NFPA

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PLEASURE & COMMERCIAL MOTOR CRAFT 1980

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
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See Official NFPA Definitions at the back of this pamphlet.

SC-AM-80

Errata

NFPA 302 — 1980
Motor Craft

The Technical Committee on Motor Craft notes the following errata for Table 1-4 on page 6 in the Standard on Fire Protection for Pleasure and Commercial Motor Craft. As currently displayed, it could lead to an incorrect interpretation of the information contained in the Table.

1. On page 6, Table 1-4 should appear as follows:

Table 1-4 Galvanic Series of 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[1]
- Copper[1]
- Bronzes[1]
- Copper nickel alloys[1]
- Nickel copper alloys[1]
- Silver solder
- Nickel (passive)
- Chromium-iron (passive)
- Silver
- Graphite
- Gold
- Platinum

Protected End (cathodic, or most noble)

[1]These metals and alloys are considered the best to use together in marine application.

Errata

Standard on Fire Protection for
Pleasure and Commercial Motor Craft

NFPA 302-1980

The Technical Committee on Motor Craft notes the following errata in the *Standard on Fire Protection for Pleasure and Commercial Motor Craft*

1 On page 60, paragraph C-4.2.5, add "not" *between* "should" *and* "be" *in the first sentence so that it reads:*

Tanks should not be completely filled.

2 On page 61, paragraph C-5.2.3.1 (a), change "light" *to* "lighting" *so that it reads:*

(a) Close stop valves on cylinder and burn out gas content in line by lighting all burners

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Fire Protection Standard for
Pleasure and Commercial Motor Craft

NFPA 302-1980

1980 Edition of NFPA 302

This 1980 edition of NFPA 302 was prepared by the Technical Committee on Motor Craft and was adopted by the National Fire Protection Association, Inc. at its 1980 Annual Meeting in Boston, Mass., on May 21, 1980. It was released by the Standards Council on June 11, 1980. It supersedes the 1972 Edition. Currently, the Standard is under the jurisdiction of the Sectional Committee on Motor Craft, which reports to the Association through the NFPA Committee on Marine Fire Protection.

The 1972 edition of NFPA 302 was approved as an ANSI Standard by the American National Standards Institute on May 14, 1974. This 1980 edition is being resubmitted to the ANSI for approval. The ANSI date of approval will be printed on the front cover of copies of this edition printed after approval has been received.

Origin and Development of NFPA 302

This Fire Protection Standard for Motor Craft represents the cumulative result of 48 years of attention to fire safety of power boats by the NFPA. The first edition of this standard was adopted by the Association in 1925. Amended in 1926 and 1930, a revised edition was adopted in 1936. Thirteen successive editions were adopted between 1939 and 1968. The present text consists of amendments to the 1972 edition.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in membership may have occurred.

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Standard on Fire Protection for
Pleasure and Commercial Motor Craft

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

Information on referenced publications can be found in Appendix D.

Chapter 1 General

1-1 Scope.

1-1.1 This standard provides minimum requirements for the prevention of fire and explosion due to fuel leakage. This standard also provides minimum requirements for the elimination of possible sources of vapor ignition, the provision of adequate ventilation of vital areas, the avoidance of unnecessary use of combustible materials in exposed locations, and the provision of proper fire extinguishing equipment.

1-1.2 This standard shall apply to boats of less than 300 gross tons used for pleasure and commercial purposes.

1-1.3 No requirement of this standard shall be construed as reducing applicable regulations of the United States Coast Guard.

1-2 Purpose. The purpose of this standard is to minimize the loss of life and property due to fires and explosions aboard pleasure and commercial motor craft. This standard is directed towards making motor craft as free from the hazards of fire as practicable.

1-3 Equivalency. Where strict compliance with specific requirements of this standard is impractical, alternative means shall be deemed in compliance if it can be shown that equivalent protection is provided.

1-4 Definitions. For the purposes of this standard, the following terms will have the meanings listed below.

Accessible. Capable of being reached for inspection, maintenance, or removal without disturbing the permanent hull structure (see Liquefied Petroleum Gas).

Bonding Conductor. A normally non-current-carrying conductor used to connect normally non-current-carrying metal parts of a boat and normally non-current-carrying metal parts of direct current devices on the boat to the boat's grounding system for purposes of minimizing stray current corrosion.

Engine Exhaust System. The means by which products of combustion are conducted from the engine exhaust manifold to an outboard terminus. It includes related accessories which may be metallic or nonmetallic, such as pipe, mufflers, silencers, turbochargers, spark arrestors, 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.

Galvanic Series of Metals. See Table 1-4.

Table 1-4 Galvanic Series of Metals

Corroded End (anodic, or least noble)	
Magnesium	Brasses[1]
Zinc	Copper[1]
Aluminum	Bronzes[1]
Cadmium	Copper-nickel alloys[1]
Steel or Iron	Nickel-copper alloys[1]
Cast Iron	Silver solder
Chromium-iron (active)	Nickel (passive)
Lead-tin solders	Chromium-iron (passive)
Lead	Silver
Tin	Graphite
Nickel (active)	Gold
	Platinum
Protected End (cathodic, or most noble)	

[1]These metals and alloys are considered the best to use together in marine application.

Ground. The electrical potential of the earth's surface as established by an electrically conductive connection (intentional or accidental) with the earth, including any conductive part of the wetted surface of the hull.

Grounded Conductor. A current-carrying conductor connected to the side of the source which is intentionally maintained at ground potential.

Grounding Conductor. A normally non-current-carrying conductor provided to connect the exposed metallic enclosures of electrical equipment to ground for the purpose of minimizing shock hazard to personnel.

Ignition-protected.* A means of construction of or protection for a device, permitting it to operate without igniting an explosive atmosphere surrounding (external to) the device.

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

Permanently Installed. Securely fastened in place and not intended for ready removal.

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

Ventilation. The changing of air within a compartment by natural or mechanical means. Ventilation may be achieved by introduction of fresh air to dilute contaminated air or by local exhaust of contaminated air.

Chapter 2 Hull

2-1 Arrangement.

2-1.1* The hull shall be arranged so that all compartments are accessible and all escape hatches are unobstructed, readily accessible, and adequate for their designed purposes. Clear passage through accommodation spaces shall be provided to permit escape both forward and aft.

2-1.2 Engine compartments shall be separated from accommodation spaces by bulkheads or barriers designed to serve as fire barriers and capable of minimizing the escape of fire extinguishing materials discharged into the engine compartment.

2-1.3 Bilges of spaces containing fuel line fittings shall be separated from bilges of accommodation spaces and other enclosed spaces containing sources of ignition by bulkheads which will not permit more than 0.25 oz of leakage per hour when the liquid in the bilge is at a height of 12 in. or ⅓ the maximum height of the bulkhead, whichever is less.

2-1.4 Ready access shall be provided to machinery and fuel tank compartments via an unobstructed hatch, opening, or door.

2-1.5* The galley or the area used for galley purposes shall be provided with adequate ventilation. If nonelectric stoves or other oxygen-consuming devices are used, ventilators or other means shall be provided to supply combustion air.

2-1.6 The arrangement of the boat shall minimize entry of machinery exhaust gases to accommodation spaces. This requirement applies particularly to ventilators, ports, windows, and drain outlets.

2-2 Finishing and Insulating Materials.

2-2.1* Fabrics above and within 3 ft of a galley stove, used for decorative or other purposes, shall satisfy the test requirements of NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*.

2-3* Ventilation.

2-3.1 Minimum ventilation for vessels with gasoline engines shall be in accordance with the regulations of the U.S. Coast Guard.

2-3.1.1 Accommodation spaces shall be separated from machinery spaces in accordance with 2-1.2.

2-3.1.2 In addition to general ventilation requirements, engine compartments shall be provided with sufficient ventilating air intakes to supply each engine with the amount of air necessary to operate the engine at its designed full power.

2-3.2 Enclosed propulsion and/or auxiliary engine spaces shall be provided with power ventilation in addition to natural ventilation. Spaces having less than 15 sq in. of area permanently open to the atmosphere per cubic ft of net compartment volume shall be considered enclosed.

