to the authority having jurisdiction

8.5.10.2 Containers shall be withdrawn from service under the following conditions:

(1) When they leak
(2) When corrosion, denting, bulging, or other evidence of rough usage exists to the extent that the container has been weakened
(3) When exposed to fire

8.5.11 Container Valves and Safety Relief Devices.

8.5.11.1 Each container other than nonrefillable containers shall have a manually operated shutoff valve installed directly into the container outlet opening that can be operated without the use of tools.

8.5.11.2 Where the container valve is not readily accessible from within the vicinity of the appliance, a readily accessible manual or electrically operated (solenoid) shutoff valve in addition to the valve required by 8.5.11.1 shall be installed and comply with the following:

(1) The valve shall be operable from within the vicinity of the appliance(s).
(2) The valve shall be installed in the low- or high-pressure fuel line at the fuel supply.

8.5.11.3 The location of the shutoff valve or control shall not require reaching across flame- or heat-generating surfaces for operation.

8.5.11.4 All containers shall be provided with safety relief devices as required by DOT regulations or equivalent regulations.

8.5.11.5 LPG container valves and safety relief devices shall have direct connection with the vapor space of the cylinder.

8.5.11.6 In addition to the valve required by 8.5.11.1, a multiple cylinder system shall be provided with a manual positive shutoff valve or automatic check valve at the cylinder manifold such that each cylinder shall be isolated from the pressure feedback from other cylinders.

8.5.11.7 All relief valves shall discharge to the open atmosphere at a point at least 2 ft (0.6 m) from any opening to any of the following:

(1) Cabin
(2) Hull interior
(3) Engine exhaust terminus

8.5.11.8 Valve outlets on containers shall be equipped with a plug or cap for thread protection and to keep out foreign material.

8.5.11.9 Whenever the container is not connected for use, the plug or cap required by 8.5.11.8 shall be in place and the container valve shall be kept tightly closed.

8.5.12 Reducing Regulators.

8.5.12.1 Each system shall be provided with a pressure-regulating device to deliver gas to the distribution piping that is specifically designed for the type of gas being used.

8.5.12.1.1 The regulating device required by 8.5.12.1 shall be adjusted to deliver gas at a pressure no more than 14 in. (36 cm) water column, approximately 0.735 psi (5.0 kPa gauge), for LPG systems.

8.5.12.1.2 The regulating device required by 8.5.12.1 shall be adjusted to deliver gas at a pressure no more than 6 in. (15 cm) water column, approximately 0.22 psi (1.5 kPa gauge), for CNG systems.

8.5.12.2 A low-pressure relief valve shall be integral with each regulator and shall discharge at between 1.7 and 3 times the delivery pressure of the regulator.

8.5.12.3 The relief valve vent outlet shall be located and designed to prevent water from entering the discharge system.

8.5.12.4* Each reducing regulator shall be fitted with a pressure gauge on the high-pressure side, and a leak detector shall be permitted to be used in addition to the gauge.

8.5.12.5 Each CNG system shall be supplied with a high-flow check valve located on the container pressure side of the regulating device.

8.5.12.6 The high-flow check valve required by 8.5.12.5 shall actuate and control gas flow through the vent or vent systems to the atmosphere in the event of regulator malfunction and shall maintain this gas flow within designed pressure limits of the vent system.

8.5.12.7 Relief high-flow restrictor vent outlets shall conform to the requirements of 8.5.11.7.

8.5.12.8 CNG pressure regulators shall be connected directly to the container shutoff valve, using one CGA series 350 connection.

8.5.13 Piping, Hose, and Fittings — LPG and CNG Distribution Systems.

8.5.13.1 Piping.

8.5.13.1.1 Low-pressure distribution piping between the regulator and appliances shall be galvanically compatible for a marine environment.

8.5.13.1.2 Piping shall be copper tubing of standard Type K, Type L, or equivalent.

8.5.13.1.3 Piping shall have a minimum wall thickness of at least 0.032 in. (0.8 mm) nominal.

8.5.13.1.4 Copper tubing in CNG systems shall be internally tinned.

8.5.13.2 Flexible Hose.

8.5.13.2.1 Hose Specifications.

8.5.13.2.1.1 LPG flexible distribution hose shall meet the requirements of ANSI/UL 21, *Standard for Safety LP-Gas Hose*.

8.5.13.2.1.2 CNG flexible hose shall meet the requirements of NFPA 52, *Vehicular Gaseous Fuel Systems Code*.

8.5.13.2.2 Flexible hose shall be labeled for the fuel being used.

8.5.13.3 Connecting fittings shall be accessible.

8.5.13.4 Metallic connections, if soldered, shall be soldered or brazed with a material having a melting point exceeding 840°F (450°C).

8.5.13.5 Distribution lines shall be protected from physical damage and shall be accessible for inspection.

8.5.13.5.1 Lines shall be secured against vibration.

8.5.13.5.2 Lines shall be protected from abrasion wherever they pass through decks or bulkheads.

8.5.13.5.3 Each appliance shall be served by a separate low-pressure regulated supply line, which shall originate inside the locker or protective enclosure.

8.5.13.5.4 Flexible supply hose shall have permanently attached end fittings, such as a swaged sleeve or a sleeve and threaded insert.

8.5.13.6 Metal tube or piping shall be connected by means of flare fittings or other fittings designed for resistance to loosening due to vibration or movement, and shall not be connected using metal-to-metal compression sleeve-type fittings.

8.5.13.7 Flexible hose sections connecting appliances to their fuel supply shall be nonmetallic.

8.5.13.8 Flexible metallic connectors shall not be used to connect appliances to their fuel supply.

8.5.13.9 A flexible hose section shall be installed to allow the free swing of gimbaled stoves without stress to end fittings at expected extremes of travel.

8.5.13.10 Fuel supply lines, except for flexible hose installed to connect tube or piping to a device, shall be continuous lengths of tubing, piping, or hose to the appliance from one of the following:

(1) Regulating device
(2) Solenoid valve
(3) Leak detector (if installed)
(4) Manifold

8.5.13.11 Metallic fuel supply lines shall not be used for electrical grounding or bonding.

8.5.14 Appliances.

8.5.14.1 Appliances with automatic igniters for burner ignition, other than those with sealed combustion chambers, are prohibited.

8.5.14.2 All gas-fueled appliances, other than stoves with integral gas cylinders not exceeding 8 oz (230 g) capacity, shall incorporate a flame failure device on each burner or oven control flame to prevent gas flow if flame is not present.

8.5.14.3 Cabin space heaters, water heaters, gas-fueled refrigerators, and air conditioners shall be of the sealed combustion chamber type, designed to provide complete separation of the combustion system from the atmosphere in the boat.

8.5.14.4 A combustion air inlet and flue gas outlet shall be provided as integral parts of the appliances identified in 8.5.14.3.

8.5.14.5 Burner controls shall be equipped or designed to provide a push-turn or other two-phase operation when moved from the OFF position to the ON position.

8.5.14.6 Cooking appliances shall meet the combustion requirements of ANSI Z21.57, *Recreational Vehicle Cooking Gas Appliances*.

8.5.14.7 A permanent, legible label shall be affixed in a conspicuous location on or adjacent to appliances not having sealed combustion chambers that shall contain at a minimum the following informational elements:

CAUTION
Open-flame appliances consume oxygen.
Lack of oxygen can cause asphyxiation or death.
Maintain open ventilation when appliance is in use.

8.5.14.8 Means shall be provided on stove top cooking surfaces to prevent both deep and shallow cooking utensils from sliding across or off the stove at boat pitch or roll up to 30 degrees horizontal in any direction.

8.5.14.9 Cooking Equipment with Integral Fuel Cylinders.

8.5.14.9.1 Printed instructions for proper installation, operation, fuel storage, refueling, and maintenance shall be provided with each stove.

8.5.14.9.2 Fuel cylinders with a capacity of 8 oz (230 g) or less shall be DOT approved 2P/2Q cylinders with rim vent release.

8.5.14.9.3 Where used in the boat interior, stoves shall be secured in a designated location with a positive means of mechanical retention and the installation shall meet the requirements of Section 8.2.

8.5.14.9.4 A means shall be provided for storing all unattached fuel cylinders in a protected, self-draining location on the exterior of the boat so that vapors can flow overboard only.

8.5.14.10 The appliance shall have a label that indicates the required location of the device relative to all combustible surfaces and that identifies the type of fuel to be used with the appliance.

8.5.15 Location and Installation.

8.5.15.1 LPG and CNG containers, regulating devices, and safety equipment shall meet the following criteria:

(1) They shall be rigidly secured.
(2) They shall be readily accessible for operation of valves and testing for leakage.
(3) They shall be protected by a dedicated locker unless permitted otherwise by 8.5.15.2.1 or 8.5.15.2.2.

8.5.15.2 Dedicated Locker.

8.5.15.2.1 Containers shall not be required to be installed in a dedicated locker where located on open decks such that escaping vapor cannot accumulate in a cockpit or enclosed spaces, provided regulators, tank valves, and fittings are protected against mechanical damage by a vented housing, shield, or guard.

8.5.15.2.2 A CNG container shall not be required to be installed in a dedicated locker in CNG systems with a single container connected to the system having a capacity to hold 100 ft^3 (2.83 m^3) or less of gas, when the gas is at 14.5 psi (99.97 kPa) and 70°F (21.1°C).

8.5.15.2.3 A protective dedicated locker shall meet the following criteria:

(1) It shall be located above the waterline.
(2) It shall be vaportight to the hull interior.
(3) It shall be provided with a means to latch its cover.
(4) It shall be vented to the atmosphere.
(5) It shall be located so that, with its cover open or closed, escaping vapor cannot reach the bilges, machinery spaces, accommodations, or other enclosed spaces.

8.5.15.2.4 An LPG container locker shall be vented from the bottom by means of a vent pipe that meets the following criteria:

(1) The vent pipe shall be of at least ½ in. (12.7 mm) internal diameter.
(2) The vent pipe shall lead outboard.
(3) The vent pipe shall be without pockets that can trap water.
(4) The vent pipe shall pass through the hull above the waterline and at a point lower than the locker bottom.
(5) The vent pipe opening shall be at least 2 ft (0.6 m) distant from, and not directly above, any hull opening, including the engine exhaust.

8.5.15.2.5 Compartments and lockers in which CNG cylinders are stored shall have a ventilation opening located above the level of the cylinder of at least ½ in. (12.7 mm) internal diameter.

8.5.15.3 Installation of gas equipment in lockers or housing shall be such that, when the means of access to the lockers or housing is open, the container valves can be conveniently and quickly operated and the system pressure gauge dials are fully visible.

8.5.15.4 Lockers or housings for gas equipment shall not be used for storage of any other equipment, nor shall quick access to the gas system be obstructed in any way.

8.5.15.5 Provisions for storage of unconnected reserve containers, filled or empty, shall be the same as required for containers in use.

8.5.15.6* Leakage Tests.

8.5.15.6.1 After installation, distribution tubing shall be tested prior to its connection to the regulator and appliance using an air pressure of not less than 5 psi (34.5 kPa gauge) above ambient.

8.5.15.6.2 The container valve shall be tested for leakage at its outlet and at its connection to the container by application of a soapy water solution prior to connection of the system.

8.5.15.6.3 After the tests in 8.5.15.6.1 and 8.5.15.6.2, and when appliances and high-pressure equipment have been connected, the entire system shall be subjected to the following test:

(1) With appliance valves closed, solenoid valve or master shutoff valve at the appliance open, and one container valve open, note the pressure on the gauge.
(2) Close the container valve.
(3) Ensure pressure remains constant for at least 5 minutes.
(4) If the pressure drops, locate the leakage by application of soapy water solution at all connections.

8.5.15.6.4 Flame shall not be used to check for leaks.

8.5.15.7 CNG cylinders shall not be installed in compartments containing an internal combustion engine.

8.5.15.8 CNG cylinder storage compartments shall not have openings that communicate with the engine space above the level of the pressure regulator.

8.6 Service Water Heating Units and Cabin Heaters.

8.6.1 Vent stacks shall meet the following criteria:

(1) They shall lead to the atmosphere.
(2) They shall be equipped with an effective device for preventing flame extinguishment or flareback from backdraft and entrance of rain or spray.

8.6.2 Dampers shall not be installed in vent stacks.

8.7 Lamps.

8.7.1 Gasoline shall not be used for fuel.

8.7.2 Oil lamps shall have metal bodies and shall be hung in gimbals.

8.7.3 Oil lamps shall not be located directly over galley stoves or heating units.

8.7.4 Metal shields shall be secured above chimneys.

8.8 Electric Stoves.

8.8.1 Electric stoves shall meet the requirements of ANSI/UL 858, *Standard for Safety for Household Electric Ranges*.

8.8.2 Electric stoves equipped with a lid or cover shall incorporate an automatic power disconnect switch that turns off all surface burners when the lid or cover is lowered over the heating elements.

8.8.3 Electric stoves shall have a light indicating when one or more heating elements are energized.

8.8.4 Electric stoves shall be installed in accordance with the manufacturer's instructions.

8.9 Portable Electric Heaters.

8.9.1 Portable heaters shall be UL listed.

8.9.1.1 Portable heaters shall be designed to operate on 120 VAC current.

8.9.1.2 Portable heaters shall not be rated at more than 5000 Btuh.

8.9.2 Portable heaters shall be used on boats only when attended.

8.10 Portable Dehumidifiers.

8.10.1 Portable dehumidifiers shall meet the requirements of ANSI/UL 474, *Standard for Safety for Dehumidifiers*, and be so listed.

8.10.1.1 Portable dehumidifiers shall be designed to operate on 120 VAC current.

8.10.1.2 Portable dehumidifiers shall draw no more than 9 amperes at maximum capacity.

8.10.2 Portable dehumidifiers may be permitted to operate unattended only if connected to a dedicated outlet and the shore power inlet connection has been physically examined within the last month.

Chapter 9 Electrical Systems Under 50 Volts

9.1 Scope.

9.1.1 The standards and practices of this chapter shall apply to the design and installation of direct current (dc) electrical systems on boats that operate at potentials of 50 volts or less except for the systems addressed in 9.1.2.

9.1.2 The standards and practices of this chapter shall not apply to any wire permanently attached to an outboard engine and extending not more than 72 in. (183 cm) from the outboard engine.

9.2* General Requirements.

9.2.1 Conductor Length Measurement. All lengths for conductors shall be measured along the conductors.

9.2.2* Two-Wire System.

9.2.2.1 Branch circuits shall be of the two-wire type and shall use insulated conductors to and from each item of equipment unless permitted otherwise by 9.2.2.4 or 9.2.2.5.

9.2.2.2 The feed and return wires for the circuits of 9.2.2.1 shall be run together from the power source to the equipment.

9.2.2.3 If a common return is used for the circuits of 9.2.2.1, it shall be of equal wire gauge to the panelboard feeder.

9.2.2.4 The electrical system on a propulsion or auxiliary engine shall be permitted to be of the one-wire type, with the negative side of the system connected directly to the engine block.

9.2.2.5 The accessory negative bus of an outboard engine shall be permitted to be connected to the battery.

9.2.3 Return Circuit. A metal hull, bonding conductor, or grounding conductor shall not be used as a return circuit unless permitted otherwise by Section 9.11.

9.2.4 Grounded Systems. If one side of a two-wire dc system is connected to ground, it shall be the negative side, and the system shall be polarized.

9.2.5 Multiple Engine Installation.

9.2.5.1 If a boat has more than one inboard propulsion or auxiliary engine, grounded cranking motor circuits shall be connected to each other by a common conductor that can carry the starting current of each of the grounded cranking motor circuits.

9.2.5.2 Outboard engines shall be connected at the battery negatives.

9.2.6 Crossover (Parallel) Cranking Motor Circuits.

9.2.6.1 In multiple inboard engine installations (including auxiliary generators) with crossover (parallel) cranking motor systems, the engines shall be connected together with a cable except for where the installation uses ungrounded dc electrical systems.

9.2.6.2 The cable required by 9.2.6.1 shall be large enough to carry the cranking motor current of the largest cranking motor.

9.2.6.3 The cable required by 9.2.6.1 and its terminations shall be in addition to, and independent of, any other electrical connections to the engines, including those required in 9.2.5.

9.3 Batteries.

9.3.1 Batteries shall be accessible for inspection and maintenance.

9.3.2 Batteries shall not be tapped for voltages other than the total voltage of all the cells comprising the battery.

9.3.3* A vent system or other means shall be provided to allow hydrogen gas released by the battery to discharge from the boat.

9.3.4 Battery boxes with a cover that forms a pocket over the battery shall be vented.

9.3.5* Batteries shall be secured to provide immobilization to the extent practicable.

9.3.6 Battery Trays.

9.3.6.1 Batteries capable of releasing electrolytes shall be located in a liquidtight tray or battery box of adequate capacity to retain normal spillage or boilover of electrolytes when the boat is subjected to 30 degrees of roll, pitch, or heel for 15 seconds.

9.3.6.2 Battery trays shall be constructed of, or lined with, materials resistant to deterioration by the electrolytes.

9.3.7 A nonconductive, perforated cover or other means shall be provided to prevent accidental shorting of the ungrounded battery terminals and cell connectors.

9.3.8 Batteries with metal cell containers shall be assembled in nonconductive trays having insulated cell supports, and provision shall be made to prevent other conductive materials that could cause a short circuit from contacting cell containers.

9.3.9* Each metallic fuel line and fuel system component located within 12 in. (30 cm) of the battery and above the horizontal plane of the battery top surface, as installed, shall be shielded with dielectric material.

9.3.10 The positive terminal of each battery shall be marked on the terminal, or on the battery case near the terminal, by one of the following:

(1) The letters "POS"
(2) The letter "P"
(3) The symbol "+"

9.3.11 Battery terminal connections shall not depend on spring tension.

9.4 Power Distribution System Negative Connections.

9.4.1 The negative terminal of the battery and the negative side of the electrical power distribution system shall be connected to the engine negative terminal or its bus, unless permitted otherwise by 9.4.2.

9.4.2 The negative side of the electrical power distribution system shall be permitted to use the battery negative terminal on outboard boats.

9.4.3 Accessory Negative Bus. An accessory negative bus shall be permitted, provided the following conditions are met:

(1) All accessories connected to the bus shall be branch circuits from the same panelboard.
(2) Negative buses, negative bus return conductors, and their terminals and connections shall have an ampacity equal to the panelboard feeder.
(3) Negative return conductors from the panelboard feeding the branch circuits that use the accessory negative bus shall be equal in size to the positive feeder to the panelboard.

9.5 Continuously Energized Parts.

9.5.1 Continuously energized parts other than those addressed in 9.5.2, such as the positive battery terminal and both ends of all wires connected thereto, shall be physically protected by boots, sleeving, or other insulation to prevent an accidental short.

9.5.2 The protection specified in 9.5.1 shall not apply to conductors that have overcurrent protection at the source of power in accordance with Section 9.9.

9.6 Marking.

9.6.1 Marking of Controls.

9.6.1.1 Switches and electrical controls shall be marked to indicate their use unless otherwise permitted by 9.6.1.2.

9.6.1.2 A switch or electrical control shall not be required to be marked where it meets the following criteria:

(1) Its purpose is obvious.
(2) Its erroneous operation cannot cause a hazardous condition.

9.6.2* Marking of Equipment. Electrical equipment, unless it is part of an identified assembly, shall be marked or identified by the manufacturer to indicate the following:

(1) Manufacturer
(2) Identifying number
(3) Electrical rating (dc) in volts
(4) Terminal polarity or identification, if necessary to operation
(5) Ignition protection, if applicable

9.6.3 Rated Current.

9.6.3.1 The rated current of electrical equipment, unless it is part of an identified assembly, shall be made available.

9.6.3.2 Marking the device with the rated current shall be permitted to meet the requirements of 9.6.3.1.

9.7 Ambient Temperature.

9.7.1 The ambient temperature of machinery spaces shall be considered to be 122°F (50°C).

9.7.2 The ambient temperature of spaces other than machinery spaces shall be considered to be 86°F (30°C).

9.8 Ignition Sources.

9.8.1 Potential sources of ignition, except those isolated from a gasoline fuel source in accordance with 9.8.2, shall be ignition protected if located in spaces containing one of the following:

(1) Gasoline-powered machine
(2) Gasoline fuel tank
(3) Joint, fitting, or other connection between components of a gasoline fuel system

9.8.2* An electrical component shall be considered to be isolated from a gasoline fuel source provided that one of the following conditions is met:

(1) The distance between the electrical component and the gasoline fuel source is at least 2 ft (0.6 m), and the space is open to the atmosphere.
(2) Electrical component is located below the gasoline fuel source, and a means is provided to prevent gasoline fuel and vapors that can leak from the gasoline fuel sources from exposure to the electrical component.
(3) Electrical component is located above the gasoline fuel source, and a deck or other enclosure is located between the ignition source and the gasoline fuel source.