2-3.3 **Power Ventilation.** Ventilation by power means shall be provided in the spaces immediately surrounding each propulsion and auxiliary engine. The power ventilation system shall be of the local exhaust type.

2-3.3.1 Each power exhaust duct pickup shall be permanently and substantially fixed as nearly as possible below the engine which it serves, but above normal accumulation of bilge water.

2-3.3.2 One blower may be used to provide local exhaust from two or more points, providing the system is properly balanced to ensure the required air flow at each pickup.

2-3.3.3 Each ignition switch location shall be placarded with instructions to operate the power exhaust system before and during the engine-starting operation.

2-3.4 **Natural Ventilation.** The natural ventilation system shall be designed and installed to function on the general dilution principle, as opposed to local exhaust power ventilation. Ducts shall be located to introduce outside air to the compartment or space so that contaminated air is diluted and, through the exchange of air, is gradually removed from the space.

2-4* Lightning Protection.

2-4.1* Metallic fittings at extremities of wooden masts and yards shall be effectively grounded, and all metallic structural parts and accessories of any appreciable size installed on spars shall be connected to the grounding conductor.

2-4.2 The grounding conductor shall have conductivity equal to or greater than No. 8 AWG (3.3-mm) copper cable, shall be essentially straight, shall terminate in a sharp point at least 6 in. above the mast, and shall be led as directly as practicable to a ground plate attached to the wetted surface of the hull.

2-4.3* Metallic standing rigging, metal masts, and any continuous metal track on masts or booms should be grounded in accordance with 2-4.2.

2-4.4 A radio antenna may serve as a lightning protective mast provided it has conductivity equal to or greater than No. 8 AWG (3.3-mm) copper cable and is equipped with lightning arrestors, lightning protective gaps, or means for grounding during electrical storms.

2-4.5 Grounding of metal rod-type radio antennas constitutes sufficient protection for nonmetallic boats having no masts or spars, provided the conditions of 2-4.5.1 through 2-4.5.4 are met.

2-4.5.1 The antenna and all conductors in the grounding circuit of the antenna shall have a conductivity equivalent to No. 8 AWG (3.3-mm) copper cable.

2-4.5.2 A line drawn from the top of the antenna downward toward the water at an angle of 45 degrees to the vertical shall not intercept any part of the boat. *(See Figure 2-4.5.2.)*

2-4.5.3* Antennas with loading coils are considered to end at a point immediately below the loading coil unless this coil is provided with a suitable protective device for bypassing the lightning current.

2-4.5.4 Nonconducting antenna masts with spirally wrapped conductors are not considered suitable for lightning protection measures.

2-4.6 A metal hull provides an adequate ground. If there is good metal-to-metal contact between the hull and metal masts, no further protection from lightning shall be necessary.

Ungrounded objects projecting above metal masts or metal superstructures shall be bonded to them.

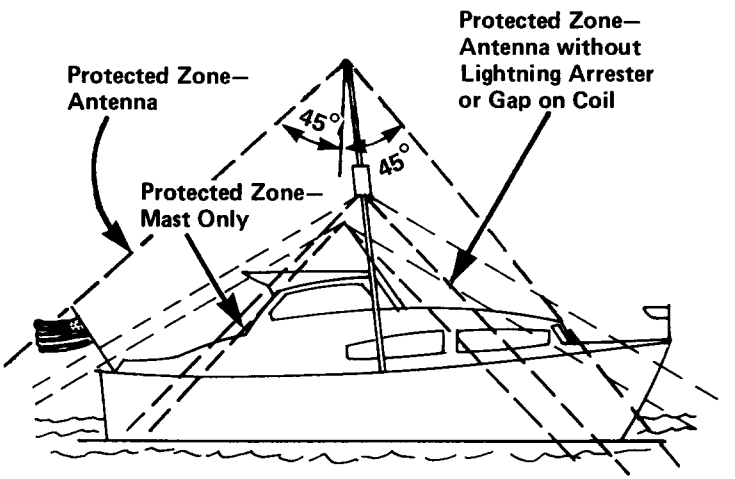

Figure 2-4.5.2

Diagrams above illustrate the "cone of protection" provided by a grounded mast or antenna. This protective zone is largely immune to direct strokes of lightning. No part of this vessel to be protected should extend outside the cone of protection. Thus in the cabin cruiser illustrated, adequate lightning protection is afforded only by the grounded antenna equipped with a lightning arrester or gap on the coil.

Chapter 3 Engines

3-1 Main Engines. Main engines shall be suitable in type and design for propulsion requirements of the hull in which they are installed and capable of operating at constant load without exceeding their design limitations.

3-1.1 Engine heads, blocks, and exhaust mainfolds shall be water-jacketed and cooled by water from a pump which operates whenever the engine is operating.

Exception: As provided for in 3-1.8.

3-1.2 Engine fuel pumps of the diaphragm type shall be designed so that fuel is not released to the engine space should primary diaphragm failure occur. Means shall be provided to determine that diaphragm failure has occurred without having to dismantle the fuel pump.

3-1.3 Marine carburetors shall be designed to prevent leakage of fuel around shafts or other connections and shall not be externally vented.

3-1.3.1 Carburetors shall have integral or enclosed drip collectors which return drip and overflow to the engine intake manifold.

3-1.3.2 Carburetors shall be installed to prevent any internal drip or accumulation of fuel in the drip collector from escaping to the bilge.

3-1.3.3 Air intakes shall be fitted with a means of backfire flame control approved by the U.S. Coast Guard.

3-1.4 Engine electrical components shall comply with applicable parts of Chapters 7 and 8.

3-1.4.1 Electrical components on engines shall be mounted as high above the bilges and as remote from the fuel system as practicable.

3-1.5 Gages to indicate cooling water temperature and lubricating oil pressure shall be provided and located so that they are readable by the operator at all helm positions.

Warning lights may be used in lieu of gages, provided they are of a type that can be tested by the operator.

3-1.6 Air-cooled engines may be used if they comply with 3-1.6.1 through 3-1.6.4.

3-1.6.1 Carburetors and electrical components shall comply with 3-1.3 and 3-1.4.

3-1.6.2 Fuel systems shall comply with Chapter 5.

3-1.6.3 Exhaust systems shall comply with applicable parts of Chapter 4.

3-1.6.4 An audible or visual device shall be installed to warn of excessive engine temperature.

3-1.6.5 If air-cooled engines are enclosed, the following shall apply:

(a) Compartment ventilation shall be adequate to meet the needs of the engine-cooling system.

(b) Air used for engine cooling shall be discharged outside the hull by a duct system.

3-1.7 Permanently installed air-cooled engines with self-contained fuel systems shall be used only on open decks or on cabin tops. Any housing over such units shall be open whenever the engine is operating.

3-1.8* Portable engines shall be secured when in use. When not in use, they shall be stowed so that fuel or vapors cannot reach interior spaces.

Chapter 4 Engine Exhaust Systems

4-1 General Requirements.

4-1.1 Exhaust systems shall be:

(a) gastight to hull interiors

(b) designed and installed to prevent water from the exterior of the boat or from the cooling system from returning to the engine

(c) accessible throughout their length

(d) supported to prevent undue stress that could cause fractures.

4-1.2 Wherever personnel or combustibles may come in contact with hot surfaces, effective protection shall be provided by water-jacketing, lagging, shielding, or guards.

4-1.3 Hangers, brackets, and other supporting components shall be of noncombustible materials and shall be installed so that heat is not transferred to adjacent combustible materials.

4-1.4 An audible or visual device at the helm position shall be provided to warn of excess heat on the surface of any water-cooled exhaust systems.

4-1.5 A separate exhaust system shall be provided for each engine.

4-2 Materials.

4-2.1 Materials used in engine exhaust systems shall be resistant to fuels, products of combustion, water corrosion, and to the highest temperatures which may be encountered. If metallic components are in contact, they shall be galvanically compatible. (*See Table 1-4.*)

4-2.2 Copper shall not be used in contact with diesel exhaust gases.

4-2.3 Nonmetallic flexible or rigid tubing may be used in a marine engine exhaust system if it is listed or labeled for such use.

4-3 Installation of Wet Exhaust Systems.

4-3.1 That part of the system between the point of cooling water injection and the engine exhaust manifold shall be water-jacketed or shall be protected according to the provisions of Section 4-4.

4-3.2 Metallic wet exhaust pipes shall have a minimum clearance of 2 in. from any combustible materials or shall be separated by fire resistant thermal insulation.

4-4 Installation of Dry Exhaust Systems. Dry exhaust pipes shall have a minimum clearance of 9 in. from any combustible materials, including paint, or shall be separated by fire resistant thermal insulation.

Chapter 5 Fuel Systems

5-1 Scope.

5-1.1 The requirements of this chapter apply to the design, construction, choice of materials, and installation of permanently installed fuel systems from the fuel fill opening to the connections at each engine or at auxiliary equipment.

5-1.2 The requirements of this chapter do not apply to portable fuel systems or their parts.

5-2 General Requirements.

5-2.1 Applicable U.S. Coast Guard regulations for fuel systems shall be considered a minimum requirement.

5-2.2 Fuel systems shall be liquid- and vapor-tight with respect to hull interiors. Individual system components and the system as a whole shall be designed and installed to withstand the stresses of and exposure to marine service such as pressure, vibration, shock, movement, grease, lubricating oil, bilge solvents, high aromatic fuels, and corrosive environment.

5-2.3 All individual components of the fuel system, as installed in the boat, shall be capable of withstanding a 2½ minute exposure to free-burning fuel without failure resulting in leakage of liquid or vapor.

Exception No. 1: Fuel distribution lines on boats less than 26 ft long need not comply with 5-2.3 if a break at any point in the line will result in a discharge of not more than 5.0 oz of fuel within 2½ minutes.

Exception No. 2: Self-draining fuel tank vent and fill pipes located outside the engine compartment of boats less than 26 ft long need not comply with 5-2.3.

5-2.4 The system and all its components shall be capable of operation without failure or leakage within an ambient temperature range of −20°F (−28°C) to 185°F (85°C).

5-2.5 The resistance between ground and each metallic component of the fuel fill system and fuel tank which is in contact with fuel shall be less than 100 ohms (*see 7-3.3*).

5-2.6 Pressurized fuel tanks shall not be used.

5-3 Fuel Tank — Materials.

5-3.1 Fuel tanks shall not be integral with the hull structure.

Exception: Tanks for diesel or heavier oils in metal-hulled boats.

5-3.2 Materials for fuel tanks shall be corrosion resistant. Materials meeting the specifications listed in Table 5-3.2 shall be considered as satisfying this corrosion resistance requirement. Any departure from these specifications shall be specifically listed and labeled.

Table 5-3.2 Minimum Plate Thickness for Fuel Tank Corrosion Resistance

Material	Specification	Minimum Nominal Sheet Thickness	Gage[1]
Nickel-Copper[2,3]	ASTM B127 Class A	0.031 in.	22
Copper-Nickel	ASTM B122	0.045 in.	17
Steel[4]	ASTM A93	0.0747 in.	14
Aluminized Steel[5,6]	ASTM A463	0.0478 in.	18
Aluminum	Alloy 5052 Alloy 5083 Alloy 5086	0.090 in.	

Notes to Table:

1. Gages listed in the Table are U.S. Standard for nickel-copper, AWG for copper-nickel, and Manufacturers Standard for steel.

2. U.S. Standard No. 18 (0.05-in.) nickel-copper may be used only with oxy-acetylene, shielded arc, atomic hydrogen, and electric resistance seam welding, as well as brazed joints and riveted and brazed joints.

3. U.S. Standard No. 22 (0.031-in.) nickel-copper may be used for tanks up to 30 gal capacity provided they are formed with electric resistance seam welds.

4. Steel tanks, except those used for diesel fuel, shall be galvanized inside and outside by the hot-dip process.

5. Aluminized steel tanks of less than 0.0785 in. thickness shall only be installed above the cockpit floor or above deck if no clearly defined cockpit exists.

6. Aluminized steel tanks of less than 0.0785 in. thickness shall be examined at least annually. The tank may be reused only if detailed examination indicates suitability for further use.

5-3.3 Nonmetallic materials meeting the applicable requirements of Chapter 5 may be used.

5-3.4 Metal fuel tanks for diesel or heavier oils shall be made from steel, nickel-copper, aluminized steel, or alloys of aluminum, as set forth in Table 5-3.2.

5-3.5 Diesel fuel tanks shall not be galvanized internally.

5-4 Fuel Tank — Design and Construction.

5-4.1 Tanks shall have no openings in bottoms, sides, or ends. Openings for fill, vent, and feed pipes and level gages (if used) shall be at or above the topmost surface of tanks.

5-4.2 Cleanout plates shall not be installed.

5-4.3 Fitting plates shall be secured in such a manner that they cannot be used for cleanout purposes.

5-4.4 Tanks shall be constructed so that, when installed, exterior surfaces will not hold water.

5-4.5 All connections to the tank shall be liquid- and vapor-tight and shall have sufficient flange area to provide good local reinforcement.

5-4.6 Threaded fittings shall conform to Table 5-4.6.

Table 5-4.6 Minimum Thread Engagement

I.P.S.	Minimum Length of Thread Engagement
1/4 in.	3/8 in.
3/8 in.	3/8 in.
1/2 in.	1/2 in.
3/4 in.	9/16 in.
1 in.	11/16 in.
1 1/4 in.	11/16 in.
2 in.	3/4 in.

5-4.7 Baffles shall be provided where necessary for strength or to prevent excessive surge of tank contents. Attachment of baffles to tank walls shall be such as to prevent failure from flexing or vibration.

5-4.8 The use of gage glasses shall be restricted to day or service tanks of diesel fuel systems.

5-4.9 All metal tanks shall be fitted with a substantial bonding terminal.

5-4.10 Indentations for labeling or other identification shall not weaken the fuel tank.

5-4.11 All fuel tanks shall bear a legible, permanent label located so that it is visible for inspection after installation. The label shall provide the following information:

(a) manufacturer's name or logo and address

(b) month (or lot or serial number) and year of manufacture

(c) capacity in U.S. gallons

(d) construction material and thickness

(e) fuel for which tank is intended

(f) maximum test pressure

(g) model number, if applicable

(h) the statement "This tank has been tested under 33CFR183.580" (as applicable)

(i) if the tank is tested under 33CFR183.584, at less than 25 g vertical accelerations, the statement "Must be installed aft of the half length of the boat."

5-4.12 All fuel tanks shall be tested by the manufacturer or boat builder for fuel tightness at 3.0 psig or 1½ times the maximum head to which it may be subjected in service, whichever is greater.

5-4.13 Fuel pickup tubes shall be designed and installed to pick up fuel within 3/8 in. of the tank bottom. Because the tank may flex in service, the design of the pickup tube shall preclude damage to the tank bottom.

5-4.14* If aluminum is used in the fuel system, it shall be separated from copper-based alloy components by a galvanic barrier.

5-5 Fuel Tank — Installation.

5-5.1 Fuel tanks and their fittings shall be accessible.

5-5.2 All labels shall be visible.

Exception: If tank locations prevent ready inspection, access panels shall be provided.

5-5.3 Metallic fuel tanks shall be positioned above normal accumulations of bilge water and supported in a manner that will ensure complete drainage of water from all exterior tank surfaces, as installed.

Exception: Fuel tanks for diesel or heavier oils may be integral with a metal hull.

5-5.4 All fuel tanks shall be adequately supported and braced to prevent movement and permanent deformation. Tanks may be supported by brackets welded to the tank.

5-5.5 Metallic fuel tanks shall be supported on chocks or bearers located under the tank ends and under each baffle or by tank bearers running the length of the tank perpendicular to the baffles. Metallic tanks shall not be supported on a large area surface which will trap moisture.

5-5.6 Contact between metallic fuel tanks and other structures shall be limited to necessary supports in order to permit free circulation of air.