(4) A bulkhead is located between the gasoline fuel source and ignition source that meets the following criteria:
   (a) Separates the electrical component(s) from the gasoline fuel source and extends the length of both the vertical and horizontal distances of the open space between the gasoline fuel source and the ignition source
   (b) Resists a water level of 12 in. (30 cm) or of one-third the maximum height of the bulkhead, whichever is lower, without seepage of more than ¼ fl oz (7.4 ml) of fresh water per hour
   (c) Has no opening higher than 12 in. (30 cm) or one-third the maximum height of the bulkhead, whichever is lower, unless the opening meets the following criteria:
      i. Is used for the passage of items such as conductors, piping, ventilation ducts, and mechanical equipment, or for doors, hatches, and access panels
      ii. Has a maximum annular space around each item passing through it not more than ¼ in. (6.4 mm)

9.9 Overcurrent Protection.

9.9.1 General.

9.9.1.1 The distances specified in Section 9.9 shall be measured along the conductor.

9.9.1.2 The requirements of 9.9.2 through 9.9.10.2 shall not apply to pigtails less than 7 in. (18 cm) in length.

9.9.2* Overcurrent Protection Location. Conductors other than cranking motor conductors shall be provided with overcurrent protection at the source of power unless permitted by 9.9.2.1, 9.9.2.2, or 9.9.2.3.

9.9.2.1 Where not practical to locate overcurrent protection at the source of power, conductors other than cranking motor conductors shall be provided with overcurrent protection no more than 7 in. (18 cm) from the point at which the conductor is connected to the source of power measured along the conductor.

9.9.2.2 If the conductor is contained in a sheath or enclosure, such as a junction box, control box, or enclosed panel, throughout the required distance, and where not practical to locate overcurrent protection at the source of power, conductors other than cranking motor conductors shall be provided with overcurrent protection no more than 40 in. (102 cm) from the point at which the conductor is connected to the source of power.

9.9.2.3 If the conductor is connected directly to the battery terminal, and where not practical to locate overcurrent protection at the source of power, conductors other than cranking motor conductors shall be provided with overcurrent protection no more than 72 in. (183 cm) from the battery terminal.

9.9.3 Charging Sources.

9.9.3.1* Only battery charging sources designed to meet the requirements of the battery manufacturer shall be used for charging.

9.9.3.2 Overcurrent Protection of Conductors.

9.9.3.2.1 Each ungrounded dc conductor that runs from the battery charger or other charging source to a battery or other point of connection to the dc system shall be provided with overcurrent protection within a distance of 7 in. (18 cm) from the point of connection to the dc electrical system or battery, unless otherwise permitted by 9.9.3.2.2, 9.9.3.2.3, or 9.9.3.2.4.

9.9.3.2.2 Where a conductor specified in 9.9.3.2.1 is connected directly to the battery terminal and is contained throughout its entire distance in a sheath or enclosure such as a conduit, junction box, control box, or enclosed panel, the overcurrent protection shall be placed no more than 72 in. (183 cm) from the battery.

9.9.3.2.3 Where a conductor specified in 9.9.3.2.1 is connected to a source of power other than the battery terminal and is contained in a sheath or enclosure such as a conduit, junction box, control box, or enclosed panel, the overcurrent protection shall be placed no more than 40 in. (102 cm) from the point of connection.

9.9.3.2.4 Overcurrent protection is not required in conductors from self-limiting alternators with integral regulators if the following criteria are met:

(1) The conductor is no more than 40 in. (102 cm).
(2) The conductor is connected to a source of power other than the battery.
(3) The conductor is contained throughout its entire distance in a sheath or enclosure.

9.9.3.3 Overcurrent Protection within Charging Source.

9.9.3.3.1 Unless otherwise permitted by 9.9.3.3.2, each ungrounded dc output conductor shall be provided with overcurrent protection both within the charging source that is based on the maximum output and at the point of connection to the dc system or battery based on the conductor size.

9.9.3.3.2 Self-limiting devices that are not capable of producing current in excess of the current rating of the connecting conductors shall not require overcurrent protection for the dc output conductors but do require overcurrent protection at the point of connection to the dc system or battery.

9.9.4 Motors and Motor-Operated Equipment.

9.9.4.1* Motors and motor-operated equipment, except for engine cranking motors, shall be protected internally at the equipment or by branch-circuit overcurrent devices suitable for motor current.

9.9.4.2* The protection required in 9.9.4.1 shall preclude a fire hazard if the circuit, as installed, is energized for 7 hours under any conditions of overload, including locked rotor.

9.9.5 Overcurrent Protection Device Rating. The rating of overcurrent protection devices used to protect both the conductor and a load other than a dc motor shall not exceed 150 percent of the current-carrying capacity of the conductor being protected.

9.9.6 Branch Circuits. Each ungrounded conductor of a branch circuit shall be provided with overcurrent protection at the point of connection to the panelboard, unless the main circuit breaker or fuse provides such protection.

9.9.7* Distribution Panels, Panelboards, and Switchboards (Panelboards).

9.9.7.1 A trip-free circuit breaker or a fuse shall be installed at the power source for panelboards.

9.9.7.2 The protection required by 9.9.7.1 shall be rated at no more than 150 percent of the current-carrying capacity of either the supply or return conductor it serves.

9.9.7.3 If the protection required by 9.9.7.1 also serves as the panelboard overcurrent protection, it shall be rated at no more than 100 percent of the panelboard load capacity.

9.9.7.4 The overcurrent protection device in a panelboard shall be rated at no more than 100 percent of the total load capacity of the panelboard and no more than 100 percent of the current-carrying capacity of the feeders to the panelboard.

9.9.8 Circuit Breakers. The following shall apply to circuit breakers:

(1) They shall have a dc voltage rating of not less than the nominal system voltage.
(2) They shall be of the trip-free type.
(3) They shall be capable of an interrupting capacity in accordance with Table 9.9.8.
(4)*They shall meet the marine requirements of one of the following:
   (a) ANSI/UL 489, *Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*
   (b) ANSI/UL 1077, *Standard for Safety for Supplementary Protectors for Use in Electrical Equipment,* if used as a branch circuit breaker and able to interrupt the current specified for branch circuit breakers in Table 9.9.8 alone or in combination with the main circuit breaker
(5)*If located in a space that requires ignition protection, they shall meet the requirements of UL 1500, *Standard for Safety for Ignition-Protection Test for Marine Products,* at four times their rated current.

Table 9.9.8 Circuit Breaker Minimum Amperage Interrupting Capacity

	Ampere Interrupting Capacity (AIC) (Amperage available at circuit breaker terminals)	
Cold Cranking Current Rating at 0°F (–18°C) of Total Connected Battery Capacity	**Main Circuit Breaker (Amperes)**	**Branch Circuit Breaker (Amperes)**
12 volts and 24 volts		
650 or less	1500	750
651–1100	3000	1500
Over 1100	5000	2500
32 volts		
1250 or less	3000	1500
Over 1250	5000	2500

Notes:
(1) The main circuit breaker is considered to be the first breaker(s) in a circuit connected in series with the battery. All subsequent breakers connected in series with a main circuit breaker are considered to be branch circuit breakers.
(2) Under Battery Council International conversion factors, the following approximate correlations are used for 0°F (–18°C):

Cold Cranking Amperes	Ampere Hours (20-hour rating)
630	120
1076	205
1260	240

For the purpose of converting the 20-hour ampere/hour rating to approximate cold cranking amperes, use a value of 5.25 × the ampere/hour rating.

9.9.9 Fuses. The following shall apply to fuses:

(1) They shall have a dc voltage rating of not less than the nominal system voltage.
(2) They shall be capable of an interrupting capacity in accordance with Table 9.9.8.
(3)*If located in a space that requires ignition protection, they shall meet the requirements of SAE J1171, *External Ignition Protection for Marine Electrical Devices,* or UL 1500, *Standard for Safety for Ignition-Protection Test for Marine Products*; and if an internal explosion test is required, the test shall be conducted at no less than 4 times the current rating of the fuse.

9.9.10 Integral Overcurrent Protection Devices.

9.9.10.1 Integral overcurrent protection devices without a manual reset shall be permitted to be used as an integral part of an electrical device, provided the remainder of the circuit is protected by a trip-free circuit protection device(s) or a fuse(s).

9.9.10.2 Integral overcurrent protection shall be sized to protect the accessory in which it is installed.

9.10 Switches.

9.10.1 Battery Switch Location. If used, a battery switch shall be mounted as close as practicable to the battery and shall be readily accessible.

9.10.2 Master Battery Switch.

9.10.2.1 All boats with a battery or battery bank with a cold cranking capacity of greater than 800 amperes shall have a master battery switch that meets the requirements of Section 9.8.

9.10.2.2 Electronic devices with protected memory and protective devices, such as bilge pumps and protected alarm systems, shall be permitted to be connected to the continuously energized side of the switch required in 9.10.2.1.

9.10.3 Battery Switch Ratings.

9.10.3.1 The intermittent rating of a battery switch shall be not less than the maximum cranking current of the largest engine cranking motor it serves.

9.10.3.2 The continuous rating of a battery switch shall be not less than the total of the ampacities of the main overcurrent protection devices connected to the battery switch.

9.10.4 Branch Circuit Switches. Single-pole switches used in branch circuits, except for the following, shall be installed in the positive conductor of the circuit:

(1) Engine-mounted pressure, vacuum, and temperature-operated switches
(2) Switches used for control of alarm systems

9.10.5* Voltage Rating. Switches shall have a voltage rating of no less than the system voltage.

9.10.6 Current Rating. Switches shall have a current rating of no less than the connected load.

9.11 Appliances and Equipment.

9.11.1 Current-Carrying Parts.

9.11.1.1 Appliances and fixed dc electrical equipment, other than devices identified in 9.11.1.2 and 9.11.1.3, shall be designed so that the current-carrying parts of the devices are insulated from all exposed electrically conductive parts.

9.11.1.2 Engine-mounted equipment shall be permitted to have their negative conductors connected to exposed electrically conductive parts.

9.11.1.3 Specific Devices.

9.11.1.3.1 The following devices shall be permitted to have their negative conductors connected to exposed electrically conductive parts:

(1) Communications and audio equipment
(2) Electronic navigation equipment
(3) Instruments and instrument clusters
(4) Cigarette lighters
(5) Liquid level gauge transmitters (for installation on conductive surfaces)
(6) Navigation lights operating at nominal 12 volts or less

9.11.1.3.2 If a device identified in 9.11.1.3.1 has negative conductors connected to exposed electrically conductive parts, the device shall meet the following criteria:

(1) The polarity of both the positive and negative connections shall be identified.
(2) It shall be mounted only on electrically nonconductive material.
(3) It shall not be bonded.

9.11.2 Grounded Liquid Level Gauge Transmitters (Senders).

9.11.2.1 Grounded liquid level gauge transmitters mounted on metallic tanks or tank plates shall have the transmitter negative return conductor connected directly to the engine negative terminal, its bus, or, for outboard boats, the battery negative terminal.

9.11.2.2 The transmitter negative return conductor shall serve as the static ground or the bonding conductor, or both.

9.11.2.3 If the transmitter negative return conductor is used as the tank system bonding conductor, it shall be minimum No. 8 AWG.

9.11.2.4 No device or component other than a grounded liquid level gauge transmitter, tank, tank fill components, or tank vent components shall be connected to the transmitter negative return conductor or statically grounded to the tank.

9.11.3 Pigtail connections on submersible devices such as submersible bilge pumps shall not be shorter in length than 16 in. (41 cm).

9.11.4 Battery chargers and their installation shall comply with the requirements of ABYC A-31, *Battery Chargers and Inverters*.

9.11.5 Inverters.

9.11.5.1 Inverters and their installation shall comply with the requirements of ABYC A-31, *Battery Chargers and Inverters*.

9.11.5.2 Inverter chargers and their installation shall comply with the requirements of ABYC A-31, *Battery Chargers and Inverters*.

9.12 System Wiring.

9.12.1 Conductors and flexible cords shall have a minimum rating of 50 volts.

9.12.2* The construction of insulated cables and conductors shall conform with the requirements of SAE J1127, *Standard for Low Voltage Battery Cable*; SAE J1128, *Standard for Low Voltage Primary Cable*; or UL 1426, *Standard for Safety for Electrical Cables for Boats*.

9.12.3 Conductors shall be permitted to be selected from the types provided in Table 9.12.3(a) and Table 9.12.3(b).

Table 9.12.3(a) SAE Conductors

Type	Description	Available Insulation Temperature Rating °C	°F
GPT	Thermoplastic insulation, braidless	60	140
		90	194
		105	221
HDT	Thermoplastic insulation, braidless	60	140
		90	194
		105	221
SGT	Thermoplastic insulation, braidless	60	140
		90	194
		105	221
STS	Thermosetting synthetic rubber insulation, braidless	85	185
		90	194
HTS	Thermosetting synthetic rubber insulation, braidless	85	185
		90	194
SXL	Thermosetting cross-linked polyethylene insulation, braidless	125	257

Source: SAE J378, *Recommended Practice for Marine Propulsion System Wiring.*
Note: The temperature ratings shown assume the routing of wires above bilge water in locations protected from dripping, exposure to weather, spray, and oil.

9.12.4 Flexible cords shall conform with *NFPA 70, National Electrical Code*, and shall be selected from the types specified in Table 9.12.4.

9.12.5 Conductors and flexible cords shall be stranded copper according to Table 9.12.5(a) and shall be sized in accordance with Table 9.12.5(b).

9.12.6 Conductors and flexible cords shall be sized for voltage drop as follows:

(1) 3 percent for panelboard main feeders
(2) 3 percent for navigation light circuits
(3) 3 percent for electronic equipment circuits
(4) 3 percent for bilge pump, blower, and refrigeration motor circuits
(5) 10 percent for all noncritical circuits not identified in 9.12.6(1) through 9.12.6(4)

Table 9.12.3(b) Acceptable Insulation Types

Type	Description	Available Insulation Temperature Rating °C	°F
THW	Moisture- and heat-resistant, thermoplastic	75	167
TW	Moisture-resistant, thermoplastic	60	140
THWN	Moisture- and heat-resistant, thermoplastic	75	167
XHHW	Moisture- and heat-resistant, cross-linked synthetic polymer	90	194
MTW	Moisture-, heat-, and oil-resistant, thermoplastic	90	194
AWM	Moisture-, heat-, and oil-resistant, thermoplastic	105	221
Style Nos.:* 1230 1231 1275 1276 1329 1335 1336 1337 1339 1340 1345 1388 3403	Thermosetting		
UL 1426	Boat cable	*(See UL 1426, Standard for Safety for Electrical Cables for Boats.)*	

*Numbers listed are style numbers.

Table 9.12.4 Flexible Cords

Type	Description	Insulation Temperature Rating	Application
SO	Hard service cord —oil-resistant compound	60°C (140°F) 75°C (167°F) and higher	General use except for machinery space General use
ST	Hard service cord — thermoplastic	60°C (140°F) 75°C (167°F) and higher	General use except for machinery space General use
STO	Hard service cord —oil-resistant thermoplastic	60°C (140°F) 75°C (167°F) and higher	General use except for machinery space General use
SJO	Junior hard service cord—oil-resistant compound	60°C (140°F) 75°C (167°F) and higher	General use except for machinery space General use
SJT	Junior hard service cord —thermoplastic	60°C (140°F) 75°C (167°F) and higher	General use except for machinery space General use
SJTO	Junior hard service cord —thermoplastic	60°C (140°F) 75°C (167°F) and higher	General use except for machinery space General use

Table 9.12.5(a) Conductor Circular Mil (CM) Area and Stranding (for Electrical Systems Under 50 Volts)

Conductor Size (AWG)	Minimum Acceptable CM Area[a]	Minimum Number of Strands Type 2[b]	Type 3[c]
18	1,537	16	—
16	2,336	19	26
14	3,702	19	41
12	5,833	19	65
10	9,343	19	105
8	14,810	19	168
6	25,910	37	266
4	37,360	49	420
2	62,450	127	665
1	77,790	127	836
1/0	98,980	127	1064
2/0	125,100	127	1323
3/0	158,600	259	1666
4/0	205,500	418	2107

Note: Metric wire sizes are to be used if of equivalent circular mil area. If the circular mil area of the metric conductor is less than that specified, the wire ampacity can be corrected based on the ratio of the circular mil area.

[a]Applies only to systems under 50 volts.

[b]Conductors with Type 2 stranding, used for general-purpose wiring, which is subject to some movement from vibration or minor flexing.

[c]Conductors with Type 3 stranding, used for any wiring where flexing is involved in normal use.

9.12.7 Conductor Sizing Formula.

9.12.7.1 Conductor sizes shall be permitted to be calculated by means of the following formula:

$$\text{CM} = \frac{K \times I \times L}{E} \qquad \textbf{[9.12.7.1]}$$

where:

CM = circular mil area of conductor
K = 10.75 (constant representing the mil-foot resistance of copper)
I = load current in amperes
L = length of conductor from the positive power source connection to the electrical device and back to the negative power source connection, measured in feet
E = voltage drop at load in volts (e.g., 12 volt @ 3 percent = 0.36)

9.12.7.2 If the circular mil area calculated in 9.12.7.1 is less than the value specified in Table 9.12.5(a), the next larger size conductor shall be used.

9.13 Wiring Installation.

9.13.1* Current-carrying conductors shall be routed above the bilge water level and other areas where water can accumulate where the wiring and connectors are not watertight.

Table 9.12.5(b) Allowable Amperage of Conductors for Under 50 Volts

Conductor Size		Temperature Rating of Conductor Insulation												
		60°C (140°F)		75°C (167°F)		80°C (176°F)		90°C (194°F)		105°C (221°F)		125°C (257°F)		200°C (392°F)
English	Metric	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside or Inside Engine Spaces
18	0.8	10	5.8	10	7.5	15	11.7	20	16.4	20	17.0	25	22.3	25
16	1	15	8.7	15	11.3	20	15.6	25	20.5	25	21.3	30	26.7	35
14	2	20	11.6	20	15.0	25	19.5	30	24.6	35	29.8	40	35.6	45
12	3	25	14.5	25	18.8	35	27.3	40	32.8	45	38.3	50	44.5	55
10	5	40	23.2	40	30.0	50	39.0	55	45.1	60	51.0	70	62.3	70
8	8	55	31.9	65	48.8	70	54.6	70	57.4	80	68.0	90	80.1	100
6	13	80	46.4	95	71.3	100	78.0	100	82.0	120	102.0	125	111.3	135
4	19	105	60.9	125	93.8	130	101.4	135	110.7	160	136.0	170	151.3	180
2	32	140	81.2	170	127.5	175	136.5	180	147.6	210	178.5	225	200.3	240
1	40	165	95.7	195	146.3	210	163.8	210	172.2	245	208.3	265	235.9	280
0	50	195	113.1	230	172.5	245	191.1	245	200.9	285	242.3	305	271.5	325
00	62	225	130.5	265	198.8	285	222.3	285	233.7	330	280.5	355	316.0	370
000	81	260	150.8	310	232.5	330	257.4	330	270.6	385	327.3	410	364.9	430
0000	130	300	174.0	360	270.0	385	330.3	385	315.7	445	378.3	475	422.8	510

9.13.2* Conductors, other than wiring on engines and exhaust temperature sensor wiring, shall be routed in a manner that complies with the following criteria:

(1) There shall be a clearance of no less than 2 in. (5 cm) between conductors and water-cooled exhaust components.

(2) There shall be a clearance of no less than 9 in. (23 cm) between conductors and dry exhaust components where the conductor is not directly above the exhaust.

(3) There shall be a clearance of no less than 18 in. (46 cm) between conductors and dry exhaust components where conductors are located directly above the exhaust.

9.13.3 Battery Cables.

9.13.3.1 Battery cables shall not contact any metallic fuel system components.

9.13.3.2* Where contact occurs between battery cables and nonmetallic fuel system components, cables shall be secured to prevent relative motion and abrasion between the two system components.

9.13.4 Physical Damage.

9.13.4.1 Conductors subject to exposure to physical damage shall be protected by loom, conduit, tape, raceways, or other equivalent protection.

9.13.4.2 The protection required by 9.13.4.1 shall be self-draining.

9.13.4.3* Conductors passing through or around bulkheads or structural members shall be protected to minimize insulation damage such as chafing or compression. To minimize the potential for migration of carbon monoxide from machinery compartments containing gasoline engines to adjacent accommodation compartments, bulkhead and deck penetrations shall be in accordance with the requirements of 4.1.2.1.

9.13.4.4 Conductors shall be routed clear of sources of chafing such as steering cable and linkages, engine shafts and belts, and throttle connections.

9.13.5 Minimum Size.

9.13.5.1 Conductor sizes shall be no less than No. 16 gauge unless permitted otherwise by 9.13.5.2 or 9.13.5.3.

9.13.5.2 No. 18 gauge conductors shall be permitted to be used if they are included with other conductors in a sheath and do not extend more than 30 in. (75 cm) outside the sheath.

9.13.5.3 Conductor sizes shall be permitted to be less than No. 16 gauge where the conductor is contained completely within equipment or enclosures.

9.13.6 Conductor Support.

9.13.6.1 Conductors shall be supported for their entire length unless permitted otherwise by 9.13.6.2 through 9.13.6.4.

9.13.6.2 Conductors shall be permitted to be supported at least every 18 in. (46 cm) by nonmetallic clamps of a size to hold the conductors firmly in place.

9.13.6.2.1 Nonmetallic straps or clamps shall not be used over engine(s), moving shafts, other machinery, or passageways if failure can result in a hazardous condition.

9.13.6.2.2 Conductor material shall be resistant to oil, gasoline, and water and shall not break or crack under flexing within a temperature range of –30°F to 250°F (–34°C to 121°C).

9.13.6.3 Metal Straps Without Insulating Material.

9.13.6.3.1 Conductors, other than battery cables within 36 in. (91 cm) of a battery terminal and cables attached to outboard motors, shall be permitted to be supported at least every 18 in. (46 cm) by metal straps or clamps with smooth, rounded edges.

9.13.6.3.2 Sections of the conductor or cable located directly under the strap or clamp shall be protected by means of loom, tape, or other suitable wrapping to prevent injury to the conductor.

9.13.6.4 Conductors shall be permitted to be supported at least every 18 in. (46 cm) by metal clamps lined with an insulating material resistant to the effects of oil, gasoline, and water.

9.13.7 Loom used to cover conductors shall be manufactured from material that is self-extinguishing, classified V-2 or better, in accordance with ANSI/UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*.

9.14 Wiring Connections.

9.14.1 Metals.

9.14.1.1 Metals used for the terminal studs, nuts, and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug.

9.14.1.2 Aluminum and unplated steel shall not be used for studs, nuts, and washers.

9.14.2 Wiring connections and terminals shall be designed specifically for use with stranded wire.

9.14.3 Each conductor splice joining conductor to conductor, conductor to connectors, and conductor to terminals shall be able to withstand a tensile force equal to at least the value shown in Table 9.14.3 for the smallest conductor size used in the splice for a 1-minute duration without breaking.

9.14.4 Terminal Connectors.

9.14.4.1 Terminal connectors shall be of the ring or captive spade type unless permitted otherwise by 9.14.4.2.

Table 9.14.3 Tensile Test Values for Connections

Conductor Size (gauge)	Tensile Force		Conductor Size (gauge)	Tensile Force	
	lb	N		lb	N
18	10	44	4	70	311
16	15	66	3	80	355
14	30	133	2	90	400
12	35	155	1	100	444
10	40	177	0	125	556
8	45	200	00	150	667
6	50	222	000	175	778
5	60	266	0000	225	1000

9.14.4.2 Terminal connectors shall be permitted to be of the friction type where the following conditions are met:

(1) The circuit is rated not more than 20 amperes or the manufacturer's rating for a terminal designed to meet the requirements of ANSI/UL 310, *Standard for Safety for Electrical Quick-Connect Terminals*, or ANSI/UL 1059, *Standard for Safety for Terminal Blocks*.
(2) Circuits under 20 amps where conductors exceed No. 16 AWG must provide support either through bundling or direct support.
(3) Voltage drop from terminal to terminal does not exceed 50 millivolts for a 20-ampere current flow.
(4) Connection does not separate if subjected to a 6 lb (26.7 N) tensile force along the axial direction of the connector for 1 minute.

9.14.5 Connections shall be permitted to be made using a set-screw, pressure-type conductor connector, provided a means is used to prevent the set screw from bearing directly on the conductor strands.

9.14.6 Twist-on connectors (wire nuts) shall not be used.

9.14.7* Solder shall not be the sole means of mechanical connection in any circuit except in the following situations:

(1) Battery lugs with a solder contact length of not less than 1.5 times the diameter of the conductor
(2) Conductors contained completely within equipment or enclosures

9.14.8 Solderless crimp-on connectors shall be attached with the type of crimping tools designed for the connector used.

9.14.9 Each battery terminal post shall be used for no more than one conductor and any of the following:

(1) Connections made for paralleling batteries
(2) One conductor where installed in accordance with 9.9.2

9.14.10 When a battery terminal post incorporates a threaded terminal stud, the wire size connected to the terminal stud shall not be greater than No. 2 AWG.

9.14.11 No more than four conductors shall be secured to any terminal stud.

9.14.12 Terminal connectors of the ring and captive spade type shall be the same nominal size as the stud.

9.14.13 Conductors terminating at switchboards in junction boxes or at fixtures shall be arranged to provide a length of conductor to relieve tension, to allow for repairs, and to permit multiple conductors to be fanned at terminal studs.

9.14.14 The shanks of terminals, other than those used in grounding systems, shall be protected against accidental shorting by the use of insulation barriers or sleeves.

9.15 Receptacles.

9.15.1 Receptacles shall be installed in locations normally not subject to rain, spray, or flooding, or shall be protected as follows:

(1) Weatherproof if subject to rain or spray
(2) Watertight if subject to flooding

9.15.2 Receptacles and matching plugs used on dc systems shall not be interchangeable with receptacles and matching plugs used elsewhere on the boat for ac systems.

9.16 Plug Connectors. Connectors used in conjunction with harness-type wiring systems shall comply with the following:

(1) Connectors shall incorporate means such as cable clamps, molded connectors, insulation grips, or extended terminal barrels to limit flexing at the connection.
(2) Connectors exposed to weather shall be weatherproof.
(3) Connectors subject to immersion shall be watertight.
(4) Each terminal in a multiwire connector shall be protected from accidental short-circuiting to adjacent terminals.
(5) Connectors shall have provisions such that they will not disengage when a force of 6 lb (26.7 N) is applied along the axial direction of the connector for 1 minute.

Chapter 10 Alternating Current (ac) Electrical Systems on Boats

10.1* Scope. The standards and practices of this chapter establish requirements for the design and installation of ac electrical systems on boats operating at frequencies of 50 or 60 hertz and less than 300 volts, including shore-powered systems up to the point of connection to the shore outlet.

10.2 General Requirements.

10.2.1 Conductor Length Measurement. All lengths for conductors shall be measured along the conductors.

10.2.2 The system shall be polarized.

10.2.3 Grounded Neutral System.

10.2.3.1 A grounded neutral system shall be required unless otherwise permitted by 10.2.4.

10.2.3.2* The neutral shall be grounded only at the power source.

10.2.3.3 A shore power neutral grounded through the shore power cable shall not be grounded on the boat.

10.2.4 Transformer Grounding.

10.2.4.1 On systems using an isolation or polarization transformer, the generator or inverter neutral shall be permitted to be the transformer.

10.2.4.2 Secondary neutrals shall be permitted to be grounded at a main grounding bus instead of at the generator inverter or transformer secondaries.

10.2.5 The boat's ac system grounding (green, or green with yellow stripe) conductor shall be connected to the engine negative terminal or its bus.

10.2.6 Individual circuits shall not be capable of being energized by more than one source of electrical power at a time, and each shore power inlet or generator shall be a separate source of electrical power.

10.2.7 Energized Parts.

10.2.7.1 Energized parts of electrical equipment shall be protected against accidental contact by the use of enclosures or other protective means.

10.2.7.2 The protective means required in 10.2.7.1 shall not be used for nonelectrical equipment and electrical equipment together.

10.2.7.3 Access to enclosures containing energized parts of electrical equipment shall require the use of hand tools.

10.2.8* The transfer from one power source circuit to another shall be made by a means that opens all current-carrying conductors, including neutrals, before closing the alternate source circuit, and that prevents arc over between sources.

10.3 Marking.

10.3.1 Shore Power Inlet Warning.

10.3.1.1 A permanently mounted, waterproof warning label shall be located alongside each shore power inlet location on the boat and shall contain at a minimum the following informational elements, unless permitted otherwise by 10.3.1.2 or 10.3.1.3:

WARNING
Electrical shock and fire hazard. Failure to follow these instructions can result in injury or death.
(1) Turn off the boat's shore connection switch before connecting or disconnecting shore cable.
(2) Connect shore power cable at the boat first.
(3) Immediately disconnect cable if polarity warning indicator is activated.
(4) Disconnect shore power cable at shore outlet first.
(5) Close shore power inlet cover tightly.
(6) Do not alter shore power cable connectors.

10.3.1.2 If a polarity indicator is not required, the informational element (3) shall not be required for the label specified in 10.3.1.1.

10.3.1.3 If the shore power cable is permanently connected to the boat, the informational elements (2) and (5) shall not be required for the label specified in 10.3.1.1.

10.3.2 Marking of Controls.

10.3.2.1 Switches and electrical controls shall be marked to indicate their use unless otherwise permitted by 10.3.2.2.

10.3.2.2 A switch or electrical control shall not be required to be marked where it meets the following criteria:

(1) Its purpose is obvious.
(2) Its erroneous operation cannot cause a hazardous condition.

10.3.3 Marking of Equipment. Electrical equipment, unless it is part of an identified assembly, shall be marked or identified by the manufacturer to indicate the following:

(1) Manufacturer's identification
(2) Model number
(3) Rating in volts and amperes or volts and watts
(4) Phase identification, if applicable
(5) Ignition protection, if applicable

10.4 System Voltage. Nominal system voltages for ac electrical systems shall be one of the following:

(1) 120 volts ac, single-phase
(2) 240 volts ac, single-phase
(3) 120/240 volts ac, single-phase
(4) 120/240 volts ac, delta three-phase
(5) 120/208 volts ac, wye three-phase

10.5 Ambient Temperature. The ambient temperature of machinery spaces shall be considered to be 122°F (50°C), and the ambient temperature of all other spaces shall be considered to be 86°F (30°C).

10.6 Ignition Source.

10.6.1 Potential sources of ignition, except those isolated from a gasoline fuel source in accordance with 10.6.2, shall be ignition protected if located in spaces containing one of the following:

(1) Gasoline-powered machine
(2) Gasoline fuel tank
(3) Joint, fitting, or other connection between components of a gasoline fuel system

10.6.2* An electrical component shall be considered to be isolated from a gasoline fuel source provided that one of the following conditions is met:

(1) The distance between the electrical component and the gasoline fuel source is at least 2 ft (0.6 m), and the space is open to the atmosphere.
(2) Electrical component is located below the gasoline fuel source, and a means is provided to prevent gasoline fuel and vapors that can leak from the gasoline fuel sources from exposure to the electrical component.
(3) Electrical component is located above the gasoline fuel source, and a deck or other enclosure is located between the ignition source and the gasoline fuel source.
(4)*A bulkhead is located between the gasoline fuel source and ignition source that meets the following criteria:
   (a) Separates the electrical component(s) from the gasoline fuel source and extends the length of both the vertical and horizontal distances of the open space between the gasoline fuel source and the ignition source
   (b) Resists a water level of 12 in. (30 cm) or of one-third the maximum height of the bulkhead, whichever is lower, without seepage of more than ¼ fl oz (7.4 ml) of fresh water per hour
   (c) Has no opening higher than 12 in. (30 cm) or one-third the maximum height of the bulkhead, whichever is lower, unless the opening meets the following criteria:
      i. Is used for the passage of items such as conductors, piping, ventilation ducts, and mechanical equipment, or for doors, hatches, and access panels
      ii. Has a maximum annular space around each item passing through it not more than ¼ in. (6.4 mm)

10.7 Shore Power Polarity Devices.

10.7.1* Reverse-polarity indicating devices having a continuously visible or audible signal shall be installed in 120-volt ac shore power systems, where there is no polarization or isolation transformer that establishes the polarity of the onboard system, and one of the following conditions exists:

(1) The polarity of the system must be maintained for the proper operation of electrical devices in the system.
(2) A branch circuit is provided with overcurrent protection in the ungrounded current-carrying conductors only.

10.7.2 The total impedance of polarity-indicating and protection devices connected between normal current-carrying conductors and the grounding conductor shall be not less than 25,000 ohms at 120 volts, 60 hertz at all times.

10.7.3 Conductors shall be identified to indicate polarity in accordance with Figure 10.7.3(a) through Figure 10.7.3(i).

10.8 Overcurrent Protection.

10.8.1 Rating of Overcurrent Protection Devices.

10.8.1.1 Overcurrent protection devices shall have a temperature rating and demand load characteristics consistent with the protected circuit and their location in the boat (e.g., in a machinery space).

10.8.1.2 The rating of the overcurrent protection device shall not exceed the maximum current-carrying capacity of the conductor being protected.

10.8.2 Circuit Breakers. The following shall apply to circuit breakers:

(1) They shall have an ac voltage rating of not less than the nominal system voltage.
(2) They shall be of the trip-free type.
(3) They shall be capable of an interrupting capacity in accordance with Table 10.8.2.
(4)*They shall meet the marine requirements of one of the following:
   (a) ANSI/UL 489, *Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*
   (b) ANSI/UL 1077, *Standard for Safety for Supplementary Protectors for Use in Electrical Equipment*, if used as a branch circuit breaker and able to interrupt the current specified for branch circuit breakers in Table 10.8.2 alone or in combination with the main circuit breaker
(5)*If located in a space that requires ignition protection, they shall meet the requirements of UL 1500, *Standard for Safety for Ignition-Protection Test for Marine Products*, at four times their rated current.

10.8.3 Fuses. Fuses shall comply with the following:

(1) They shall have an ac voltage rating of not less than the nominal system voltage.
(2) They shall be capable of an interrupting capacity in accordance with Table 10.8.2.
(3)*If located in a space that requires ignition protection, they shall meet the requirements of SAE J1171, *External Ignition Protection of Marine Electrical Devices*, or UL 1500, *Standard for Safety for Ignition-Protection Test for Marine Products*; and if an internal explosion test is required, the test shall be conducted at no less than 4 times the current rating of the fuse.
(4) They shall meet the requirements of the applicable part of ANSI/UL 248, *Low Voltage Fuses,* as dictated by the fuse class.

10.8.4 Fuse Holders. Fuse holders shall meet the requirements of ANSI/UL 4248, *Series of Standards for Safety for Fuseholders*, for the class of fuse being used.

10.9 Main Supply.

10.9.1 Common-trip circuit breakers shall be provided in main supply conductors as follows:

(1) 120-volt ac, single-phase — ungrounded and grounded conductors (white)
(2) 240-volt ac, single-phase — both ungrounded conductors
(3) 120/240-volt ac, single-phase — both ungrounded conductors
(4) 120/240-volt ac, delta three-phase — all ungrounded conductors
(5) 120/208-volt ac, wye three-phase — all ungrounded conductors

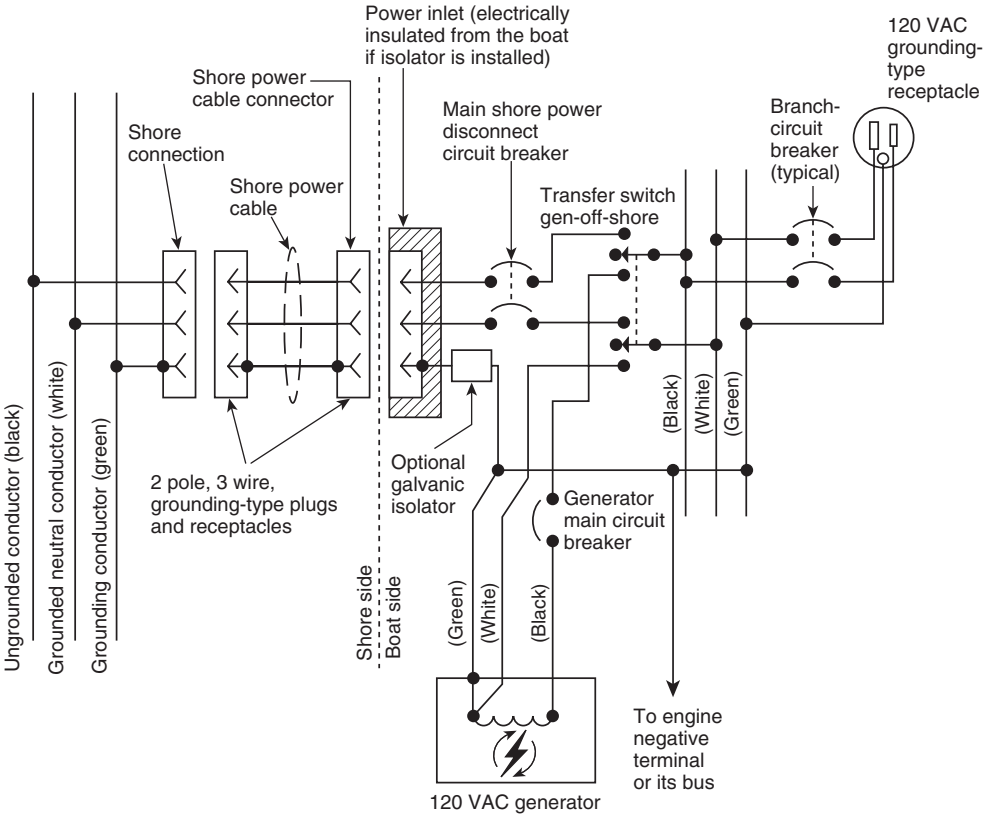


FIGURE 10.7.3(a) Single-Phase 120-Volt Auxiliary Generator Shore Power Selector Switch Circuit.

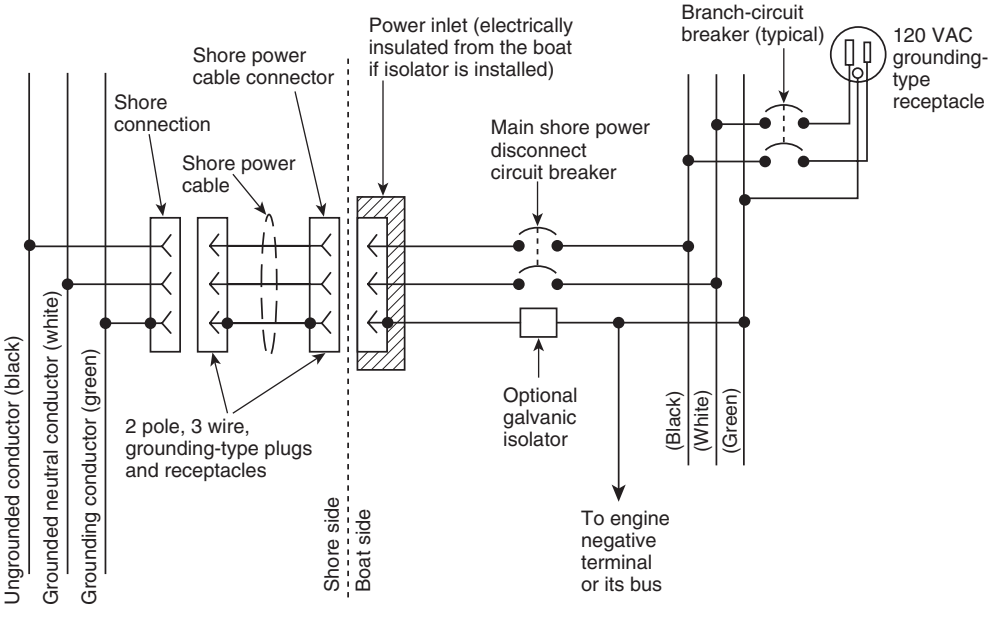


FIGURE 10.7.3(b) Single-Phase 120-Volt System with Shore-Grounded Neutral Conductor and Shore Grounding Conductor.