Exception: As permitted by 5-5.10.

5-5.7 All wood or metal surfaces of tank supports and braces shall be effectively insulated from contact with tank surfaces by a nonabrasive and nonabsorbent material.

5-5.8 All metallic fuel tank components in contact with the fuel shall be electrically bonded to the boat's common ground.

5-5.9 Aluminized steel tanks of thicknesses less than 0.0785 in. shall be installed above the cockpit deck, or above deck if there is no clearly defined cockpit.

5-5.10 Nonferrous and nonmetallic fuel tanks may be foamed in place if they comply with the requirements of 5-5.1, 5-5.2, 5-5.4, and 5-5.8.

5-5.11 Diesel, day, or service tanks shall not be installed above the engine or other sources of ignition.

5-6 Fuel Lines and Related Accessories.

5-6.1 For the purposes of this section, fuel lines shall mean all pipes, tubing, or hose that conduct fuel from the deck fill plate to the engine connection. Related accessories shall include any attachments to fuel lines such as valves, filters, strainers, pumps, and connecting fittings.

5-6.2 General Requirements.

5-6.2.1 Fuel lines, connections, and accessories shall be accessible.

5-6.2.2 Fuel lines shall be secured against damaging movement or vibration by using noncombustible clips or straps having no rough surfaces or sharp edges.

5-6.2.3 When making up threaded pipe connections, a gasoline resistant sealing compound or tape shall be used.

5-6.2.4 When making flared tubing connections, it is essential that tubing be cut squarely and flared by tools designed for the purpose. Tubing shall be deburred and copper tubing shall be annealed prior to being flared.

5-6.2.5 Outlets for drawing fuel from the system shall be prohibited.

Exception: Filter bowl plugs provided for the purpose of servicing only.

5-6.2.6 All related accessories of the system shall be approved for marine use and so listed or labeled.

5-6.2.7 Manually operated multiposition valves need only indicate their open and closed positions. Manually operated stop valves shall be designed with positive stops in the open and closed positions.

5-6.3 Installation of Fill and Vent Pipes.

5-6.3.1 Fuel tank fill and vent pipes shall be located so that overflow cannot escape to the inside of the hull and to provide protection against escaping vapors flowing into the hull. Separation between compartment ventilators and both fuel tank fill and vent fittings shall be provided.

5-6.3.2 The minimum inside diameter of the fill pipe system shall be 1¼ in. (32 mm) [minimum hose diameter of 1½ in. (38 mm)].

5-6.3.3 The fill pipe shall run as directly as possible, preferably in a straight line, from deck plate or other closable plate to tank top spud.

5-6.3.4* The fuel fill shall be identified by a permanent marking on or adjacent to the deck flange plate. If there is no flange, the marking shall be on the fuel fill cap, and the cap shall be attached to the fill pipe by a chain or similar means.

5-6.3.5 If a nonmetallic hose is used in the fill pipe system, it shall be tightly secured with a minimum of two clamps at each end.

5-6.3.5.1 When the flexible section of the hose is a nonconductor of static electricity, the metallic sections separated thereby shall be joined by a conductor for protection against static sparks when filling. (*See also 7-3.3.*)

5-6.3.5.2* Bonding wire ends shall not be clamped between the fill pipes and the flexible tubing.

5-6.3.5.3 Clamps depending solely on the spring tension of the metal and clamps having a nominal width of less than ½ in. shall not be used.

5-6.3.6 If the tank cannot be sounded through the fill pipe, a fuel gage shall be provided.

5-6.3.7 The vent pipe shall terminate as remotely as practicable from any hull opening and shall be installed to minimize the intake of water without resisting the release of vapor.

5-6.3.8 The vent pipe connection shall be at the highest point of the tank, as installed in the boat, under conditions of normal trim.

5-6.3.9 The vent pipe shall not be tapped into the fill pipe.

5-6.3.10 The minimum inside diameter of any component of the vent line system shall be not less than 7/16 in. (1.1 mm).

5-6.3.11 The vent line hull fittings shall be effective flame arrestors and the aggregate net open cross-sectional area of the flame arrestor shall not be less than the cross-sectional area of the vent line.

5-6.4 Installation of Fuel Feed Lines and Accessories.

5-6.4.1* Engine fuel pumps shall be installed so that they operate only when the engine which they serve is operating and shall be located either on or within 12 in. (30 cm) of that engine.

5-6.4.2 Fuel lines shall be run with as few connections as practicable and shall be protected.

5-6.4.3* Anti-siphon protection shall be provided in gasoline fuel systems.

5-6.4.4 A shutoff valve may be installed directly at the tank connection to close against fuel flow. This valve may be electrically or manually operated. If electrically operated, it shall be energized only to be open when the engine ignition is on and shall have provision for manual override.

5-6.4.5 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, an approved manual stop valve shall be installed at the engine end of the fuel line to stop fuel flow when the engine is being serviced. Such valves should be listed or labeled for marine use.

5-6.4.6 That part of the fuel feed line secured to the hull members shall be separated from that part secured to the engine by a flexible section approved for marine fuel system use and so listed or labeled.

5-6.4.6.1 Locked-in torsional stresses shall be avoided in the fuel line.

5-6.4.6.2 The flexible section shall be of sufficient length in excess of the distance between the points of connection to ensure proper functioning.

5-6.4.6.3 The fixed fuel line shall be clamped to the hull members to secure against vibration and movement of the point of connection to the flexible fuel line.

5-6.4.7 If diesel fuel requiring heating above its flash point is used in centrifugal purifiers, the purifiers and all connections thereto and therefrom shall be gastight.

Chapter 6* Cooking, Heating, and Auxiliary Appliances

6-1 Cooking Equipment.

6-1.1 Galley stoves shall be manufactured, approved, and labeled for marine use. Printed instructions for proper installation, operation, and maintenance shall be furnished by the manufacturer. A durable and permanently legible instruction sign covering safe operation and maintenance shall be provided by the manufacturer and installed on or adjacent to the stove where it may be readily read.

6-1.2 Stoves using gasoline for fuel shall not be used aboard boats.

6-1.3 Stoves shall be installed in adequately ventilated areas to comply with 2-1.5.

6-1.4 Stoves shall be securely fastened when in use and when stored.

6-1.5 Any burner system that may affect safety by reason of motion of the boat shall not be used.

6-1.6 All woodwork or other combustible materials above stove tops and all woodwork or combustibles immediately surrounding stoves shall be effectively insulated with noncombustible materials.

6-2 Coal, Charcoal, and Wood Burning Stoves.

6-2.1 Coal, charcoal, and wood burning stoves shall be either mounted on a noncombustible base (preferably hollow tile) or mounted on legs providing clearance of at least 5 in. between stove bottom and deck and the deck shall be effectively insulated with a noncombustible material or sheathing.

6-2.2 Stove sides and backs shall have a minimum clearance of 4 in. from the insulation provided in accordance with 6-1.6.

6-2.3 Smoke pipes and stacks shall have a minimum clearance of 9 in. from combustible materials, including painted surfaces, or shall be separated by fire resistant thermal insulation.

Exception: At decks equipped with water irons.

6-2.4 Smoke pipes or stacks shall terminate with approved smoke heads designed to prevent water entry, spark emission, and back draft.

6-2.5 Fuel shall be stowed in a ventilated, metal-lined locker or bin.

6-3 Alcohol, Fuel Oil, and Kerosene Stoves.

6-3.1 Both pressure or gravity fed burners shall be permitted.

6-3.2 Fuel supply tanks shall be constructed of corrosion resistant metal with welded or brazed joints and fittings.

6-3.2.1 Pressure tanks integrally installed with stoves shall withstand a test pressure of at least 200 psig. They shall be effectively protected from the heat of burners.

6-3.2.2 Pressure tanks for remote installation shall be approved and shall be able to withstand a test pressure of at least 100 psig. They shall be rigidly secured in an accessible location permitting convenient filling and pump operation.

6-3.2.3 Gravity tanks shall be substantially secured. They shall be so located or shielded that, under continuous operation at maximum output, the temperature of contained fuel will not be substantially raised by heat from the burners.