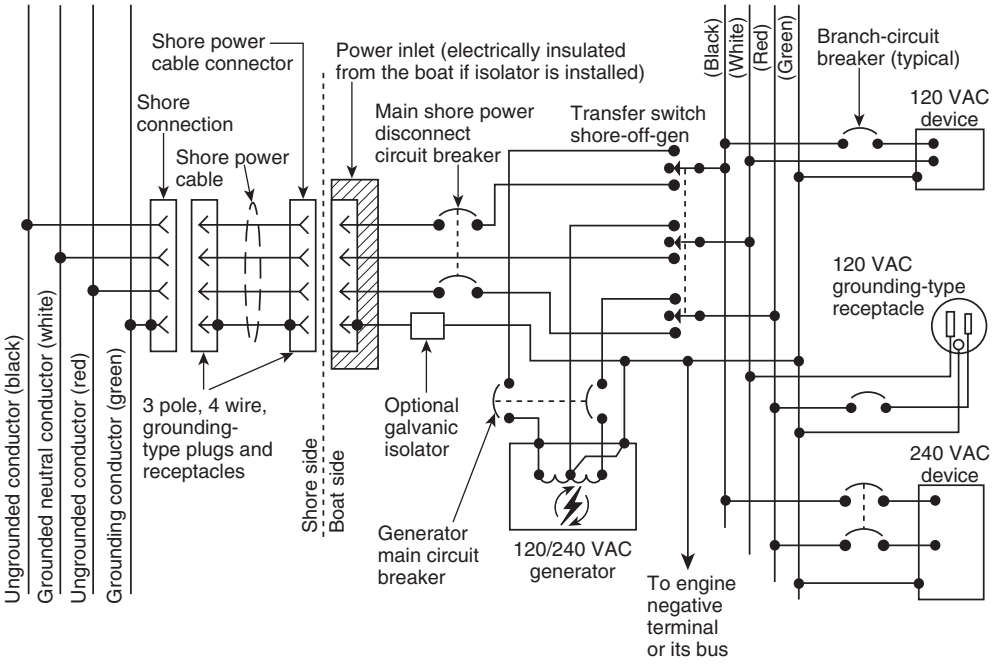


FIGURE 10.7.3(c) Single-Phase 120/240-Volt System with Shore-Grounded Neutral Conductor and Grounding Conductor.

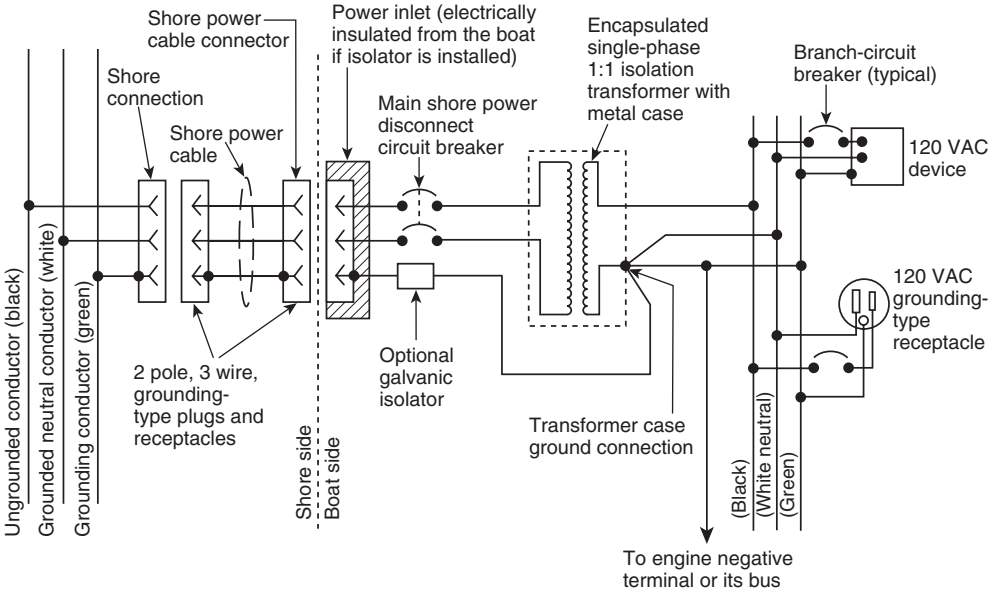


FIGURE 10.7.3(d) Single-Phase 120-Volt Polarization Transformer System with Shore Grounding Wire Protection of Transformer Primary.

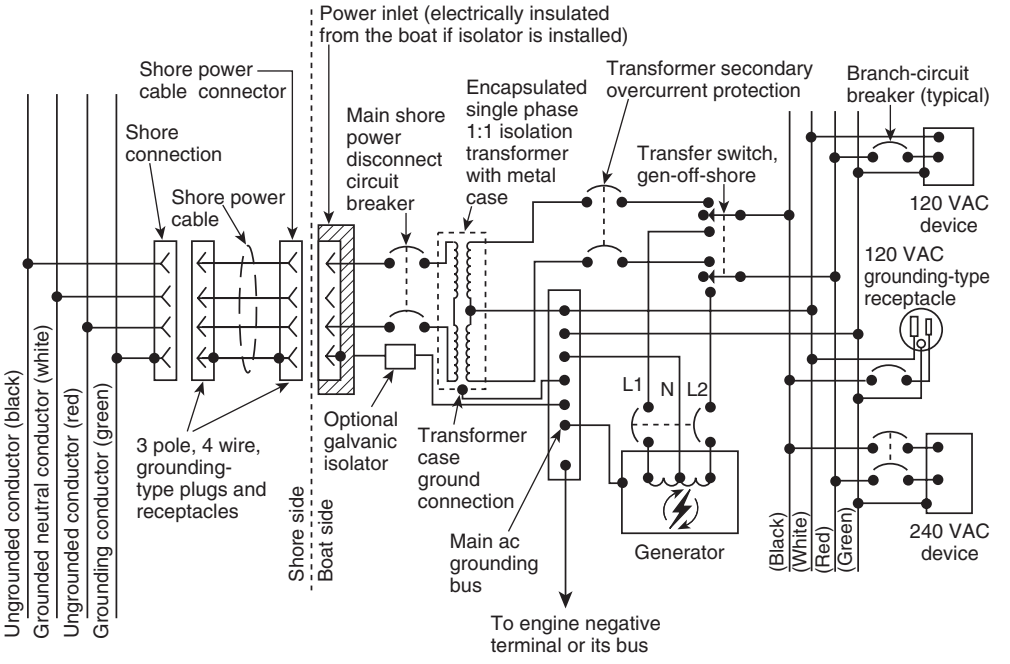


FIGURE 10.7.3(e) Single-Phase Polarization Transformer System with Single-Phase 240-Volt Input and 120/240-Volt Single-Phase Output — Shore Grounding Protection of Transformer.

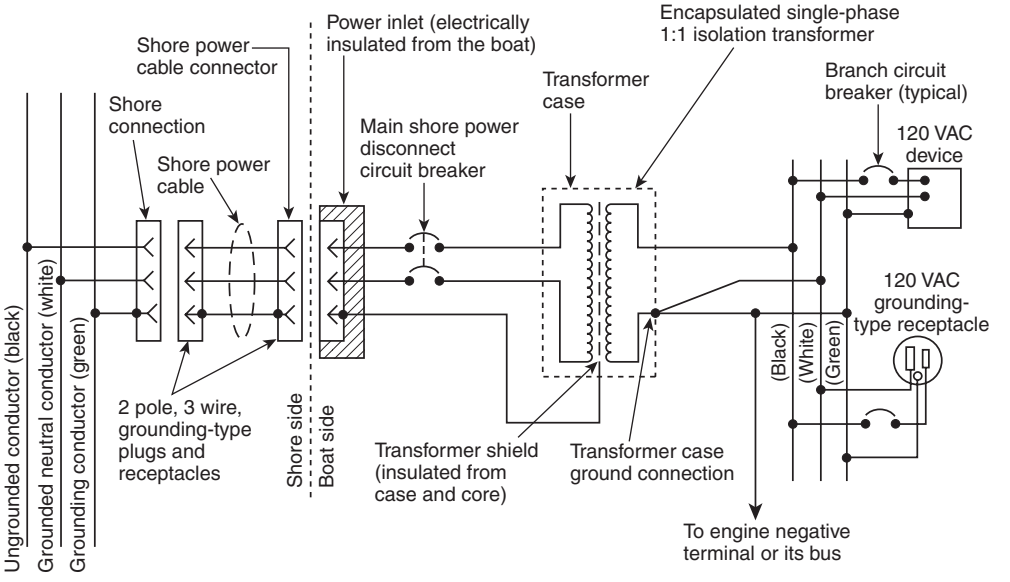


FIGURE 10.7.3(f) Single-Phase 120-Volt Isolation Transformer System with Boat-Grounded Secondary, Shore-Grounded Transformer Shield, and Boat-Grounded Transformer Metal Case.

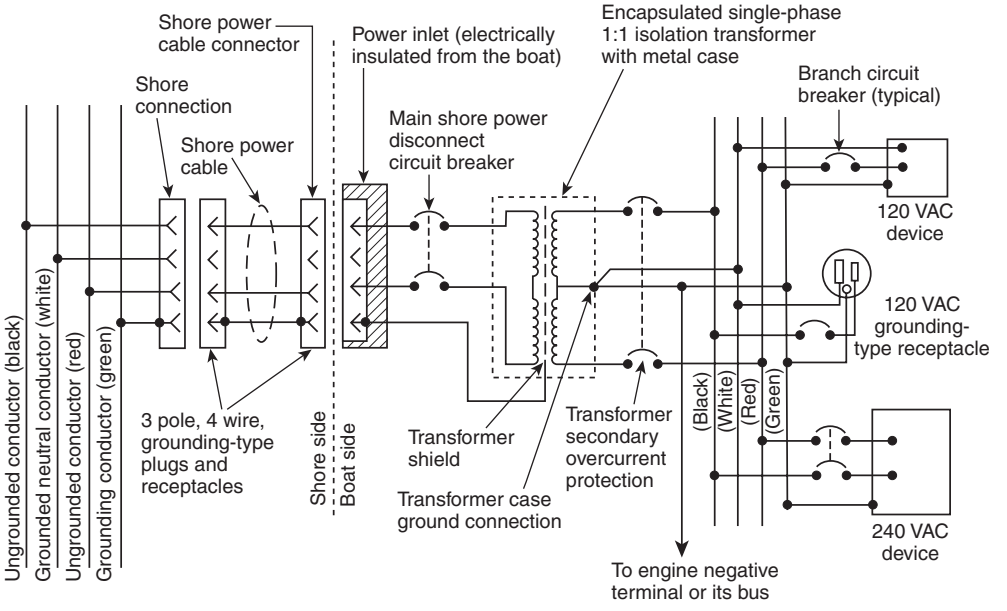


FIGURE 10.7.3(g) Isolation Transformer System — Single-Phase 240-Volt Input and 120/240-Volt Output with Boat-Grounded Secondary, Shore-Grounded Transformer Shield, and Boat-Grounded Transformer Metal Case.

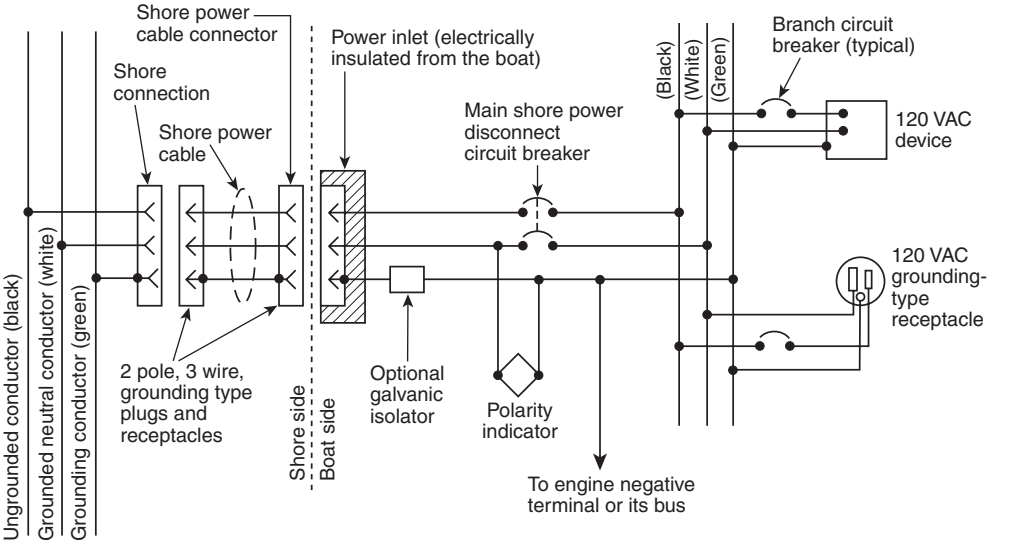


FIGURE 10.7.3(h) Single-Phase 120-Volt System with Polarity Indicating Device, Shore-Grounded Neutral Conductor, and Shore-Grounded Grounding Conductor.

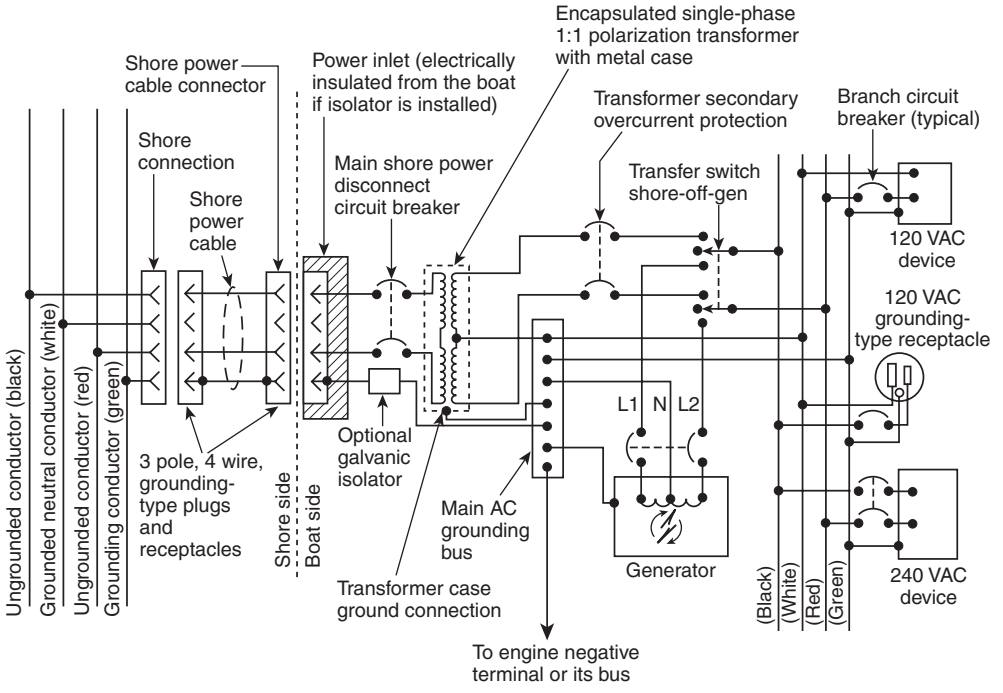


FIGURE 10.7.3(i) Polarization Transformer System — Single-Phase 240-Volt Input and 120/240-Volt Output — Generator with Main ac Grounding Bus.

Table 10.8.2 Circuit-Breaker Interrupting Capacity (Amperes)

	Main Shore Power	
Shore Power Source	Disconnect Circuit Breaker	Branch Breaker
120V–30A	3000	3000
120V–50A	3000	3000
120/240V–50A	5000	3000
240V–50A	5000	3000
120/208V–3-phase/wye 30A	5000	3000
120/240V–100A	5000	3000
120/208V–3-phase/wye 100A	5000	3000

Notes:
(1) The main circuit breaker shall be considered the first circuit breaker(s) connected to a source of ac power. All subsequent breakers, including submain breakers connected in series with a main circuit breaker, are considered to be branch circuit breakers.
(2) A fuse in series with, and ahead of, a circuit breaker shall be permitted to be required by the circuit-breaker manufacturer to achieve the interrupting capacity specified in Table 10.8.2.

10.9.2 Supply Feeders Exceeding 10 ft (3 m).

10.9.2.1* If the location of the main feeder supply disconnect circuit breaker is in excess of 10 ft (3 m) from the shore power inlet or the electrical attachment point of a permanently installed shore power cord, additional fuses or circuit breakers shall be provided within 10 ft (3 m) of the inlet or attachment point to the electrical system of the boat.

10.9.2.2 If additional fuses are required by 10.9.2.1, their rating shall be such that circuit breakers trip before the fuses open the circuit in the event of overload.

10.9.2.3 If additional fuses are required by 10.9.2.1, the ampere rating of the additional fuses or circuit breaker shall not exceed 125 percent of the rating of the main shore power disconnect circuit breaker.

10.9.3* Overcurrent Protection Location. Conductors shall be provided with overcurrent protection at the source of power unless permitted by 10.9.3.1, or 10.9.3.2.

10.9.3.1 Where not practical to locate overcurrent protection at the source of power, conductors shall be provided with overcurrent protection no more than 7 in. (18 cm) from the point at which the conductor is connected to the source of power measured along the conductor.

10.9.3.2 If the conductor is contained in a sheath or enclosure, such as a junction box, control box, or enclosed panel, throughout the required distance, and where not practical to locate overcurrent protection at the source of power, conductors shall be provided with overcurrent protection no more than 40 in. (102 cm) from the point at which the conductor is connected to the source of power.

10.9.4 Self-limiting generators, whose maximum overload current does not exceed 120 percent of its rated current output, shall not be required to have external overcurrent protection.

10.10 Branch Circuits.

10.10.1 Ungrounded Conductor.

10.10.1.1 Each ungrounded conductor of a branch circuit shall be provided with overcurrent protection at the point of connection to the panelboard bus.

10.10.1.2 Each circuit breaker or fuse required by 10.10.1.1 shall not be rated in excess of the current rating of the smallest conductor between the fuse or circuit breaker and the load.

10.10.2 In branch circuits, circuit breakers and switches shall open all grounded and ungrounded conductors simultaneously except for the following conductors:

(1) A polarized circuit with a polarity indicator
(2) The neutral leg of a grounded secondary of a polarization or isolation transformer

10.10.3 Fuses shall not be used in the grounded conductor.

10.10.4 If circuits contain two or more ungrounded current-carrying conductors that are protected by fuses, means shall be provided to disconnect all energized legs of the circuit simultaneously or to remove all fuses from the circuit simultaneously.

10.10.5 All ac branch-circuit conductors to receptacles or equipment, other than those contained completely within equipment or enclosures, shall be of the jacketed type.

10.10.6 Alternating Current (ac) Motors.

10.10.6.1 Each motor or motor-operated device shall be individually protected by an overcurrent protection device unless the motor will not overheat under locked rotor conditions.

10.10.6.2 The overcurrent protection device shall not be rated at more than 125 percent of the motor full-load current rating.

10.10.6.3 The overcurrent protection device shall be permitted to be integral and of an automatic resetting type.

10.10.7 Battery Chargers and Inverters.

10.10.7.1 Each ungrounded conductor to a battery charger shall be provided with overcurrent protection at the point of connection to the main switchboard or the distribution panel.

10.10.7.2 Battery chargers, inverters, and inverter/chargers, and their installation shall comply with the requirements of ABYC A-31, *Battery Chargers and Inverters*.

10.10.7.3 Each battery charger shall be fitted with a means of indicating the output current.

10.11 Ground-Fault Circuit Interrupters (GFCIs).

10.11.1 A GFCI shall be permitted to be used on any single-phase ac circuit and shall be used for all receptacles in a head, a galley, or a machinery space or on a weather deck as required by 10.15.7.

10.11.2 GFCI breakers shall comply with the following:

(1) They shall meet the requirements of ANSI/UL 943, *Standard for Safety for Ground-Fault Circuit-Interrupters*, and ANSI/UL 489, *Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*.
(2) They shall be permitted to be installed as panelboard feeder breakers to protect all associated circuits, or in individual branch circuits.

10.11.3 GFCI receptacle devices shall comply with the following:

(1) They shall meet the requirements of ANSI/UL 943, *Standard for Safety for Ground-Fault Circuit-Interrupters*, and ANSI/UL 498, *Standard for Safety for Attachment Plugs and Receptacles*.
(2) They shall be permitted to be installed as part of a convenience outlet installation, either in single outlet applications or in multiple "feed-through" installations.

10.11.4* GFP circuit breakers shall be permitted to be installed as the main breaker on the primary side of isolation transformers.

10.12 Appliances and Equipment.

10.12.1 Appliances and fixed ac electrical equipment used on boats shall be designed so that the current-carrying parts of the device are insulated effectively from all exposed electrically conductive parts.

10.12.2 All exposed electrically conductive non-current-carrying parts of fixed ac electrical equipment and appliances intended to be grounded shall be connected to the grounding system.

10.12.3 If an appliance has a neutral-to-ground bonding strap, the bonding strap shall be removed.

10.13 Conductors and Flexible Cords.

10.13.1 Conductors shall have a minimum rating of 600 volts.

10.13.2 Flexible cords shall have a minimum rating of 300 volts.

10.13.3 Conductors shall be selected from the types specified in Table 9.12.3(b).

10.13.4 Flexible cords shall be selected from the types specified in Table 9.12.4.

10.13.5 Conductors and flexible cords shall be of stranded copper with circular mil area and stranding in accordance with Table 10.13.5.

10.13.6 Conductor sizes, as determined by Table 10.13.5, shall not carry current greater than that indicated in Table 10.13.6(a), based on the temperature rating of the wire, and the following derating factors:

(1) Conductors used in or routed through an engine space shall be corrected in accordance with Table 10.13.6(b).
(2) Current-carrying conductors that are bundled shall be derated in accordance with Table 10.13.6(c).

10.13.7 Conductors, other than those contained completely within equipment or enclosures, shall be at least No. 16 AWG.

10.13.8 All conductors shall meet UL 1426, *Standard for Safety for Electrical Cables for Boats*, and shall be so labeled.

10.14 Installation.

10.14.1 All connections normally carrying current shall be made in enclosures with interior surfaces having a flame spread rating of not more than 25 as tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

10.14.2 All conductors, other than those contained completely within equipment or enclosures, shall be supported to relieve strain on connections.

10.14.3 Where ac and dc conductors are run together, other than conductors contained completely within equipment or enclosures, the ac conductors shall be sheathed, bundled, or otherwise kept separate from the dc conductors.

Table 10.13.5 Conductor Circular Mil (CM) Area and Stranding (for Alternating Current (ac) Electrical Systems on Boats)

Conductor Size (AWG)	Nominal CM Area[a]	Minimum Number of Strands	
		Type 2[b]	Type 3[c]
18	1,620	16	—
16	2,580	19	26
14	4,110	19	41
12	6,530	19	65
10	10,380	19	105
8	16,510	19	168
6	26,240	37	266
4	41,740	61	420
2	66,360	127	665
1	83,690	127	836
1/0	105,600	127	1064
2/0	133,100	127	1323
3/0	167,800	259	1666
4/0	211,600	418	2107

Note: Metric wire sizes can be used if of equivalent circular mil area. If the circular mil area of the metric conductor is less than that listed, the wire ampacity needs to be corrected based on the ratio of the circular mil areas.

[a]To recognize stranded conductors made of AWG elements, note that the actual nominal CM area can differ from the specified nominal CM area but by no more than 7 percent. The circular mil area is equal to the mathematical square of the specified diameter of the AWG stranded solid copper conductor measured in one-thousandths of an inch, as shown in the following equation:

$$\text{Area in.}^2 = \frac{\pi \times (\text{circular mils})}{4(1{,}000{,}000)}$$

[b]Conductors with Type 2 stranding are permitted to be used for wiring that is subject to movement from vibration or minor flexing. If four or more conductors are run in a cable, Type 2 stranding is permitted to be used for frequent flexing applications.

[c]Conductors with Type 3 stranding can be used for any wiring where frequent flexing is involved in normal use.

10.14.4* Conductor Support.

10.14.4.1 Conductors shall be supported for their entire length unless permitted otherwise by 10.14.4.2 through 10.14.4.4.

10.14.4.2 Conductors shall be permitted to be supported at least every 18 in. (46 cm) by nonmetallic clamps of a size to hold the conductors firmly in place.

10.14.4.2.1 Nonmetallic straps or clamps shall not be used over engine(s), moving shafts, other machinery, or passageways if failure can result in a hazardous condition.

10.14.4.2.2 Conductor material shall be resistant to oil, gasoline, and water and shall not break or crack under flexing within a temperature range of –30°F to 250°F (–34°C to 121°C).

10.14.4.3 Metal Straps with Insulating Material.

10.14.4.3.1 Conductors shall be permitted to be supported at least every 18 in. (46 cm) by metal straps or clamps with smooth, rounded edges to hold the conductors firmly in place without damage to the conductors or insulation.

10.14.4.3.2 Sections of the conductor or cable located directly under the strap or clamp shall be protected by means of loom, tape, or other suitable wrapping to prevent injury to the conductor.

10.14.4.4 Conductors shall be permitted to be supported at least every 18 in. (46 cm) by metal clamps lined with an insulating material resistant to the effects of oil, gasoline, and water.

10.14.5 Junction boxes, cabinets, and other enclosures in which electrical connections are made shall be weatherproof or installed in a protected location to minimize the entrance or accumulation of moisture or water within the boxes, cabinets, or enclosures.

10.14.6 In wet locations, metallic boxes, cabinets, or enclosures shall be mounted to minimize the entrapment of moisture between the box, cabinet, or enclosure and the adjacent structure.

10.14.7 If an air space is used to achieve the requirement of 10.14.6, the space shall be no less than ¼ in. (6.4 mm).

10.14.8 Unused openings in boxes, cabinets, and weatherproof enclosures shall be closed.

10.14.9* Current-carrying conductors shall be routed above the bilge water level and other areas where water can accumulate unless the wiring is of a submersible type, and connections shall be watertight.

10.14.10* Conductors shall be routed in accordance with the following criteria:

(1) Unless an equivalent thermal barrier is provided, there shall be a clearance of no less than 2 in. (5 cm) between conductors and water-cooled exhaust components.
(2) There shall be a clearance of no less than 9 in. (23 cm) between conductors and dry exhaust components where the conductor is not directly above the exhaust.
(3) Conductors shall not be routed directly above a dry exhaust.

10.14.11 Physical Damage.

10.14.11.1 Conductors subject to physical damage shall be protected by loom, conduit, tape, raceways, or other equivalent protection.

10.14.11.2 The protection required by 10.14.11.1 shall be self-draining.

10.14.11.3 Conductors passing through or around bulkheads or structural members shall be protected to minimize insulation damage such as chafing or compression.

10.14.11.4 Conductors also shall be routed clear of sources of chafing such as steering cable and linkages, engine shafts, and throttle connections.

10.14.12 All permanently installed appliances and utilization equipment shall be mounted securely to the boat's structure.

10.14.13 Wiring Connections.

10.14.13.1 Wiring connections shall be designed and installed to make mechanical and electrical joints without damage to the conductors.

Table 10.13.6(a) Ampacities of Insulated Conductors

Conductor Size (AWG)	Temperature Rating of Conductor Insulation						
	60°C (140°F)	75°C (167°F)	80°C (176°F)	90°C (194°F)	105°C (221°F)	125°C (257°F)	200°C (392°F)
18	10	10	15	20	20	25	25
16	15	15	20	25	25	30	35
14	20	20	25	30	35	40	45
12	25	25	35	40	45	50	55
10	40	40	50	55	60	70	70
8	55	65	70	70	80	90	100
6	80	95	100	100	120	125	135
4	105	125	130	135	160	170	180
3	120	145	150	155	180	195	210
2	140	170	175	180	210	225	240
1	165	195	210	210	245	265	280
0	195	230	245	245	285	305	325
00	225	265	285	285	330	355	370
000	260	310	330	330	385	410	430
0000	300	360	385	385	445	475	510

Table 10.13.6(b) Engine Room Temperature Derating Factor

	60°C (140°F)	75°C (167°F)	80°C (176°F)	90°C (194°F)	105°C (221°F)	125°C (257°F)	220°C (392°F)
Temperature rating of conductor	0.58	0.75	0.78	0.82	0.85	0.89	1.00

Table 10.13.6(c) Current-Carrying Conductor Bundling Derating Factor

Number of Energized Wires in a Bundle	Correction Factor
3	0.70
4 to 6	0.60
7 to 24	0.50
25 and above	0.40

10.14.13.2 Metals.

10.14.13.2.1 Metals used for the terminal studs, nuts, and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug.

10.14.13.2.2 Aluminum and unplated steel shall not be used for studs, nuts, and washers.

10.14.13.2.3 Each conductor splice joining conductor to conductor, conductor to connectors, and conductor to terminals shall be able to withstand a tensile force equal to at least the value shown in Table 9.14.3 for the smallest conductor size used in the splice for a 1-minute duration without breaking.

10.14.13.3 Terminal Connectors.

10.14.13.3.1 Terminal connectors shall be of the ring or captive spade type unless permitted otherwise by 10.14.13.3.2.

10.14.13.3.2 Terminal connectors shall be permitted to be of the friction type where the following conditions are met:

(1) Circuit is rated at not more than 20 amperes or the manufacturer's rating if the terminal design meets the requirements of ANSI/UL 310, *Standard for Safety for Electrical Quick-Connect Terminals*, or ANSI/UL 1059, *Standard for Safety for Terminal Blocks*.

(2) Voltage drop from terminal to terminal does not exceed 50 millivolts for a 20-ampere current flow.

(3) Connection does not separate if subjected to a 6 lb (26.7 N) tensile force along the axial direction of the connector for 1 minute.

10.14.14 Set-Screw, Pressure-Type Connectors.

10.14.14.1 Connections shall be permitted to be made using a set-screw, pressure-type conductor connector.

10.14.14.2 The connectors addressed in 10.14.14.1 shall be provided with a means to prevent the set screw from bearing directly on the conductor strands.

10.14.15 Twist-on connectors (wire nuts) shall not be used.

10.14.16 Solder shall not be the sole means of mechanical connection in any circuit unless the conductor is contained completely within equipment or enclosures.

10.14.17 Solderless crimp-on connectors shall be attached with the type of crimping tools designed for the connector used. *(See Table 9.14.3.)*

10.14.18 No more than four conductors shall be secured to any terminal stud.

10.14.19 Two or more terminal studs shall be connected together by means of jumpers or copper straps where more than four conductors would be needed at a terminal stud.

10.14.20 Terminal connectors of the ring and captive spade type shall be the same nominal size as the stud.

10.14.21 Conductors terminating at panelboards in junction boxes or fixtures shall be arranged to provide a length of conductor to relieve tension, to allow for repairs, and to permit multiple conductors to be fanned at terminal studs.

10.14.22 The shanks of terminals, other than those used in grounding systems, shall be protected against accidental shorting by the use of insulation barriers or sleeves.

10.15 Receptacles.

10.15.1 Receptacles shall be installed in locations normally not subject to rain, spray, or flooding, or shall be protected as follows:

(1) Weatherproof if any of the following apply:
    (a) Installed on a weather deck
    (b) Installed in a machinery space
    (c) Subject to rain or spray
(2) Watertight if subject to flooding

10.15.2 Receptacles shall be of the grounding type with a terminal provided for the grounding (green, or green with yellow stripe) conductor in accordance with NEMA/ANSI WD-6, *Wiring Devices — Dimensional Requirements*.

10.15.3 Receptacles and matching plugs used on ac systems shall not be interchangeable with receptacles and matching plugs used on dc systems.

10.15.4 Power wiring for receptacles shall be connected as follows:

(1) They shall be connected so that the grounded (white) conductor attaches to the terminal identified by a letter(s) or a light color (normally silver).
(2) They shall be connected so that the ungrounded conductor(s) shall be attached to the terminal identified by a letter(s) or a dark color (normally brass or copper).

10.15.5 A branch circuit supplying a combination of receptacle loads and permanently connected loads shall not supply fixed loads in excess of the following:

(1) 600 W for a 15-ampere circuit
(2) 1000 W for a 20-ampere circuit

10.15.6 Receptacles provided for the galley shall be located so that, when appliance cords are plugged in, they do not cross a traffic area, galley stove, or sink.

10.15.7* If installed in a head, a galley, or a machinery space or on a weather deck, the receptacle shall be protected by a Type A (nominal 5 milliamperes) GFCI.

10.15.8 Electrical systems not equipped with polarity indicators using two-pole circuit breakers shall use a two-pole GFCI breaker in place of single-pole GFCI receptacles in the circuits that supply receptacles, unless the system employs polarization or isolation transformers that establish the polarity on the boat.

10.16 Main Panelboard.

10.16.1 A main panelboard shall meet the following criteria:

(1) It shall be installed in a readily accessible location.
(2) It shall be weatherproof or protected from weather and splash.

10.16.2 A main panelboard shall be permitted to serve as a distribution center.

10.16.3 Boats equipped with both ac and dc electrical systems shall have their distribution on separate panelboards or, in the case of systems with combined ac and dc panelboards, the panel shall be designed so that when the panel is open there is no access to energized ac parts without the use of tools.

10.16.4 Panelboards shall be permanently marked with the system voltage value and either "VAC" or the system frequency (e.g., "120 VAC" or "120V-60 hertz").

10.16.5 If the frequency is other than 60 hertz, the frequency shall be indicated.

10.16.6 For three-phase systems the following shall be indicated:

(1) System voltage
(2) Phase
(3) Number of conductors

10.16.7 Voltmeters.

10.16.7.1 A system voltmeter shall be installed for any of the following situations:

(1) System is designed to supply motor circuits.
(2) Onboard generator is installed.
(3) Inverter.

10.16.7.2 Where a voltmeter is required by 10.16.7.1(3), the voltmeter shall be located on or in close proximity to the panelboard.

10.17 Alternating-Current (ac) Generators.

10.17.1 Alternating-current generators shall be connected to the electrical distribution system through a selector switch in accordance with 10.2.8 and Figure 10.7.3(a) through Figure 10.7.3(i).

10.17.2 Power Feeders.

10.17.2.1 Power feeders from ac generators shall be sized to accommodate at least the generator's maximum rated output.

10.17.2.2 The power feeder shall be protected at the generator with overcurrent protection devices in accordance with Section 10.8 unless the generator is a self-limiting generator having a maximum overload current of no more than 120 percent of the generator's rated current output.

10.17.2.3 The rating of overcurrent protection devices required by 10.17.2.2 shall not exceed 120 percent of the generator's rated output.

10.18 Isolation of Galvanic Currents.

10.18.1 Boats using an isolation transformer to reduce galvanic corrosion shall use an isolation transformer system in accordance with ABYC E-11, *AC and DC Electrical Systems on Boats*, and 10.20.4 or 10.20.7.

10.18.2 Boats using a galvanic isolator to reduce galvanic corrosion shall use a galvanic isolator in the grounding conductor in accordance with ABYC A-28, *Galvanic Isolators*.

10.19 Shore Power.

10.19.1 Power Inlet.

10.19.1.1 The receptacle installed to receive a connecting cable to carry ac shore power aboard shall be a male-type connector.

10.19.1.2 Power inlets shall comply with the following:

(1) Power inlets installed in locations subject to rain, spray, or splash shall be weatherproof, whether or not in use.
(2) Power inlets installed in areas subject to flooding or momentary submersion shall be watertight, whether or not in use.
(3) A warning label shall be located alongside each shore power inlet location on the boat. *(See 10.3.1.)*
(4) If a boat uses an isolation transformer or an isolator to prevent galvanic current flow through the grounding conductor, the metallic shell of the shore power inlet shall be insulated from metallic surfaces or any contact with a boat ground. *[See Figure 10.7.3(d) through Figure 10.7.3(f).]*

10.19.2 Shore Power Cable. Boats with an ac electrical system(s) intended to use shore power provided in accordance with *NFPA 70*, *National Electrical Code*, Article 555, and NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, shall be provided with a shore power cable that complies with the following criteria:

(1) A male locking and grounding-type connection that conforms with *NFPA 70*, *National Electrical Code*, Article 555, and NEMA/ANSI WD-6, *Wiring Devices — Dimensional Requirements*, if a configuration for that service exists in NEMA/ANSI WD-6
(2) A female boat connection of the locking and grounding type that conforms with NEMA/ANSI WD-6, *Wiring Devices — Dimensional Requirements*, if a configuration for that service exists in NEMA/ANSI WD-6, unless the shore power cable is permanently connected to the boat and the boat end of the cable is terminated with a locking and grounding female type connector to match the boat power inlet
(3) A minimum length of 25 ft (7.6 m) and meets the marine requirements of ANSI/UL 817, *Standard for Safety for Cord Sets and Power-Supply Cords*

10.19.2.1 Shore power cable shall be listed or labeled by a qualified testing agency and shall be installed and connected in accordance with listing requirements and/or manufacturer's instructions.

10.19.3 Shore power inlet connections and the shore power cable terminals shall be inspected at a minimum semiannually for evidence of alteration, damage, arcing, or overheating of the terminal connectors.

10.19.3.1 Any evidence of alteration, damage, arcing, or overheating of the terminal connectors shall require renewal of the affected component.

10.19.3.2 Any evidence of alteration, damage, arcing, or overheating of the terminal connectors shall require inspection of the shore power supply feeder(s) for damage to the insulation.

10.19.3.3 Any evidence of alteration, damage, arcing, or overheating of the terminal connectors shall require the cause of the alteration, damage, arcing, or overheating to be determined and corrective action taken.

10.20 Application of Types of Shore Power Circuits.

10.20.1 Single-Phase 120-Volt System with Shore-Grounded Neutral Conductor and Shore Grounding Conductor.

10.20.1.1 The system specified in 10.20.1 shall be permitted to be used on any nonmetallic hull boat with underwater hardware of metal alloys that are at least as galvanically noble as manganese bronze.

10.20.1.2 The system specified in 10.20.1 shall be permitted to be used with metal hull boats if protection against galvanic corrosion is provided by means of a cathodic protection system or a galvanic isolator.

10.20.1.3 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(b).

10.20.2 Single-Phase 120/240-Volt System with Shore-Grounded Neutral Conductor and Shore Grounding Conductor.

10.20.2.1 The system specified in 10.20.2 shall be permitted to be used on any nonmetallic hull boat with underwater hardware of metal alloys that are at least as galvanically noble as manganese bronze.

10.20.2.2 The system specified in 10.20.2 shall be permitted to be used with metal hull boats if protection against galvanic corrosion is provided by means of a cathodic protection system or a galvanic isolator.

10.20.2.3 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(c).

10.20.3 Single-Phase 120-Volt Primary and Secondary Isolation Transformer System.

10.20.3.1 With shore grounding protection of the transformer core, the system specified in 10.20.3 shall be permitted to be used with any metallic or nonmetallic hull boat.

10.20.3.2 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(d).

10.20.3.3 The grounded transformer core and the metallic shell of the shore power inlet shall be insulated from contact with any boat ground.

10.20.3.4 The transformer secondary shall be grounded on the boat.

10.20.4 Isolation Transformer with Single-Phase 240-Volt Input and 120/240-Volt Output with Shore Grounding Protection of Transformer Core.

10.20.4.1 The system specified in 10.20.4 shall be permitted to be used with any boat.

10.20.4.2 The system specified in 10.20.4 shall be used on all metal hull boats if other means of protection against galvanic corrosion, such as a galvanic isolator, is not provided.

10.20.4.3 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(e).

10.20.4.4 The metallic shell of the shore power inlet shall be insulated from contact with any boat ground.

10.20.4.5 The center leg of the transformer secondary shall be grounded on the boat, establishing a new neutral for the boat system.

10.20.5 Single-Phase 120-Volt Primary and Secondary Polarization Transformer System with Shore-Grounded Neutral and Shore Grounding Protection of Transformer.

10.20.5.1 The system specified in 10.20.5 shall be permitted to be used on any nonmetallic hull boat with underwater hardware of metal alloys that are at least as galvanically noble as manganese bronze.

10.20.5.2 The system specified in 10.20.5 shall be permitted to be used with metal hull boats if protection against galvanic corrosion is provided by means of a cathodic protection system or a galvanic isolator.

10.20.5.3 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(f).

10.20.5.4 The transformer secondary shall be grounded on the boat.

10.20.6 Single-Phase 120-Volt Primary and Secondary Polarization Transformer System with Shore-Grounded Neutral and GFCI Protection of Transformer Primary.

10.20.6.1 The system specified in 10.20.6 shall be permitted to be used with any metallic or nonmetallic hull boat.

10.20.6.2 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(f).

10.20.6.3 The metallic shell of the shore power inlet shall be insulated from contact with any boat ground.

10.20.6.4 The transformer secondary shall be grounded on the boat.

10.20.7 Single-Phase Isolation Transformer with 240-Volt Input and 120/240-Volt Secondary with GFCI Protection of Transformer Primary.

10.20.7.1 The system specified in 10.20.7 shall be permitted to be used with any metallic or nonmetallic hull boat.

10.20.7.2 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(g).

10.20.7.3 The metallic shell of the shore power inlet shall be insulated from contact with any boat ground.

10.20.7.4 The central leg of the transformer secondary shall be grounded on the boat, establishing a new neutral for the boat system.