6.3.2.4 No gravity tank shall have a capacity exceeding 2 gal. Tanks of larger capacity shall meet the requirements of Section 5-3.

6-3.2.5 Gravity tanks shall have provisions for filling and venting outside the galley space.

6-3.3 If fuel tanks are remotely located, as is preferred for gravity feed systems, approved stop valves shall be installed close to tanks and fuel lines shall be installed with as few fittings as practicable between valves and stove connections.

6-3.4 If solidified fuel is used, the containers shall be properly secured on a fixed base to prevent sliding or overturning due to a sudden roll of the vessel.

6-3.5 Stacks and uninsulated stoves shall comply with the requirements of Section 6-2.

6-4* Liquefied Petroleum Gas Systems.

6-4.1 General Requirements.

6-4.1.1 Liquefied pertroleum gas systems shall be designed and installed in accordance with provisions outlined herein and shall be subject to the inspection and approval of the authority having jurisidiction.

6-4.1.2 The use or storage of stoves with attached LPG containers is prohibited on boats having enclosed accommodation spaces.

6-4.1.3 Comprehensive printed instructions and a labeled diagram covering details of proper installation and operation shall be furnished with each system installed on a boat and shall be kept on board for ready reference.

6-4.1.4 All liquefied petroleum gases shall be effectively odorized by an approved agent of such character as to indicate positively, by a distinctive odor, the presence of gas down to a concentration in air of not more than 20 percent of the lower limit of flammability.

6-4.1.5 All component parts of systems other than containers and low pressure distribution tubing between regulators and appliances shall be approved for marine use and shall be so listed or labeled.

6-4.1.6 All component parts of systems subject to container pressures shall have a rated working pressure of not less than 250 psig.

6-4.1.7 With each liquefied petroleum gas system installed on a boat, at least two of the signs required by 6-1.1 shall be provided. These signs shall include the following information statements:

(a) the signal word "WARNING"

(b) the statement "To Avoid Fire and Explosion"

(c) the following directions:

1. Keep container valves closed when boat is unattended. Close them immediately in any emergency.

2. Be sure all appliance valves are closed before opening the container valve.

3. Always apply lit match or other flame to burner before opening burner valve.

4. Close master valve on appliance whenever appliance is not in use (if applicable).

5. Test system for leakage at least twice a month and after any emergency in accordance with the following procedure.

With appliance valves closed, the master shutoff valve on the appliance open, and with one container valve open, note pressure on the gage. Close container valve. The pressure should remain constant for at least 10 minutes. If pressure drops, locate leakage by application of soapy water solution at all connections. Repeat test for each container in multi-container systems. Never use flame to check for leaks.

NOTE: If a leak detection device is installed, these instructions shall be modified as appropriate.

6-4.1.8 The required warning signs shall be installed in plainly visible locations on the outside of each container enclosure and adjacent to each consuming appliance.

6-4.2 Containers.

6-4.2.1 Containers shall be constructed, tested, marked, maintained, requalified for continued service, and refilled:

(a) in accordance with the regulations of the U.S. Department of Transportation for containers in LP-Gas service or

(b) in accordance with equivalent specifications or regulations determined by the authority having jurisdiction.

6-4.2.2 Containers shall be condemned and withdrawn from service when they leak, when corrosion, denting, bulging or other evidence of rough usage exists to the extent they may be weakened appreciably, or when they have been involved in a fire.

6-4.3 Valves and Safety Relief Devices.

6-4.3.1 Each container shall have a manually operated shutoff valve installed directly at the container outlet, which shall be equipped with a securely attached hand wheel for convenient operation without the use of a separate wrench.

6-4.3.2 All containers shall be provided with safety relief devices as required by U.S. Department of Transportation regulations or equivalent regulations.

6-4.3.3 Container valves and safety relief devices shall have direct connection with the vapor space of the cylinder.

6-4.3.4 In addition to the valve required at the container, a dual container system shall be provided with a two-way positive shutoff valve of manually operated type, or equivalent, at the manifold.

6-4.3.5 Discharge of the safety relief valves shall be vented into the open atmosphere.

6-4.4 Reducing Regulators.

6-4.4.1 Each system shall be provided with a pressure-regulating device, so adjusted as to deliver gas to the distribution piping at a pressure not to exceed 18 in. of water (approximately 0.653 psig).

6-4.4.2 A relief valve on the low pressure side of the system shall be integral with each regulator. It shall be set to discharge at not less than twice and not more than three times the delivery pressure.

6-4.4.3 The regulator vent termination shall be turned downward to prevent water entering the discharge line.

6-4.4.4* Each reducing regulator shall be fitted with a pressure gage or leak detector. If a gage is used, it shall be on the high pressure side of the regulator.

6-4.5 Piping and Fittings.

6-4.5.1 All low pressure distribution piping between the regulator and appliances shall be either copper tubing of standard type K, L, or equivalent or flexible hose listed or labeled for use with LPG.

6-4.5.2 Flexible sections used to allow free swing of gimballed stoves shall be approved for marine use.

6-4.5.3 Connecting fittings shall comply with applicable requirements of 5-6.2. Connections may be soldered or brazed with a material having a melting point exceeding 1000°F (538°C).

6-4.6 LPG Appliances.

6-4.6.1 All gas-consuming appliances shall be labeled as suitable for marine use.

6-4.6.2 Cooking stoves, service water heaters, cabin heaters, and similar appliances shall comply with applicable provisions of 6-1.1 and with the following:

(a) Appliances designed for operation with continuous pilot lights or automatic glow plugs are prohibited.

Exception: Cabin heaters complying with 6-4.6.2(b).

(b) Cabin space heaters shall be of the sealed combustion chamber type, designed to provide complete separation of the combustion system from the atmosphere in the boat. A combustion air inlet and flue gas outlet shall be provided as integral parts of the appliance.

6-4.7 Location and Installation.

6-4.7.1 Containers, regulating equipment, and safety equipment shall be rigidly secured, readily accessible, and so located that escaping vapor cannot reach the bilges, machinery space, accommodations, or other enclosed spaces.

6-4.7.2 Except as permitted by 6-4.7.3, locations of containers and regulators shall be confined to open deck, cabin top, outside of cockpits, or semi-enclosures. Equipment shall be protected by a housing vented to open air near the top and bottom.

6-4.7.3 If construction or design prevents compliance with locations specified above, the container, regulating equipment, and safety equipment shall be mounted in a locker or housing that is vapor-tight to the hull interior and located above the waterline in an open cockpit, provided the locker or housing is constructed of or lined with corrosion resistant material. It shall open only from the top by means of a cover seated on a gasket and tightly latched but capable of being conveniently and quickly opened for operation of container valves and for testing of the system for leakage. It shall also be vented at the bottom by a pipe of at least ½ in. internal diameter, led outboard without pockets through the hull sides to a point lower than the locker or housing bottom but above the waterline.

6-4.7.4 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 gage dials are fully visible.

6-4.7.5 Lockers or housings shall not be used for storage of any other equipment nor shall quick access to the gas system be obstructed in any way.

6-4.7.6 Provisions for storage of unconnected reserve containers, filled or empty, shall be the same as for containers in use. Valves to containers, even those considered empty, shall be kept tightly closed.

6-4.7.7 Distribution lines shall be protected from physical damage and shall be accessible for inspection.

6-4.7.7.1 Lines shall be secured against vibration.

6-4.7.7.2 Lines shall be protected from abrasion wherever they pass through decks or bulkheads.

6-4.7.7.3 Lines shall be continuous lengths of tubing from the tank location to the appliance.

6-4.7.8 After installation, distribution tubing shall be tested prior to its connection to the regulator and appliance by an air pressure of not less than 5 psig. The container valve shall be checked for leakage at its outlet and at its connection to the container by application of liquid detergent or soapy water solution prior to connection of the system. After these tests and when appliances and high-pressure equipment have been connected, the entire system shall be subjected to the following test.

(a) With appliance valves closed, the master shutoff valve (if provided) on the appliance open, and with one container valve open, note the pressure on the gage.