10.20.8 Single-Phase Polarization Transformer with 240-Volt Input and 120/240-Volt Secondary and Shore Grounding Conductor Protection of Transformer Core.

10.20.8.1 The system specified in 10.20.8 shall be permitted to be used on any nonmetallic hull boat with underwater hardware of metal alloys that are at least as galvanically noble as manganese bronze.

10.20.8.2 The system specified in 10.20.8 shall be permitted to be used with metal hull boats if protection against galvanic corrosion is provided by means of a cathodic protection system or a galvanic isolator.

10.20.8.3 The system shall be wired in accordance with the basic circuit shown in Figure 10.7.3(e).

10.20.8.4 The center leg of the transformer secondary shall be grounded on the boat, establishing a new neutral for the boat system.

10.20.8.5 Ground-fault protection equipment shall be installed in the main shore power conductors with or in addition to the main shore power disconnect circuit breaker(s) aboard the vessel.

10.20.8.5.1 The device trip level shall be a maximum of 30 mA and the trip time shall be a maximum of 100 mS. The device shall be readily accessible.

Chapter 11 Lightning Protection

11.1 General. Lightning protection systems shall follow the guidelines in ABYC TE-4, *Lightning Protection* , or Chapter 10 of NFPA 780, *Standard for the Installation of Lightning Protection Systems.*

Chapter 12 Fire Protection Equipment

12.1 Fire Suppression Equipment.

12.1.1 General Requirements.

12.1.1.1 All motor craft shall be equipped with fire-fighting equipment as required by this chapter.

12.1.1.2 All boats with an enclosed machinery space(s) shall have provision for discharging extinguishing agent directly into the space immediately surrounding the engine without opening the primary access by one of the following means:

(1) A fixed system
(2) Portable clean agent or CO_2 extinguisher used in conjunction with a discharge port into the machinery space

12.1.1.3 The net volume of a protected space, for the purpose of sizing extinguishing equipment, shall be at least the gross compartment volume minus the volume of permanently installed tankage.

12.1.1.4* A permanently affixed label shall be installed in each machinery compartment that indicates the gross volume of the compartment, the volume of permanently installed tankage, and the net compartment volume.

12.1.2 Portable Fire-Extinguishing Equipment.

12.1.2.1* All boats that are less than 65 ft (20 m) in length shall be equipped with portable fire extinguishers in accordance with Table 12.1.2.1.

12.1.2.2 All boats that are equal to or greater than 65 ft (20 m) in length shall be equipped with portable fire extinguishers in accordance with Table 12.1.2.2.

12.1.2.3* Portable fire extinguishers, other than those addressed in 12.1.2.6, shall meet the requirements of, and be inspected and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers.*

12.1.2.4 Portable fire extinguishers, other than those addressed in 12.1.2.6, shall be U.S. Coast Guard–approved.

12.1.2.5 All required portable fire extinguishers located in accommodation spaces shall have Class A capability.

12.1.2.6 A bucket with attached lanyard shall be considered a Class A–rated portable fire extinguisher on boats under 26 ft

Table 12.1.2.1 Number and Distribution of Fire Extinguishers [Boats up to but not including 65 ft (20 m) in length]

Type of Boat	No. of Extinguishers	Minimum ANSI/UL Rating	Minimum USCG Classification	Location
Open boats under 16 ft (5 m) with fiberglass or metal hulls and a light load of flammable Class A materials	1	5 B:C	B-I	Steering position
Open boats under 16 ft (5 m)	1	1A:10B:C	B-I	Steering position
Boats 16 ft (5 m) to, but not including, 26 ft (8 m)	2	1A:10B:C	B-I	Steering position and galley, when onboard, or cockpit
Open boats 16 ft (5 m) to, but not including, 26 ft (8 m)	2	1A:10B:C	B-I	Steering position and galley or cockpit
Boats 26 ft (8 m) to, but not including, 40 ft (12 m)	3	1A:10B:C	B-I	Outside engine compartment, steering position, and near galley or passenger cockpit
Boats 40 ft (12 m) to, but not including, 65 ft (20 m)	4	1A:10B:C	B-I	Outside engine compartment, steering position, crew quarters, and galley, when onboard, or cockpit

Notes:
(1) For enclosed machinery spaces protected by a portable fire extinguisher, see 12.1.1.2.
(2) Extinguishers intended only for machinery space protection are not required to have a Class A rating.

Table 12.1.2.2 Number and Distribution of Fire Extinguishers [Boats equal to and greater than 65 ft (20 m) in length]

Gross Tonnage	No. of Extinguishers	Minimum ANSI/UL Rating	Minimum USCG Classification	Location
Under 50	1*	4A:60B:C	B-II	Outside machinery space
	1	4A:60B:C	B-II	Helmsman's position
	3	1A:10B:C	B-I	Galley, crew quarters, and cabin
50 to less than 100	1*	4A:60B:C	B-II	Outside machinery space
	2	4A:60B:C	B-II	Helmsman's position and galley
	2	1A:10B:C	B-I	Crew quarters and cabin
100 to less than 300	1*	4A:60B:C	B-II	Outside machinery space
	3	4A:60B:C	B-II	Helmsman's position, galley, and crew quarters
	1	1A:10B:C	B-I	Cabin

*If the total horsepower exceeds 1000 bhp, an additional Type B-II portable fire extinguisher is required for each additional 1000 bhp or fraction thereof.

(8 m) in length that do not have enclosed accommodation spaces or enclosed galleys.

12.1.2.7 It shall not be necessary to travel more than half the length of the vessel or 33 ft (10 m), whichever is less, to reach an extinguisher.

12.1.2.8* Enclosed Machinery Spaces Protected by a Portable Extinguisher.

12.1.2.8.1 Enclosed machinery spaces protected by a portable extinguisher shall be provided with a readily accessible port that is sized to accept the extinguisher nozzle and marked as to its function.

12.1.2.8.2 The port required by 12.1.2.8.1 shall be located so that the extinguisher can remain upright during discharge unless the extinguisher is equipped with a discharge hose.

12.1.2.8.3 Where portable equipment is provided for enclosed machinery space protection, the size and type shall be as specified in Table 12.1.2.8.3.

12.1.2.8.4 If an extinguisher is portable and readily removable from its fixed mounting, it shall be permitted to be credited as one of the extinguishers required in Table 12.1.2.1 or Table 12.1.2.2.

Table 12.1.2.8.3 Minimum Clean Agent or CO_2 Portable Extinguisher Sizes for Flooding an Enclosed Machinery Space

	Minimum Extinguisher Size		Maximum Compartment Volume	
Agent	lb	kg	ft^3	m^3
CO_2	5	2.3	66	2
CO_2	10	4.5	133	4
CO_2	15	7	200	6
CO_2	20	9	266	7.5
Halogenated agent	2.5	1	108	3
Halogenated agent	3	1.4	130	3.7
Halogenated agent	4	2	174	5
Halogenated agent	5	2.3	217	6
Halogenated agent	9	4	391	11
Halogenated agent	13	6	565	16
HFC-227ea	5.75	2.5	125	3.5
HFC-227ea	10.75	5	250	7.1

12.1.2.9 Installation of Portable Extinguishers.

12.1.2.9.1 Portable fire extinguishers shall be located near the means of egress and be readily accessible to the compartment that they are intended to serve.

12.1.2.9.2 Extinguishers shall be mounted with the marine bracket specified on the extinguisher label.

12.1.2.9.3 At least one extinguisher shall be located at each occupied level.

12.1.3* Fixed Fire Protection Systems.

12.1.3.1 Systems shall be manually and automatically operated.

12.1.3.2 Carbon dioxide, Halon 1211, and HCFC-124 systems that are installed to protect accommodation compartments or to protect normally occupied enclosed machinery spaces shall be equipped with a predischarge alarm.

12.1.3.3 Connected Spaces.

12.1.3.3.1 If spaces are connected as determined by 4.4.1(5), such spaces shall be considered as a single space when determining the required capacity of the system.

12.1.3.3.2 The actuation of the system shall be such that all the connecting spaces are flooded.

12.1.3.3.3 If multiple units are used to provide the required capacity for connecting spaces, they shall discharge simultaneously.

12.1.3.4* Fixed systems shall comply with the following criteria:

(1) They shall meet the requirements of the manufacturer's instructions.
(2) They shall meet the requirements of NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*; or NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, as appropriate, and shall be listed to the applicable ANSI/UL marine standard.
(3) For installation on pleasure craft, they shall be U.S. Coast Guard–approved.

12.1.3.5 The system shall incorporate a visible and/or audible means to indicate the system has discharged. This warning shall be located at the normal helm operating position.

12.1.3.6 Installation of Fixed Systems.

12.1.3.6.1 Extinguishing agent cylinders shall be mounted a minimum of 2 in. (5 cm) above moist or wet surfaces to reduce the danger of corrosion.

12.1.3.6.2 Fixed fire-extinguishing systems shall be installed as high as practical in the engine space and as far from natural and powered ventilation as possible.

12.1.3.6.3* Manual controls shall be located to be readily accessible from outside the spaces served by the systems.

12.1.3.6.4 Systems shall be designed for one of the following modes of application:

(1) An independent system installed to cover one of various unconnected protected spaces
(2) A single system of sufficient capacity to flood all protected spaces simultaneously
(3) A single system of sufficient capacity for the largest protected space, distributed to the selected space by valves at the controls

Chapter 13 Carbon Monoxide and Smoke Detection

13.1* Carbon Monoxide and Smoke Detection Systems. A carbon monoxide detection system shall be installed on all boats with an enclosed accommodation compartment(s) and a gasoline generator set, or an inboard gasoline propulsion engine.

13.2 Installation. Carbon monoxide detection systems and installation shall meet the requirements of ABYC A-24, *Carbon Monoxide Detection Systems*.

13.3* Smoke Detection. All vessels with accommodation spaces intended for sleeping shall be equipped with a single-station smoke alarm that is listed to ANSI/UL 217, *Standard for Safety for Single and Multiple Station Smoke Alarms*, for marine or recreational vehicle use and is installed and maintained according to the device manufacturer's instructions.

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.1.6 For additional conversion information, see IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 2010 edition.

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.3.2.4 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.3.3.5 Bonding Conductor. Bonding conductors connect underwater metallic objects as part of any cathodic protection system and, if sized in accordance with ABYC TE-4, *Lightning Protection*, are permitted to serve as lightning grounding conductors. If used, they should be colored green or green with yellow stripe or be of bare copper.

A.3.3.8 Clean Agent. Although commonly referred to as a clean agent in the marine industry, for the purposes of NFPA standards, CO_2 is not considered a clean agent.

A.3.3.9 Compressed Natural Gas (CNG). Mixtures of hydrocarbon gases and vapors, consisting principally of methane in gaseous form that has been compressed for use as a fuel.

A.3.3.11 Engine Exhaust System. This system includes related accessories that can be metallic or nonmetallic, such as pipes, mufflers, silencers, turbochargers, spark arresters, and all necessary connecting and supporting fittings. Wet exhaust systems are provided with water injection into the exhaust gas stream; dry exhaust systems do not have this provision.

A.3.3.15 Galvanically Compatible Metals. See Table A.3.3.15.

A.3.3.19 Ground-Fault Circuit-Interrupter (GFCI). Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. For further information, see ANSI/UL 943, *Standard for Ground-Fault Circuit Interrupters*. [**70:**100]

A.3.3.22 Halocarbon Agent. Examples of halocarbon agents are hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs or FCs), and fluoroiodocarbons (FICs). See NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, for more information.

A.3.3.23 Halogenated Agent. Halon 1211 and Halon 1301 are included in the Montreal Protocol on Substances that Deplete the Ozone Layer, signed September 16, 1987. In compliance with national regulations, production of halons ceased on January 1, 1994.

Table A.3.3.15 Galvanically Compatible Metals

Corroded End (anodic, or least noble)
Magnesium
Zinc
Aluminum
Cadmium
Steel or iron
Cast iron
Chromium-iron (active)
Lead-tin solders
Lead
Tin
Nickel (active)
Brasses*
Copper*
Bronzes*
Copper-nickel alloys*
Nickel-copper alloys
Silver solder
Nickel (passive)
Chromium-iron (passive)
Silver
Graphite
Gold
Platinum
Protected End (cathodic, or most noble)

*These metals and alloys are considered the best to use in combination for marine application.

A.3.3.24 Ignition Protection. It is not intended that such devices be "explosionproof" as the term is defined in *NFPA 70, National Electrical Code*, where it pertains to shore systems, or 46 CFR 110.15-65(e) of Coast Guard 259, Subchapter J, "Electrical Engineering." It is intended that the protection provided generally be equivalent to that of wiring permitted by this standard wherein a definite short or break is necessary to produce an open spark.

Devices that are explosionproof are considered to be provided with ignition protection where installed with the appropriate fittings to maintain their explosionproof integrity.

It is not intended that such devices be "intrinsically safe" in accordance with *NFPA 70, National Electrical Code*, Article 500, or 46 CFR 111.80-5(a)(3) of Coast Guard 259, Subchapter J, "Electrical Engineering."

Devices that are intrinsically safe are considered to be provided with ignition protection.

A.3.3.27 Liquefied Petroleum Gas (LPG). A liquefied petroleum gas is any material having a vapor pressure not exceeding that allowed for commercial propane and is composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. See NFPA 58, *Liquefied Petroleum Gas Code*.

A.3.3.32 Panelboard. Panelboards can include devices such as circuit breakers, fuses, switches, instruments, and indicators. Panelboards are intended to be installed in enclosures and are accessible from the front or rear.

A.3.3.33 Permanently Installed. Examples of tools necessary would be screwdrivers and wrenches.

A.3.3.36 Polarized System (ac). This standard assumes the shore power source is wired in accordance with *NFPA 70, National Electrical Code*, Article 555.

A.3.3.41 Sheath. Examples of sheath material are woven sleeving, molded rubber, molded plastic, loom, and flexible tubing.

A.3.3.45 Ventilation. Ventilation can be achieved by introduction of fresh air to dilute contaminated air or by local exhaust of contaminated air.

A.3.3.47 Weatherproof. For the purpose of this standard, where applied to marine use, *weatherproof* implies resistance to rain, spray, and splash.

A.4.1.2 The use of marine fire-retardant paints and varnishes is recommended for engine, fuel tank, and galley compartments.

A.4.3 Ventilation cannot be relied upon to remove all flammable vapors that can result from fuel system failures (leakage). Therefore, compliance with the ventilation requirements of this standard should be considered valid only where it has been determined that the entire fuel system complies with the requirements of Chapter 7.

A.4.3.2 The warning label should contain the following informational elements:

WARNING
Fuel vapors are a fire and explosion hazard.
To avoid injury or death, do not store fuel or flammable liquids here.
No ventilation has been provided.

The same considerations should apply to the storage of portable gasoline powered equipment, as ventilation or ignition protection of electrical devices has not been provided for explosive vapors.

A.4.3.4 Exhausts and intakes might not function as intended when wind direction varies.

A.4.3.10 See Table A.4.3.10.

Table A.4.3.10 Standard Duct Sizes

$in.^2$	cm^2	in. dia.	cm dia.
4.91	31.7	2½	6.4
7.07	45.6	3	7.6
9.62	62.1	3½	9
12.57	81.1	4	10
19.63	126.6	5	13

A.4.3.11 See Table A.4.3.10.

A.4.5.2.2 See SAE J1171, *Recommended Practice for External Ignition Protection of Marine Electrical Devices*.

A.4.6.3 These drawings only provide examples of the location and orientation necessary to prevent entry of fuel vapors. They do not supersede the requirements of 7.5.2 addressing the escape of liquid and vapor overflow. See Figure A.4.6.3.

A.4.7 Consult the engine manufacturer(s) for combustion air requirements, including inlet air temperature and restriction/depression.

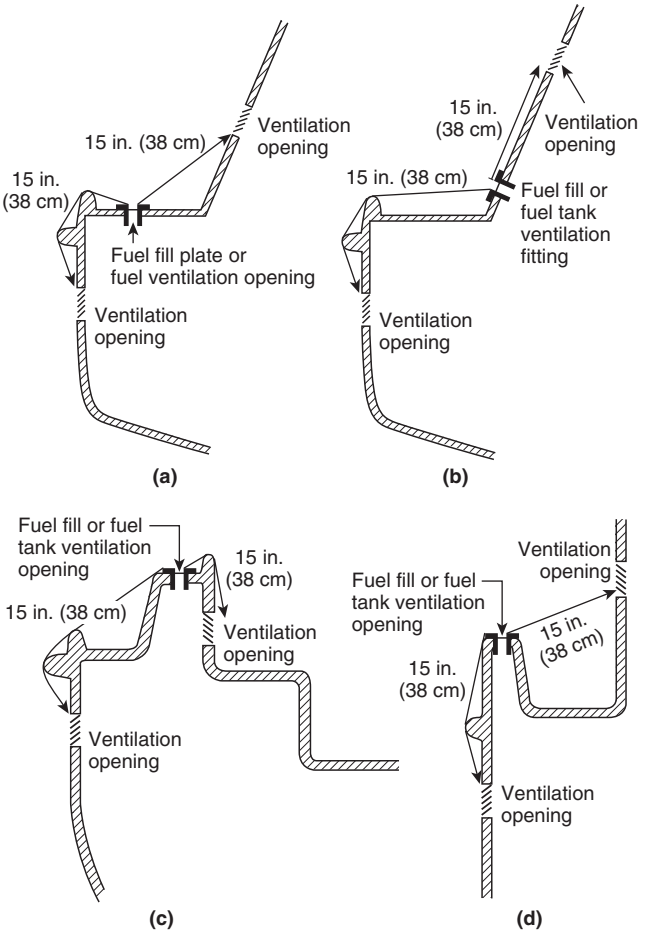


FIGURE A.4.6.3 Examples of How to Measure Ventilation Opening Separation from Fuel Fill or Vent Fitting.

A.5.3 See SAE J1223, *Recommended Practice for Marine Carburetors and Fuel Injection Throttle Bodies*.

A.5.3.3 See SAE J1223, *Recommended Practice for Marine Carburetors and Fuel Injection Throttle Bodies*.

A.5.8 See SAE J1191, *Recommended Practice for High Tension Ignition Cable Assemblies—Marine*.

A.5.9 For information on ignition distributors, see SAE J1294, *Recommended Practice for Ignition Distributors—Marine*.

A.7.2.2.5.3 Brackets will reduce the chance of crevice and pitting corrosion of the tank surfaces by ensuring air circulation to the tank surfaces.

A.7.5.1.7 Nonmetallic fuel system components degrade when exposed to ultraviolet (UV) radiation (i.e., sunlight). Such components that will be exposed to UV radiation should be chosen for their UV resistance and should be inspected periodically to determine suitability for continued service.

A.7.5.2.4 An inverted "U" bend in the fuel tank vent pipe is one way to minimize the intake of water.

A.7.5.2.9 The purpose of this requirement is to preserve the fuel tightness at either end of the flexible section.

A.7.5.3 If fuel tanks are located in a compartment other than the engine compartment, or if the engine and fuel tanks are separated by a distance of more than 12 ft (3.7 m), an approved manual stop valve should be installed at the engine end of the fuel line to stop fuel flow when the engine is being serviced.

A.7.5.3.1 The purpose of the 12 in. (30 cm) requirement is to minimize the amount of pressurized piping when the pump is operating.

A.7.5.3.5(5) "Readily accessible for operation from outside the compartment" includes a shutoff valve installed at the tank close to, and directly below, an access port through which the valve can be operated.

A.7.5.3.6.1 "Readily accessible" includes a shutoff valve that can be operated through an access port.

A.8.1 Open-flame devices are subject to careless, unskilled, or ignorant operation more than any other boat equipment involving fire risk. It is, therefore, imperative that such items be selected and installed with the aim of minimizing personal and physical hazards.

A.8.1.3 The calculation method for the minimum effective area of fixed ventilation for accommodation spaces is as follows:

$$V > 2200U + 440F + 650P \qquad \textbf{[A.8.1.3]}$$

where:
V = effective area in mm^2 (minimum 4000 mm^2)
U = nominal heat input of nonflued appliances (cooker, stove, lamps) in kW
F = nominal input of open, flued appliances (refrigerator, water heater, cabin heater) in kW
P = number of persons for which the cabin is designed

A.8.4.2.8 Examples of fuel system markings are as follows:

Stove Fuel — Diesel

Stove Fuel — Alcohol

A.8.4.6 The means to prevent cookware from sliding off a non-gimbaled stove can be attached to the adjacent counter, backsplash, or other structure, provided the intent of this requirement is met.

A.8.5 In the interest of safety, it is important that the properties of liquefied petroleum gases be understood and that safe practices for their use be followed. LPGs liquefy under moderate pressure; they readily vaporize to the gaseous state on relief of the pressure. Such characteristics prove to be an advantage when these gases are used. For convenience, they are shipped and stored under pressure as liquids. In the gaseous state, propane poses a hazard comparable to any flammable natural or manufactured gas, except that propane vapors are heavier than air. Although vapors tend to sink to the bottom of an enclosed compartment into which such gases are released, they diffuse throughout the compartment and cannot be dispelled readily by overhead ventilation. Safety demands that the escape of any propane should be prevented because when mixed with air in certain proportions propane will explode if ignited.

It also is important that the properties of natural gas be known and understood. Natural gas is a colorless, tasteless, and nontoxic flammable gas. It is a light gas, weighing about one-half as much as air, and it tends to rise and diffuse rapidly in air when it escapes from those systems covered by this standard. Natural gas is nontoxic but can cause asphyxiation when it displaces the normal 21 percent oxygen in air in a confined area without adequate ventilation. Its composition consists primarily of methane and varying amounts of ethane, propane, butane, and higher hydrocarbons. Some constituents of natural gas can be corrosive to carbon steel.

A.8.5.6 For information on external ignition protection of marine electrical devices, see SAE J1171, *Recommended Practice for External Ignition Protection of Marine Electrical Devices*.

A.8.5.12.4 The purpose of the pressure gauge is to provide a convenient and quick means of testing the system for leakage from the container valve to, and including, the appliance valves. It is recommended that testing be done at least every two weeks and after any emergency. No leakage, however minor, should be permitted.

A.8.5.15.6 Avoid soaps containing ammonia, which cause seasonal cracking at some metal fittings.

A.9.2 ABYC E-11, *AC & DC Electrical Systems on Boats*, can be used to meet the requirements of this chapter.

A.9.2.2 See Figure A.9.2.2(a) and Figure A.9.2.2(b).

A.9.3.3 These provisions also apply to installations of sealed batteries.

A.9.3.5 For information on securing batteries, see 33 CFR 183.

A.9.3.9 For information on shielding with dielectric material, see 33 CFR 183.

A.9.6.2 An engine is an example of electrical equipment that must be marked.

A.9.8.2 See Figure A.9.8.2(a) through Figure A.9.8.2(g).

A.9.9.2 See Figure A.9.9.2.

A.9.9.3.1 Sealed-valve regulator (SVR) batteries (also known as gel cells) require thermal-sensing, voltage-regulating charging devices. This applies to both electrically powered and engine-driven charging devices.

A.9.9.4.1 The requirement of 9.9.4.1 might necessitate the use of thermally responsive protection devices on the equipment or system if the motor is not capable of operating continuously at maximum possible loading.

A.9.9.4.2 If it is necessary to test as installed in order to ensure compliance with the locked rotor requirement, then voltage drop due to wire size and delay characteristics of the overcurrent protection device should be adjusted to protect the motor.

A.9.9.7 See Figure A.9.9.7.

A.9.9.8(4) For information on marine circuit breakers, see SAE J1428, *Recommended Practice for Marine Circuit Breakers*.

A.9.9.8(5) For information on external ignition protection of marine electrical devices, see SAE J1171, *Recommended Practice for External Ignition Protection of Marine Electrical Devices*.

A.9.9.9(3) For information on external ignition protection of marine electrical devices, see SAE J1171, *Recommended Practice for External Ignition Protection of Marine Electrical Devices*.

A.9.10.5 Consideration should be given to the selection of special switches for use with high-current inductive loads.

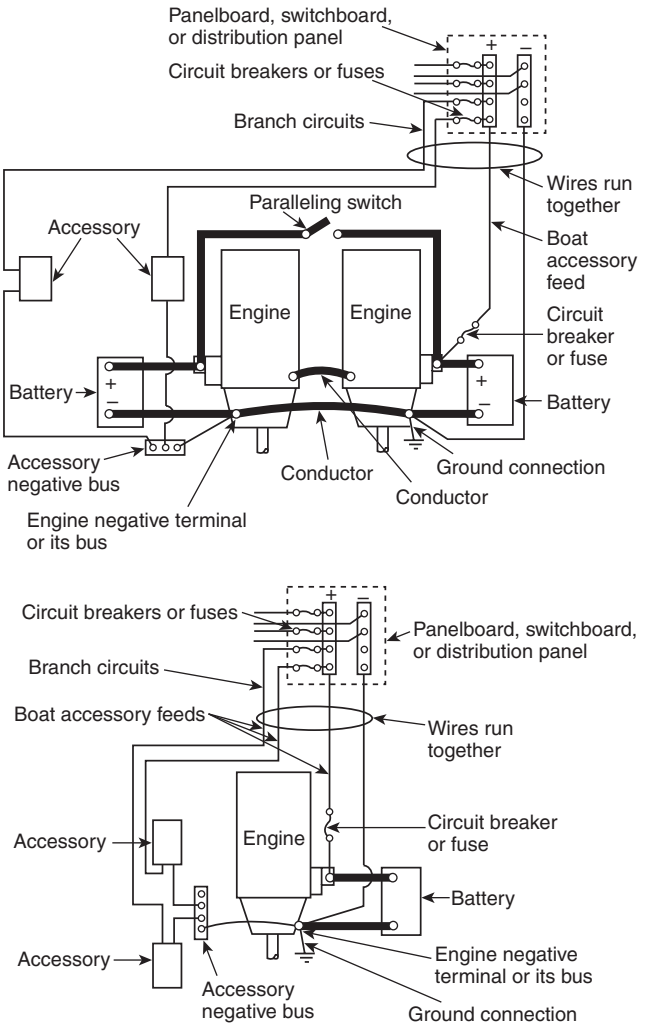


FIGURE A.9.2.2(a) Typical Inboard dc Grounding Systems.

A.9.12.2 For information on marine engine wiring, see SAE J378, *Recommended Practice for Marine Propulsion System Wiring*.

A.9.13.1 Current-carrying conductors should be routed as high as practicable above the bilge water level and other areas where water can accumulate.

A.9.13.2 Conductors should be routed as far away as practicable from exhaust pipes and other heat sources.

A.9.13.3.2 Battery cables should be routed to minimize contact with nonmetallic fuel system components.

A.9.13.4.3 For additional information, see ABYC TH-22, *Educational Information About Carbon Monoxide*, and ABYC TH-23, *Design, Construction, and Testing of Boats in Consideration of Carbon Monoxide*.

A.9.14.7 If a connection is soldered, the flexibility of the wire is affected and can be subject to failure from movement. If a crimped connection is soldered, it can reduce the mechanical strength of the joint.

A.10.1 This standard recognizes that shore power voltage varies in different geographic areas. The selection of motor-operated equipment should consider this variation.

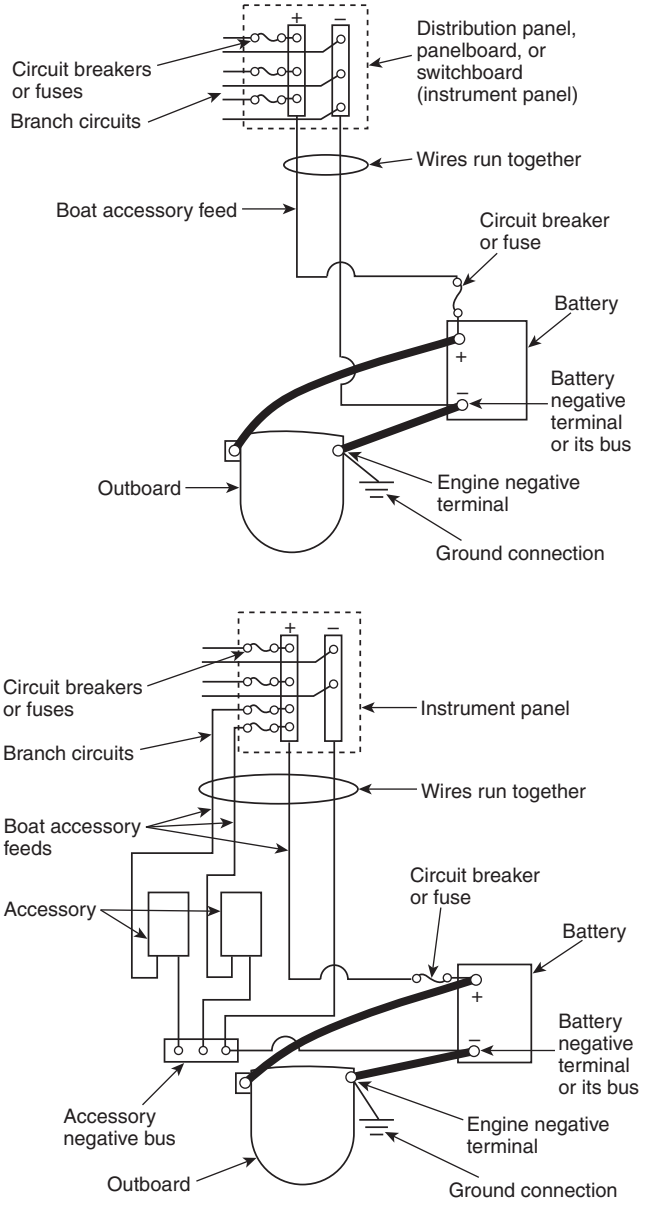


FIGURE A.9.2.2(b) Typical Outboard dc Grounding Systems.

ABYC E-11, *AC & DC Electrical Systems on Boats*, can be used to meet the requirements of this chapter.

A.10.2.3.2 Examples of locations to which the neutral could be grounded are at the onboard generator, at an inverter, at the secondary of an isolation or polarization transformer, or through the shore power connection.

A.10.2.8 Neutral conductors need not be switched if shore power transformers are installed (i.e., dockside neutral is not brought on board to the switchboard) and all power source neutrals are connected together and to ground at a single point as described in 10.2.4.2.

A.10.6.2 See A.9.8.2.

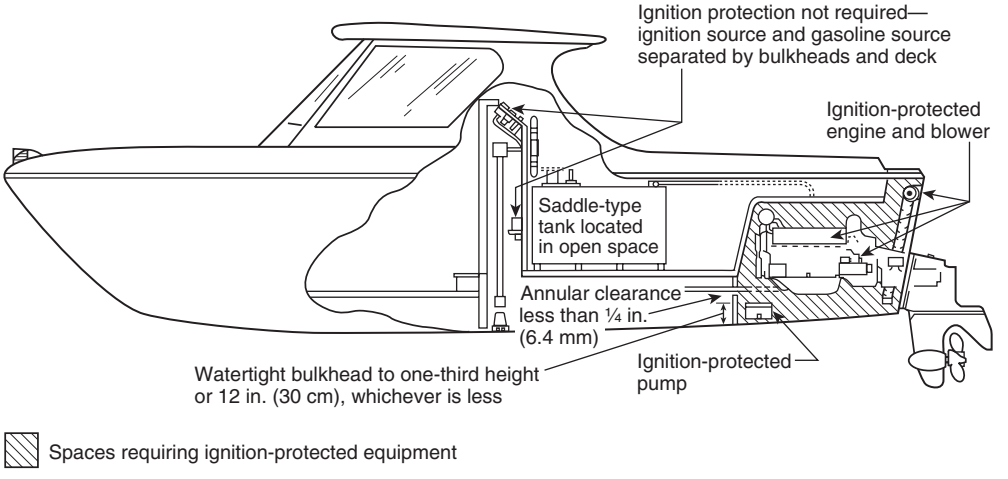


FIGURE A.9.8.2(a) Location of Ignition-Protected Equipment on Gasoline-Powered Inboard Engine Boats with Bulkhead and Deck Separations.

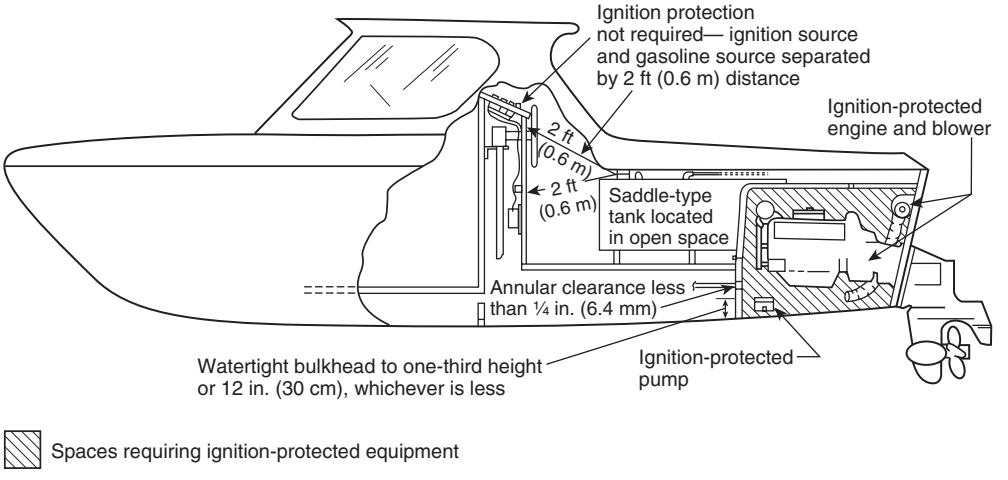


FIGURE A.9.8.2(b) Location of Ignition-Protected Equipment on Gasoline-Powered Inboard Engine Boats with Ignition Source and Gasoline Fuel Source Separated by 2 ft (0.6 m) Distance.

A.10.6.2(4) Seepage of not more than ¼ fl oz (7.4 ml) per hour is permitted below the water-resistant height. This includes bulkhead fastenings and space around hatches, doors, access panels, and items passing through the bulkhead.

Openings above the water-resistant height cannot have more than ¼ in. (6.4 mm) annular space around items passing through the openings.

A.10.7.1 Reverse-polarity indicating devices respond to the reversal of an ungrounded conductor and the grounded (white) conductor only when there is continuity of the grounding (green, or green with yellow stripe) conductor to shore.

Reverse-polarity indicating devices might not respond to reversals of an ungrounded conductor and the grounding (green, or green with yellow stripe) conductor, the grounded (white) conductor and the grounding (green, or green with yellow stripe) conductor, or three-phase conductors.

A.10.8.2(4) For information on marine circuit breakers, see SAE J1428, *Recommended Practice for Marine Circuit Breakers.*

A.10.8.2(5) For information on external ignition protection of marine electrical devices, see SAE J1171, *Recommended Practice for External Ignition Protection of Marine Electrical Devices.*

A.10.8.3(3) For information on external ignition protection of marine electrical devices, see SAE J1171, *Recommended Practice for External Ignition Protection of Marine Electrical Devices.*

A.10.9.2.1 Overcurrent protection should be located as close as practical to the source of power.

A.10.9.3 Overcurrent protection should be located as close as practical to the source of power.

A.10.11.4 This GFP breaker provides ground-fault protection for the primary winding of the transformer only.

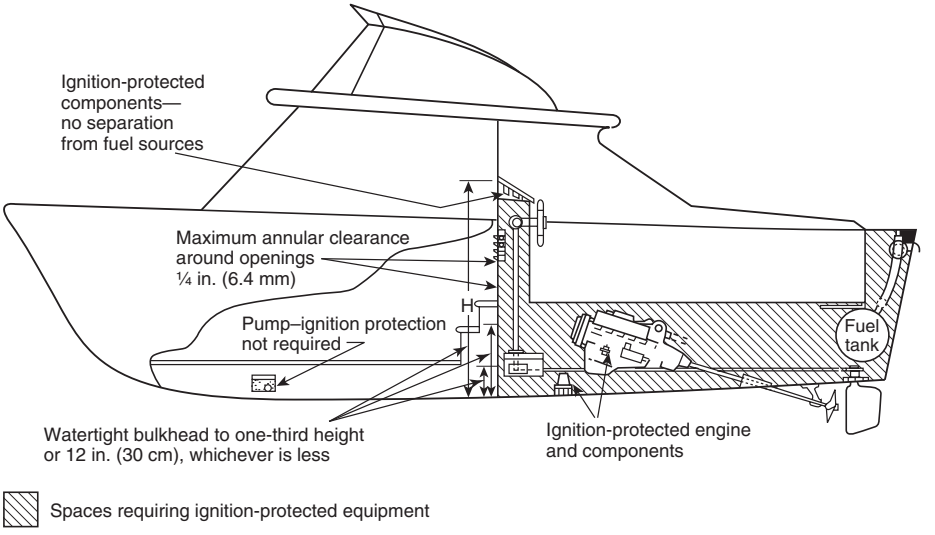


FIGURE A.9.8.2(c) Ignition Protection in Space Containing Gasoline Engine and Fuel Line Fittings.

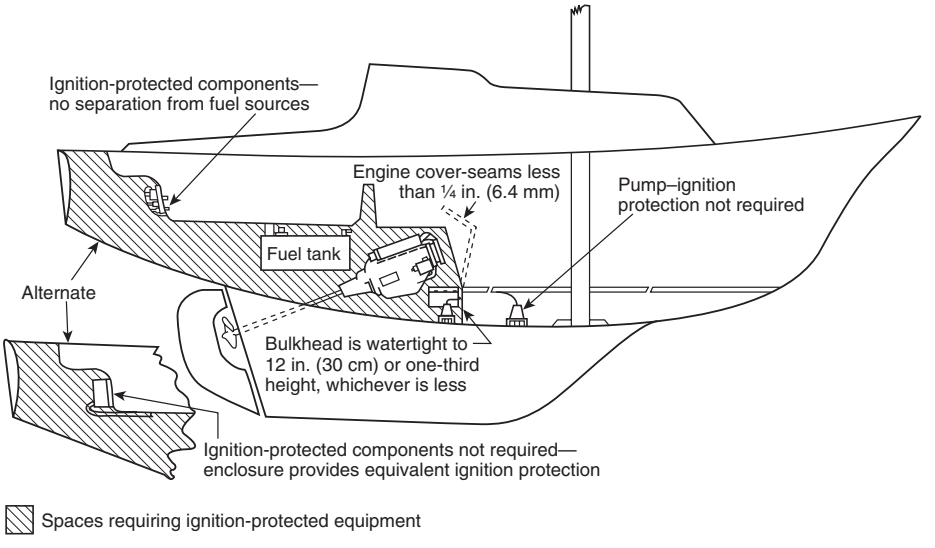


FIGURE A.9.8.2(d) Ignition Protection in Space Containing Gasoline Engine and Fuel Line Fittings on Sailboats.

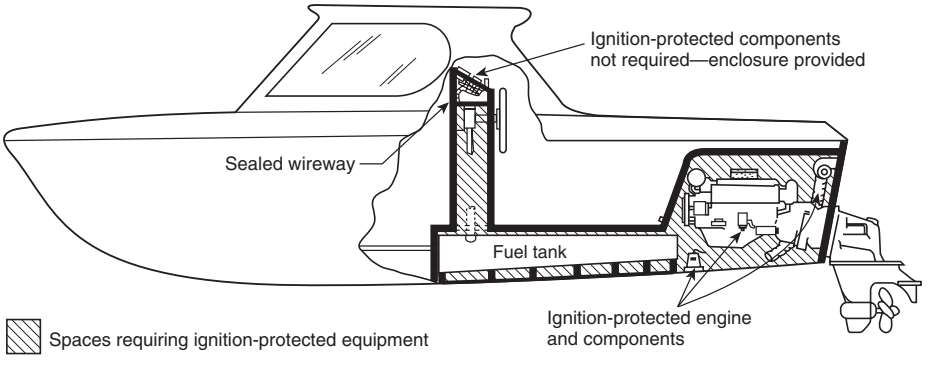


FIGURE A.9.8.2(e) Ignition Protection in Space Containing Gasoline Engine and Fuel Line Fittings.