(b) Close the container valve.

(c) Pressure should remain constant for at least 10 minutes.

(d) If pressure drops, locate leakage by application of soapy water solution at all connections.

(e) Never use flame to check for leaks.

6-4.8 Precautions.

6-4.8.1 A container shall not be charged with fuel unless it bears the proper markings of the code under which it was fabricated, its water weight capacity, and its tare weight.

6-4.8.2 No container which is due for requalification shall be charged with fuel until it has been retested or otherwise qualified for service in accordance with U.S. Department of Transportation requirements.

6-4.8.3 Container valves must be tested for leaks before the charged container is shipped from the filling plant, and it shall not be shipped with leaking fittings.

6-5 Heating Equipment.

6-5.1 Service Hot Water Heating Units.

6-5.1.1 Open flame heating units shall be installed within the galley area only, well above accommodation flooring and in compliance with applicable requirements of Sections 6-1, 6-2, 6-3, and 6-4.

6-5.1.2 A vent stack shall be fitted at the top of each heating unit and led to the atmosphere with an effective device for preventing flame extinguishment or flareback from back draft.

6-5.1.3 Dampers shall not be installed in vent stacks.

6-5.1.4 Use of water heaters designed for operation with continuous pilot lights or automatic glow plugs is prohibited.

6-5.2 Cabin Heaters.

6-5.2.1 Cabin-heating equipment shall comply with applicable provisions of Sections 6-1, 6-2, 6-3, and 6-4.

6-5.2.2 Burners and burner feed arrangements shall be such that safe operation is not affected by motion of the boat.

6-5.2.3 Heaters shall be rigidly secured.

6-5.2.4 Use of heaters designed for operation with continuous pilot lights or automatic glow plugs shall be prohibited.

Exception: As permitted in 6-4.6.2(b).

6-5.2.5 Gasoline shall not be used for fuel in open flame liquid or vapor burners.

6-5.2.6 Heating boilers shall be approved for marine use.

6-5.2.7 Sealed combustion chamber heaters burning gasoline or fuel oil may be used provided they comply with applicable parts of this standard.

6-6 Auxiliary Appliances.

6-6.1 Lamps and Lanterns.

6-6.1.1 Gasoline shall not be used for fuel.

6-6.1.2 Oil lamps and lanterns shall be approved for marine use.

6-6.1.3 Oil lamps shall have metal bodies and shall be hung in gimbals.

6-6.1.4 Oil lamps shall not be located directly over galley stoves or heating units.

6-6.1.5 Metal shields shall be secured above chimneys.

6-6.1.6 Oil lanterns, if suspended, shall be secured by clips or lashings.

6-6.1.7 Lanterns not in use shall be stowed in a noncombustible enclosure.

6-6.2 Refrigerators and Air-Conditioning Equipment. Refrigerators and air conditioners shall be suitable for marine use. They shall be installed in accordance with applicable requirements of this chapter.

Chapter 7 Electrical Systems Under 50 Volts

7-1 General. This chapter applies to AC and DC electrical systems operating at less than 50 volts.

7-1.1 Applicable Coast Guard regulations for electrical systems shall be considered a minimum requirement.

7-2 Types of Systems. Systems shall be of the two-wire type, with insulated feed and return conductors in accordance with 7-2.1 or 7-2.2.

7-2.1 Ungrounded Systems. The term "ungrounded system" shall apply to any two-wire electrical system in which all current-carrying conductors, including the source of power and all accessories, are completely insulated from the ground throughout the system.

7-2.2 Grounded Systems. The "grounded system" shall apply to any two-wire electrical system which utilizes the engine's negative terminal or busbar as a means to maintain the return conductors of one side of the system at ground potential. All electrical circuits shall be of the two-wire type, with insulated conductors to and from the power source.

Exception: Engine mounted accessories may use the engine block as a common ground return.

7-2.2.1 The grounded side of the system shall be of negative polarity.

7-2.2.2 The negative terminal of the battery, the negative side of grounded electrical power distribution systems, and the common bonding conductor shall be connected to the engine negative terminal.

7-3 Bonding System.

7-3.1 Bonding ground connections shall be made to electrical equipment installed below the water line and to electrical equipment with any potential conductive path to bilge water or water in which the boat is floating.

7-3.2 Nonmetallic boats with fixed electrical systems shall be equipped with a bonding ground system.

7-3.3 The bonding system shall be independent of the electrical system ground conductors. The common bonding conductor and bonding conductors may use bare or insulated conductors.

Exception: At the engine's negative terminal.

7-3.4 The common bonding conductor shall be sized to carry the rated current of the largest branch circuit overcurrent device, but in no instance shall the size be less than a No. 8 AWG conductor or equivalent.

7-3.5 Bonding conductors to individual items of electrical equipment shall be equal in size to the supply conductor for the device.

Exception: Double-insulated electrical devices.

7-4 Batteries.

7-4.1 Batteries shall not be tapped for voltages other than the total voltage of all the cells comprising the battery.

7-4.2 Batteries shall be located so that hydrogen gas generated during charging will not accumulate or be trapped in the boat.

7-4.3 Batteries shall be accessibly located and secured against movement in any direction and shall comply with the requirements of the *Code of Federal Regulations,* 33 CFR Part 183.

7-4.4 Acid batteries shall be located in a liquid-tight tray or battery box of adequate capacity to retain normal spillage or boilover of electrolyte. The tray shall be constructed of or lined with materials resistant to deterioration by the electrolyte.

7-4.5 A nonconductive, perforated cover or other means shall be provided to prevent accidental shorting of battery terminals.

7-4.6 Batteries with metal cell containers shall be assembled in nonconductive trays having insulated cell supports. Provision shall be made to prevent other conductive materials that could cause a short circuit from contacting cell containers.

7-4.7 Each metallic fuel line and fuel system component within 12 in. and above the horizontal plane of the battery top surface as installed shall be shielded with dielectric material (*see Code of Federal Regulations, 33 CFR Part 183.*)

7-4.8 The positive terminal of each battery shall be identified by

the letters "POS" or "P" or by the symbol "+," marked on the terminal or on the battery case near the terminal.

7-4.9 Battery terminal connections shall not depend on spring tension.

7-5 Equipment.

7-5.1 Potential sources of ignition located on a vessel powered by a gasoline engine or containing a gasoline powered accessory in machinery spaces, gasoline fuel tank spaces, or enclosed spaces containing joints, fittings or other connectors between gasoline fuel system components shall be ignition-protected.

7-5.2 If an LP-Gas system is installed on the boat, unattended potential sources of iginition in enclosed spaces shall be ignition protected.

7-5.3 Electrical equipment intended for fixed installation shall be mounted and secured independently.

7-5.4 Electrical devices not specifically designed for submersible operation or operation in wet areas shall be located and mounted so that they are accessible, protected from overhead drip or spray, and protected from bilge splash.

7-6 Circuit Protection.

7-6.1 A fuse- or manual reset-type circuit breaker shall be provided in each positive power feed to the power distribution panel.

Exception: The circuit from the battery to the starter.

7-6.2 A fuse- or manual reset-type circuit breaker shall be provided at the main switchboard in positive conductors to subdistribution panels.

7-6.3 Main or branch circuit breakers shall be of the proper voltage rating and shall be of the manual reset-type with short circuit protection.

Overcurrent protection devices without manual reset may be used at or adjacent to the load provided the rest of the circuit is protected in accordance with 7-6.5.

7-6.4 Fuses, if used for circuit protection, shall be used in conjuction with a switch located between the fuse and source of power.

7-6.5 Each positive conductor of circuits supplying lights, motors, or electrical accessories shall be protected against overload at the distribution panel, switchboard, or other source of electrical power.

7-6.6 If, for any reason, the gage of wire is reduced at a junction, the circuit overload protection device shall be based on the current-carrying capacity of the smallest gage conductor.

Exception: Short connections to instruments less than 7 in. in length.

7-6.7 Vessels 26 ft and over in overall length shall have an approved master battery switch capable of carrying the maximum current of the system (including starter circuit) in the positive conductor as close to the battery terminal connection as practicable. The switch control shall be readily accessible.