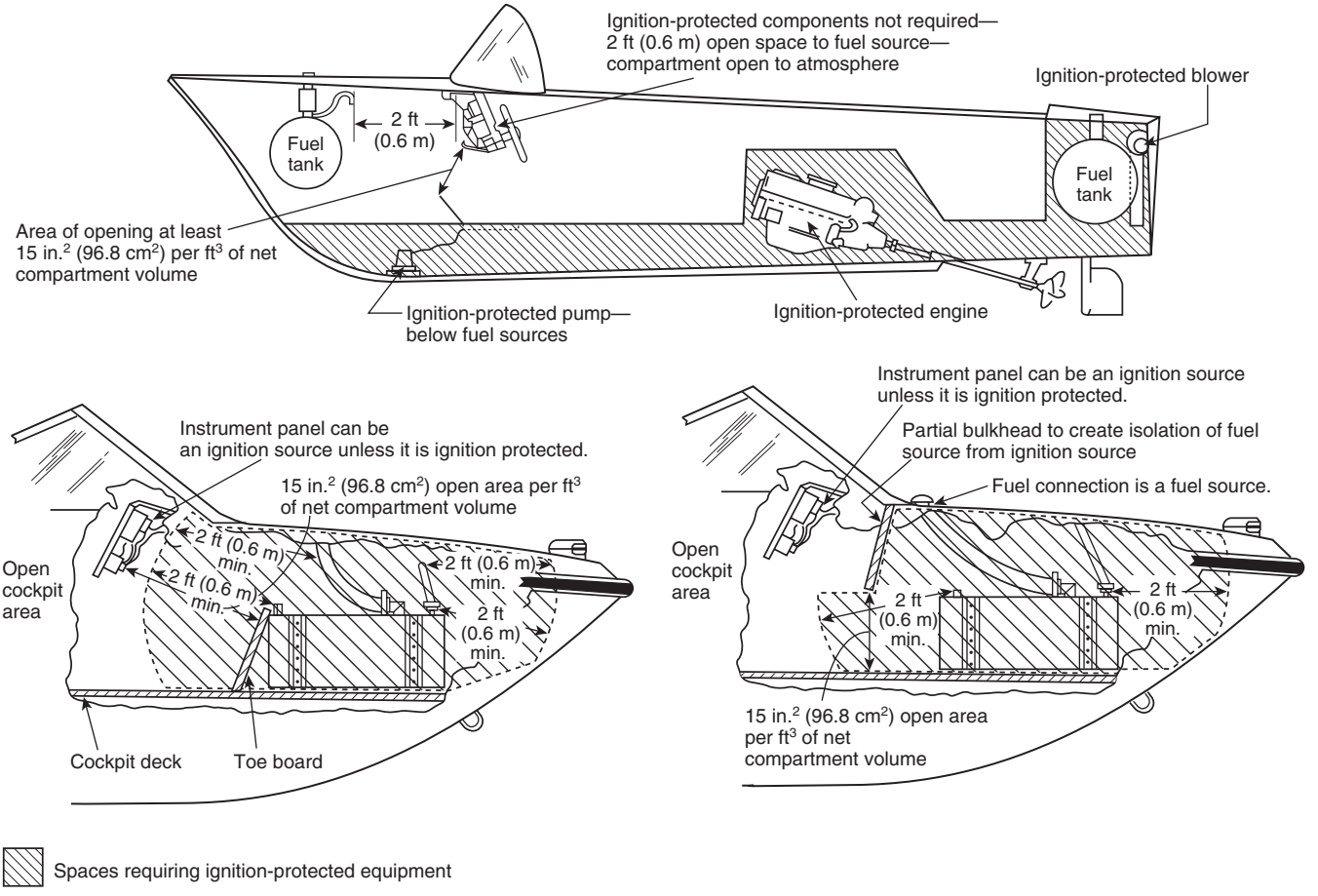


FIGURE A.9.8.2(f) Ignition Protection with No Bulkhead.

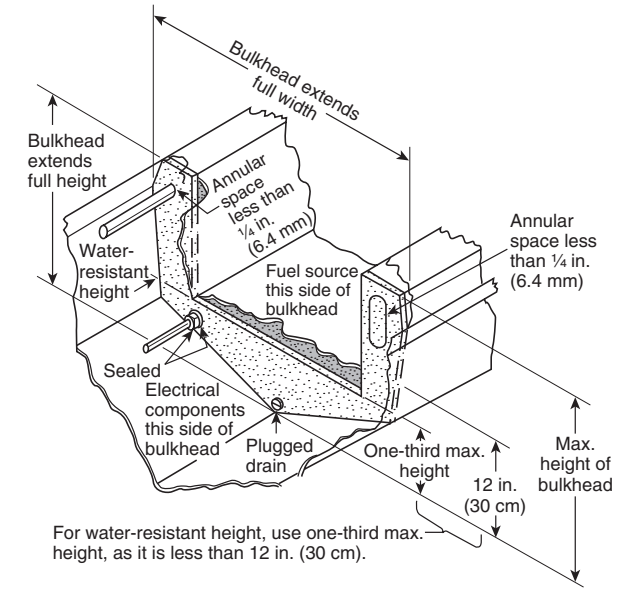


FIGURE A.9.8.2(g) Cutaway Illustration Showing Separation of Electrical Components from Gasoline Fuel Source.

A.10.14.4 If a connection is soldered, the flexibility of the wire is affected and can be subject to failure from movement. If a crimped connection is soldered, it can reduce the mechanical strength of the joint.

A.10.14.9 Current-carrying conductors should be routed as high as practical above the bilge water level and other areas where water can accumulate.

A.10.14.10 Conductors should be routed as far away as practicable from exhaust pipes and other heat sources.

A.10.15.7 See *NFPA 70, National Electrical Code*; ABYC E-11, *AC & DC Electrical Systems on Boats*; and applicable UL standards, for additional information.

A.12.1.1.2 Engine room calculations and concentrations can be used for other spaces.

A.12.1.1.4 The label should include the following statement, "Fixed fire extinguisher systems must be suitable for compartment volume of XXX ft^3. This volume is based on gross compartment volume less permanently installed tankage in this compartment determined using ABYC A-4." For boats built prior to the effective date of this standard, it might be necessary to obtain this information from the boat manufacturer or to calculate this volume accurately.

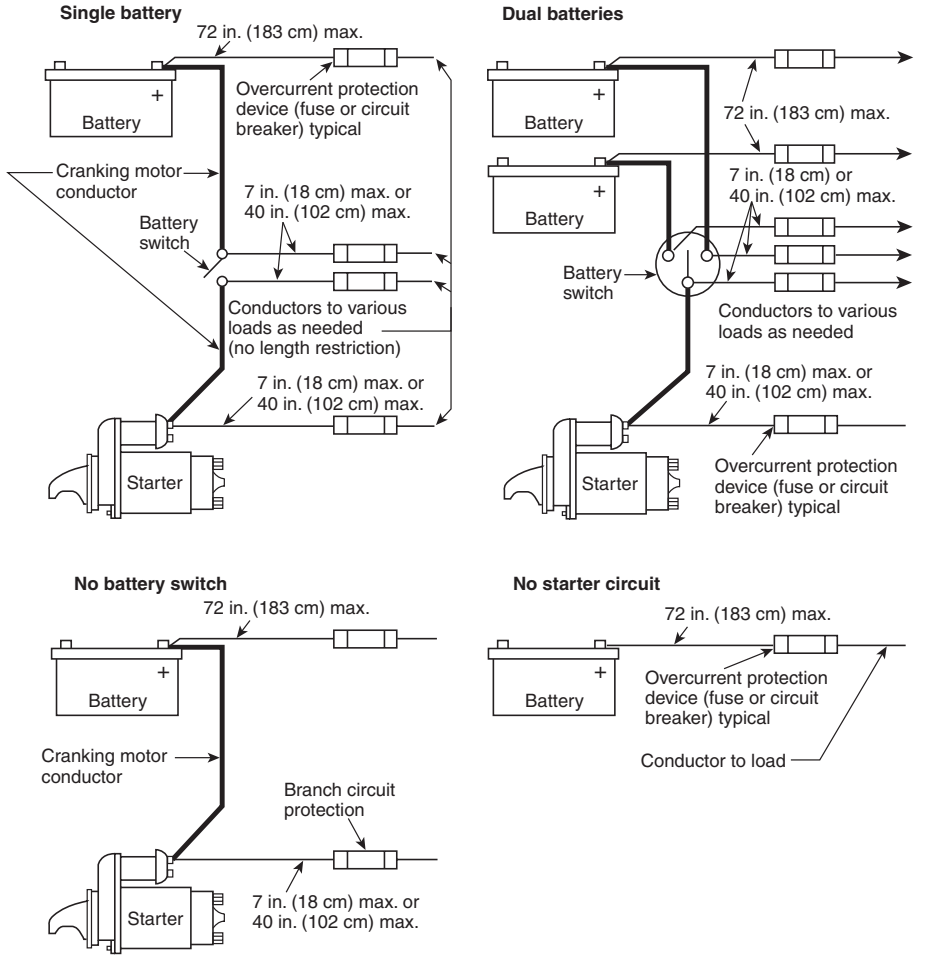


FIGURE A.9.9.2 Location of Overcurrent Protection for Conductors Served by Single or Dual Batteries or Without Battery Switch or Starter Circuit.

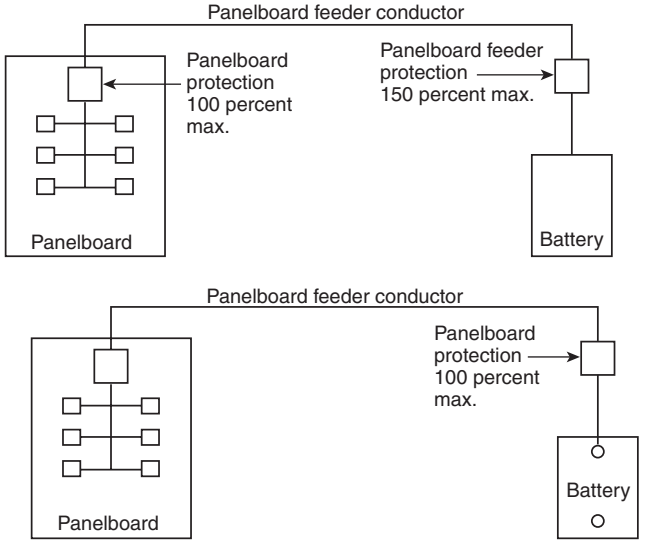


FIGURE A.9.9.7 Illustration of Overcurrent Protection for Panelboards and Panelboard Feeder Conductors.

A.12.1.2.1 On boats without Class A combustibles or accommodation spaces, a USCG Type B-I extinguisher having only B:C capabilities should be used. For equivalent ratings, use Table A.12.1.2.1.

A.12.1.2.3 On boats without Class A combustibles or accommodation spaces, a USCG Type B-I extinguisher having only B:C capabilities should be used. For equivalent ratings, see Table A.12.1.2.1. *(See Annex B.)*

A.12.1.2.8 See A.12.1.1.2.

A.12.1.3 There are two basic types of clean agent fire extinguishing systems: engineered and pre-engineered.

Engineered fire-extinguishing systems consist of components designed or selected for a specific application to a specific vessel or model series. Pre-engineered fixed fire-extinguishing systems (packaged systems) consist of those designed to be installed according to pre-tested limitations.

In calculating the volumes of the space to be protected, all connecting compartments or spaces into which extinguishing vapor can migrate easily, such as bilges, tank compartments, and storage areas, should be included. For information on connecting compartments or spaces, see 4.2.1. All devices that consume air from the protected spaces should be shut down prior to or at the time of system actuation.

Table A.12.1.2.1 U.S. Coast Guard (USCG) Classification of Portable and Semiportable Fire Extinguishers

Classification Type	Size	Halogenated Agent		Carbon Dioxide		Dry Chemical		HFC-227ea	
		lb	kg	lb	kg	lb	kg	lb	kg
B	I	2.5	1.1	5	2.3	2	0.9	5.75	2.5
B	II	10	4.5	15	6.8	10	4.5	—	—
B	III	—	—	35	16	20	9.1	—	—

Table A.12.1.3.4 Recommended Weight of Carbon Dioxide and Clean Agents for Pre-Engineered Systems

Maximum Volume of Space (Net)		Carbon Dioxide[a]		Halon 1211[b]		Halon 1301[b]		HFC-227ea[c]		HCFC-124[d]	
ft^3	m^3	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
<90	<2.5	5	2.3	2.1	0.9	1.9	0.8	3.9	1.7	3.24	1.4
140	4	10	4.5	3.3	1.5	2.9	1.32	6.1	2.8	5	2.3
220	6.2	15	6.8	5.1	2.3	4.5	2	9.5	4.3	7.9	3.6
300	8.5	20	9.1	7	3.2	6.2	2.8	13	5.9	10.8	4.9
375	10.6	25	11.3	8.8	4	7.7	3.5	16.2	7.4	13.5	6.1
525	14.9	35	15.9	12.3	5.6	10.8	4.9	22.7	10.3	18.9	8.6
800	22.7	50	22.7	18.7	8.5	16.5	7.5	34.64	15.7	28.8	13.1
1200	34	75	34	28.1	12.7	24.7	11.2	52	23.6	43.2	19.6
1600	45.3	100	45.4	37.4	17	33	14.9	69.3	31.4	57.6	26.1

Warning: Discharge of these agents in a confined space can be hazardous to personnel. When the system discharges, the protected space should be evacuated immediately of all personnel.

Note: When computing the net cubic volume to be protected, see 12.1.1.3 and 12.1.1.4.

[a]From 1600 ft^3 to 4500 ft^3 (45 m^3 to 127 m^3), there should be 1 lb per 18 ft^3 (2.9 kg per m^3) of space, and above 4500 ft^3 (127 m^3) there should be 1 lb per 20 ft^3 (3.2 kg per m^3) of space.

[b]Volumes given in the table are based on a flooding factor of 5 percent at 70°F (21°C), which is 0.0234 lb/ft^3 (0.3748 kg/m^3) for Halon 1211 and 0.0206 lb/ft^3 (0.3300 kg/m^3) for Halon 1301.

[c]Volumes given in the table are based on a flooding factor of 8.7 percent at 70°F (21°C), which is 0.0433 lb/ft^3 (0.6936 kg/m^3).

[d]Volumes given in the table are based on a flooding factor of 9.0 percent at 70°F (21°C), which is 0.0360 lb/ft^3 (0.5767 kg/m^3).

Engineered systems, when installed in accordance with the U.S. Coast Guard–approved installation manual, provide adequate protection for the volume specified in the approval documentation and the manual. A self-inspection form is available that should be completed by the installer or the owner and returned to the manufacturer. The manufacturer then provides a certificate, which is submitted to the authority having jurisdiction as evidence of an approved system.

Pre-engineered systems include an installation manual that also warns of their limitations. It is extremely important that these limitations, as outlined below, be observed:

(1) Independently activated multiple units should not be used to provide protection for a volume larger than the smallest unit installed. If multiple self-contained units are installed in a single compartment, it is extremely unlikely that they will function simultaneously.
(2) Units should be located with their sensor near the top of the protected space.

Toxic products are produced in a fire event, and necessary precautions — such as ventilating the space and/or the wearing of self-contained breathing apparatus — should be taken before entering the space.

A CO_2 fixed system consists of the storage container, actuation controls, pressure switch, and nozzles. All devices that consume air from the protected spaces should be shut down prior to or at the time of system actuation. Since this normally includes the main propulsion engine, it frequently is preferred that the system be actuated manually without automatic detection.

A.12.1.3.4 In the absence of a manufacturer's instruction manual, Table A.12.1.3.4 provides information that can be used to determine weight per maximum volume of space protected for carbon dioxide or clean agent. A new system should be installed and maintained in accordance with the manufacturer's instructions and should be U.S. Coast Guard–approved or listed to the applicable ANSI/UL marine standard.

A.12.1.3.6.3 Well-separated dual manual controls are recommended, whether the system is designed for manual or automatic operation.

A.13.1 For additional information on carbon monoxide, see ABYC TH-22, *Educational Information About Carbon Monoxide*, and ABYC TH-23, *Design, Construction, and Testing of Boats in Consideration of Carbon Monoxide*.

A.13.3 It is recommended on commercial vessels 39.37 ft (12 m) and larger that engine room fire detection equipment be installed with notification capability at the helm.

Engine room fire suppression is not a substitute for engine room fire detection. Occupants of most vessels 39.37 ft (12 m) and larger are typically too far from the engine room to detect a fire without the assistance of properly installed detection equipment. The occupants of the vessel can be placed in further peril when it becomes necessary to escape the fire by entering the water. Engine room fires need to be detected early in order to reduce the dangers to the vessel's occupants and damage to the vessel. Heat and/or smoke alarms should be listed to appropriate standards for the device and installed according to the device manufacturer's instructions.

Annex B Portable Fire Extinguishers and Fixed Systems

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Classification of Fires. For all practical purposes, there are four general classes of fire, as follows:

(1) Class A fires — fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics
(2) Class B fires — fires in flammable liquids, oils, greases, tars, oil-base paints, lacquers, and flammable gases
(3) Class C fires — fires that involve energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance (When electrical equipment is de-energized, fire extinguishers for Class A or B fires can be used safely.)
(4) Class D fires — fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium

B.2 Classification of Fire Extinguishers. Based on the classification of fires described in Section B.1 and on fire extinguishing potential as determined by physical testing by organizations acceptable to the authority having jurisdiction, classifications have been established for portable fire extinguishers. The U.S. Coast Guard also classifies portable fire extinguishers based on the classification of fires found in Section B.1 but uses a different method of indicating extinguishment potential. *(See 46 CFR.)*

The relative extinguishment potential of various sizes and types of extinguishers as determined by Underwriters Laboratories Inc. is expressed by a numeral, and the class of fire for which the agent is suitable is represented by the letters in Section B.1. Size or weight alone does not necessarily indicate the effectiveness of the extinguisher, and this should be understood when choosing an extinguisher to ensure the best value and the maximum protection. Because of the regulatory responsibility of the U.S. Coast Guard in the field of boating safety, U.S. Coast Guard designations are followed in this standard. *(See Table B.2.)*

B.3 Fire Extinguisher Rating System. Although currently using a rating system based on the size and weight of the extinguishing agent, the U.S. Coast Guard also considers extinguisher performance on marine-type fires. Extinguishers not labeled with a U.S. Coast Guard approval classification should be listed and labeled by Underwriters Laboratories Inc., have a minimum rating of 5 B:C, and have a minimum capacity as specified in Table B.3. Those of inadequate performance are not classified as approved by the U.S. Coast Guard. Table B.3 provides the U.S. Coast Guard classification and relative unit size for the minimum size approved portable and semiportable fire extinguisher acceptable for use on flammable liquid fires.

B.4 Portable Fire Extinguishers and Fixed Systems — Maintenance.

B.4.1 See Annex E.

B.4.2 All fire extinguishers should be recharged after each use, even if only partly discharged.

B.4.3 Dry chemical fire extinguishers should be kept filled with the specified weight of chemical at all times. Cartridges, in cartridge-type extinguishers, should be reweighed annually and, if found to weigh less than the minimum weight stamped thereon, should be replaced with a full cartridge or recharged. The gauge on stored pressure units should be examined and the unit serviced if the pressure is outside the operating limits.

B.4.4 After discharge, and before recharging, the discharge hose should be cleaned of all chemicals.

B.4.5 Carbon dioxide fire extinguishers should be reweighed semiannually, and cylinders in fixed carbon dioxide systems should be reweighed at least annually but preferably every 6 months. If found to be lighter than the weight indicated on the nameplate, cylinders should be recharged.

B.4.5.1 Carbon dioxide fire extinguishers always should be recharged after each use, even if only partly discharged.

B.4.5.2 Carbon dioxide extinguishers and cylinders in fixed systems should be provided with tags indicating the date weighed, current weight, and weigher's signature.

B.4.6 Portable extinguishers should be hydrostatically tested in accordance with the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

B.4.7 All fixed systems, if installed, should be maintained on at least an annual basis in accordance with the manufacturer's maintenance manual. It is recommended that a fixed system be maintained by a qualified fixed system service person.

B.5 Fire Extinguishers and Fixed Systems — Operations.

B.5.1 For Class A fires, such as those in bedding, cushions, acoustic materials, and wood, the extinguishing agent should be water, multipurpose dry chemical, or clean agent (if listed for Class A fires). Action should be taken to extinguish completely any burning or smoldering embers, or the smoldering material should be thrown overboard. Alcohol fuel galley fires also can be extinguished with water.

B.5.2 Carbon dioxide, clean agent, and dry chemical are the most effective means of extinguishment for Class B fires in flammable liquids such as gasoline, diesel fuel, or kerosene.

B.5.2.1 Dry chemical fire extinguishers are provided with a nozzle for distributing the dry chemical in a dense cloud from about 5 ft to 15 ft (1.5 m to 4.5 m), depending upon the capacity of the extinguisher. For open fires in flammable liquids, the discharge should be applied in a rapid, sweeping motion to the near edge of the flames at their base and continued toward the far edge. For fires caused by running or dripping fuel from leaks in fuel tanks or lines, extinguishment should begin at the lower part of the fire and work upward. Leaks should be stopped as quickly as possible. For use on obstructed fires, such as in engine rooms, the discharge should be applied near the base of the fire to be effective. Such applications are not always possible.