7-6.8 The conductors supplying motors and motor operated appliances shall be protected by an overcurrent protection device which is designed to handle motor-starting current.

Overcurrent protection for bilge pumps and blowers shall, at nominal voltage, open the circuit under a stalled rotor condition.

7-7 Connectors and Terminals.

7-7.1 Metals used for terminal studs, nuts, and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug.

7-7.2 Terminals other than battery terminals shall be of the solderless type with ring or captive spade ends. Formed and soldered terminal connections shall not be used. Plug connectors may be used in accordance with 7-7.9.

7-7.3 Terminals shall have the correct hole size for the terminal stud.

7-7.4 Each termination composed of an ungrounded current-carrying conductor, terminal fitting, and connector shall be protected from short-circuiting with:

(a) an ungrounded terminal of a separate circuit

(b) any metal that is grounded.

7-7.5 A conductor shall not be joined to another conductor by a wire nut or wire screw.

7-7.6 Minimum terminal stud sizes for various wire gauges shall comply with Table 7-7.6.

Table 7-7.6 Minimum Stud Sizes for Terminal Studs

Nominal Stud Size	Minimum Stud Diameter	Conductor Size[1]
6	0.138 in.	18 AWG[2]
8	0.164 in.	14-16 AWG
10	0.190 in.	10-12 AWG
1/4 in.	0.250 in.	8 AWG
5/16 in.	0.3125 in.	6 AWG
3/8 in.	0.375 in.	4 AWG

[1]Based on use of four conductors to each terminal stud (see 7-7.7).

[2]See 7-9.3.

7-7.7 No more than four conductors shall be connected to any terminal stud. If more than four conductors are to be connected, two or more terminal studs shall be interconnected.

7-7.8 Battery connections of the soldered lug type shall have a soldered contact length of 1½ times the diameter of the metallic conductor.

7-7.9 Single and Multi-Wire Plug Connectors.

7-7.9.1 If soldered plug connections are used, the conductor shall be firmly supported adjacent to the soldered joint.

7-7.9.2 Plug connections shall be sealed or covered to prevent the accumulation of water around the connection.

7-7.9.3 In multi-wire connectors, a barrier or sleeving shall be provided to assure separation of individual conductors.

7-7.9.4 Each single friction connector, spring-type connector, or multi-connector plug that is outside of a junction box or enclosure must not separate when subjected to a 6 lb tensile force for one minute along the axial direction of the connector.

7-8 Wiring Installation.

7-8.1 Wiring shall be routed as high as possible above the bilge with consideration given to the protection of the wiring from mechanical damage.

7-8.2 Individual wires and harnessed wires shall be supported with clamps or straps at least every 18 in. to fixed structural members of the boat.

Exception: Wiring running through self-draining conduit.

7-8.2.1 Metal clamps shall be tight fitting and free of sharp edges.

7-8.2.2 If wiring is installed over engines or shafts, metallic or fire resistant clamps shall be used.

7-8.2.3 If conductors or groups of conductors are connected between two components that can move in relation to each other, each conductor or group of conductors shall have a loop, slack, or other strain relief.

7-8.3 Exposed wiring subject to mechanical damage shall be protected by a loom or other equivalent means.

7-8.4 Where wiring passes through bulkheads or other structural members, it shall be protected against chafing.

7-9 Conductors.

7-9.1 Conductors used for general wiring of circuits operating at less than 50 volts shall meet the requirements of SAE Standard J378B, J1127, or J1128 or shall be any conductor acceptable for circuits over 50 volts specified in Section 8-10.

7-9.2 Conductors shall be stranded copper.

7-9.3 No single conductor smaller than No. 16 AWG shall be used.

Exception: No. 18 AWG conductors may be used in multi-wire harness or cable.

7-9.4 Ignition wire shall meet the requirements of SAE Standard J557.

7-10 Conductor Sizes.

7-10.1 Conductors used for critical circuits where voltage drop must be kept to a minimum (navigation lights, electronic equipment, etc.) shall not have more than a 3 percent voltage drop and shall be determined according to Table 7-10.1.

Table 7-10.1 Length of Conductor in Feet from Source of Current to Most Distant Fixture and Return

AWG Wire Sizes Based on a 3 Percent Voltage Drop																
Total Current on Circuit in Amps.	Ft															
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
	6 Volts															
5	12	10	8	8	6	6										
10	8	6	6	5	4	3										
15	6	5	4	3	2	2										
20	6	4	3	2	1	1										
25	5	3	2	1	0	0										
	12 Volts															
5	14	12	12	10	10	8	8	8	8	8	6					
10	12	10	8	8	6	6	6	5	5	5	4					
15	10	8	6	6	5	5	4	4	3	3	2					
20	8	6	6	5	4	3	2	2	2	2	1					
25	8	6	5	4	3	3	2	1	1	1	0					
	32 Volts															
5	18	16	16	14	14	14	12	12	12	12	10	10	10	10	10	10
10	16	14	12	12	10	10	10	10	8	8	8	8	8	6	6	6
15	14	12	10	10	10	8	8	8	6	6	6	6	6	6	5	5
20	12	10	10	8	8	8	6	6	6	6	5	5	5	4	4	4
25	12	10	8	8	6	6	6	6	5	5	4	4	4	3	3	3

7-10.2 Conductor sizes used for cabin lighting and other circuits where voltage drop is not critical shall be determined according to Table 7-10.1 or Table 7-10.2.

7-11 Switchboards and Distribution Panels.

7-11.1 Switchboards and electrical distribution panels shall be located in accessible well-ventilated locations protected from the weather. If necessary, panels shall be provided with drip shields.

7-11.2 Switchboards and electrical distribution panels or junction boxes located adjacent to weather decks or open cockpits shall be enclosed or protected from deck wash.

Table 7-10.2 Length of Conductor in Feet from Source of Current to Most Distant Fixture and Return

AWG Wire Sizes Based on a 10 Percent Voltage Drop																
Total Current on Circuit in Amps.	Ft															
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
	6 Volts															
5	16	14	14	12	12	12										
10	14	12	10	10	8	8										
15	12	10	8	8	8	6										
20	10	8	8	8	6	6										
25	10	8	6	6	4	4										
	12 Volts															
5	16	16	16	16	14	14	14	14	12	12	12					
10	16	14	14	12	12	12	10	10	10	10	8					
15	14	14	12	10	10	10	8	8	8	8	8					
20	12	12	10	10	8	8	8	6	6	6	6					
25	10	10	10	8	8	8	6	6	6	6	4					
	32 Volts															
5	18	18	18	18	18	18	18	18	16	16	16	16	16	16	14	14
10	18	18	18	16	16	16	14	14	14	14	14	12	12	12	12	12
15	18	18	16	16	14	14	14	12	12	12	12	10	10	10	10	10
20	18	16	14	14	14	12	12	12	10	10	10	10	10	10	8	8
25	16	16	14	12	12	12	10	10	10	10	10	8	8	8	8	8
30	16	14	14	12	12	10	10	10	10	8	8	8	8	8	8	6

7-11.3 Switchboards and electrical distribution panels shall be of the dead front type. Wooden enclosures may be used for panels carrying less than 50 volts providing the terminals and all electrical connections are insulated from contact with the wood and the exposed wooden surfaces are protected with a nonabsorbent, fire resistant insulating material.

7-11.4 Connections made in conduit systems and in systems using armored cable shall be made in junction boxes.

Chapter 8* Electrical Systems 50 Volts and Over

8-1 Definition.

Isolator. A device installed in series with the grounding (green) conductor of the shore power cable to effectively block galvanic current flow but permit passage of alternating current normally associated with the grounding conductor.

8-2 Circuit Arrangement.

8-2.1 The system shall be designed so that on-board AC generators and shore power cannot simultaneously feed the same circuit.

8-2.2 The system shall be designed so that dual shore power inlets cannot simultaneously feed the same circuit.

8-3 General Requirements.

8-3.1 Applicable Coast Guard regulations for electrical systems shall be considered a minimum requirement.

8-3.2 A frequency of 60 Hz will be considered standard for AC powered systems on boats.

8-3.3 Electrical equipment and wiring intended to be installed in machinery spaces shall be designed for operation in an ambient temperature of not less than 240°F (60°C). Where equipment is designed for use outside of machinery spaces in cabins or on decks, etc., the designed ambient temperature may be reduced to 104°F (40°C).

8-3.4 The system frequency and nominal voltage shall be clearly and prominently marked at the AC switchboard or other readily visible location.

8-4 Ignition-protection.

8-4.1 All potential sources of ignition located on a vessel powered by a gasoline engine or containing a gasoline powered accessory in machinery spaces, gasoline fuel tank spaces, or enclosed spaces containing joints, fittings or other connectors between gasoline fuel system components shall be ignition-protected.

8-4.1.1 Boats utilizing diesel fuel for propulsion or auxiliary engines are exempt from ignition-protection requirements except as provided in 8-4.2 and 7-5.2.

8-4.2 If an LP-Gas system is installed on the boat, all unattended potential sources of ignition in enclosed spaces shall be ignition-protected.

8-5 System Polarization.

8-5.1 Electrical systems operating at 50 volts or higher shall be polarized.

8-5.2 A polarity-indicating device shall be installed:

(a) if the polarity must be maintained for proper operation of electrical devices

(b) in shore grounded systems if a branch circuit is provided with overcurrent protection or switches in only the ungrounded current-carrying conductors.

8-5.3 Polarity-indicating devices shall provide an impedance of not less than 100,000 ohms to ground at 120 volts, 60 Hz. Indication of improper polarity shall be a continuously operating visible or audible signal. There shall be a test means to ensure the device is operable.

8-6 Equipment.

8-6.1 Electrical equipment shall be securely mounted to the structure of the boat.

8-6.2 Fixed AC electrical equipment used on boats shall be designed so that the current-carrying parts of the device are effectively insulated from all exposed metal parts by a dielectric material suitable for use in damp and/or wet locations.

8-6.3 The frames of all electrical appliances and equipment shall be connected to the metallic hull or to the grounding or bonding system of nonmetallic hulls.

Exception: Switches and circuit breakers may be installed only in the ungrounded conductor of polarized circuits complying with Section 8-5.

8-7 Electrical Meters.

8-7.1* A system voltmeter installed to read input voltage from shore or the output voltage of on-board AC generators shall be provided and mounted in a readily visible location.

Exception: A voltmeter need not be provided for simple systems with straight resistive loads (lighting, heating, etc.).

8-8 Marking.

8-8.1 A permanently mounted waterproof warning sign shall be located adjacent to each shore power inlet location. The sign shall include the following information:

(a) the signal word "WARNING"

(b) the statement "To Minimize Shock and Fire Hazards"

(c) the following directions:

1. Turn off the boat's shore power switch before connecting or disconnecting the shore power cable.

2. Connect the shore power cable at the boat first.

3. If polarity warning indicator is activated, immediately disconnect cable and have the fault corrected by a qualified electrician.

4. Disconnect shore power cable at shore outlet first.

8-8.2 All switches and controls shall be marked to indicate their usage unless the purpose is obvious and operation of the control could not cause a hazardous condition.

8-8.3 All electrical equipment shall be marked to indicate:

(a) manufacturer's identification

(b) model number

(c) rating in volts and amperes or volts and watts

(d) phase, if applicable.

8-9 Plugs and Receptacles.

8-9.1 The shore power cable shall be compatible with the shore power inlet and the power rating of the boat.

8-9.2 Receptacles installed in locations subject to rain, spray, or splash shall be weatherproof as may be provided by a spring loaded, self-closing cover.

8-9.3 Receptacles subject to flooding or momentary submersion shall be of a watertight design as may be provided by a threaded, gasketed cover.

8-9.4 Receptacles shall be of the grounding type with a terminal provided for the grounding (green) conductor (*see Section 1-4, Grounding Conductor*).

8-9.5 Receptacles and matching plugs used on AC systems shall be noninterchangeable with receptacles and matching plugs used on DC systems.

8-9.6 A branch circuit supplying a combination of receptacle loads and permanently connected loads shall not supply fixed loads in excess of the following:

(a) 15 amperes — 600 watts

(b) 20 amperes — 1000 watts.

8-9.7 If installed in a lavatory, a receptacle shall be protected by a Type A (nominal 5 milliamperes) ground-fault circuit interrupter (GFCI).

8-9.8 All receptacles and matching plugs shall be of the grounding type and shall conform to the configurations described in ANSI C73, *Dimensions of Attachment Plugs and Receptacles,* for the appropriate voltage and current.

8-10 Installation.

8-10.1 All connections normally carrying current shall be made in enclosures such as junction boxes, fixture enclosures, or panel enclosures.

8-10.2 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.

8-10.3 In wet locations, metallic boxes, cabinets, or enclosures shall be mounted so that there is at least ¼ in. of air space between the box, cabinet, or enclosure and the supporting surface.

8-10.4 Unused conductor openings in boxes, cabinets, or enclosures shall be closed.

8-10.5 All current-carrying conductors shall be routed as high above the bilge water level and any other area where water may accumulate and as far away from exhaust pipes and other heat sources as practicable.

8-10.6 Conductors exposed to physical damage shall be protected by self-draining looms, conduits, tapes, raceways, or other equivalent protection. If conductors pass through bulkheads or structural members, means shall be provided to minimize insulation damage.

8-10.7 Conductors shall be supported throughout their length or, alternatively, shall be secured at least every 18 in.

8-10.7.1 Nonmetallic clamps shall be of sufficient size to hold the conductors firmly in place.

8-10.7.1.1 Nonmetallic straps or clamps shall not be used over engine(s), moving shafts, other machinery, or passage ways.

8-10.7.1.2 Nonmetallic straps or clamps shall be made of material that will not break or crack under flexing within a temperature range of −30°F (−34°C) to 250°F (121°C).

8-10.7.2 Metal straps or clamps shall have smooth, rounded edges to hold the conductors firmly in place without damage to the conductors or insulation. That section of the conductor or cable directly under the strap or clamp shall be protected by means of loom, tape, or other suitable wrapping to prevent injury to the conductor.

8-10.7.3 If metal clamps lined with an insulating material are used, the insulating material shall be resistant to the effects of oil, gasoline, or water.

8-10.8 Connections for General Wiring.

8-10.8.1 Metals used for terminal studs, nuts, and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug.

8-10.8.2 Each conductor splice joining conductor to conductor and conductor to connectors shall be able to withstand, without breaking, a tensile force equal to at least the value shown in Table 8-10.8.2 for the smallest conductor size used in the splice for a one minute duration.

Table 8-10.8.2 Tensile Test Values for Conductor Splices (Conductor-conductor and Conductor-connector Joints)

Conductor Size (AWG)	Tensile Force Lb/Newtons		Conductor Size (AWG)	Tensile Force Lb/Newtons	
18	10	44	4	70	311
16	15	66	3	70	355
14	30	133	2	80	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

8-10.8.3 Terminal connectors shall be of the ring or captive spade types.

8-10.8.4 Connections may be made using a set screw pressure-type conductor connector providing a means is used to prevent the set screw from bearing directly on the conductor strands. Set screw-type conductor connectors without such means may be used only on seven strand conductors.

8-10.8.5 A conductor shall not be joined to another conductor by a wire nut or a wire screw.

8-11 Conductors.

8-11.1 Conductors used for general wiring of circuits operating at 50 volts or more shall meet one of the following:

(a) has insulation that is listed and classified as moisture resistant and flame retardant, per the NFPA 70, *National Electrical Code®*

(b) flexible cord types SO, STO, ST, SJO, SJT, or SJTO per NFPA 70, *National Electrical Code*

(c) the requirements of IEEE Standard 45

(d) listed for marine use

(e) the mechanical water absorption and flame retardancy requirements of UL 83.

8-11.2 Conductors shall be stranded copper.

8-11.3 No single conductor shall be smaller than 16 AWG.

8-12 Types of Circuits.

8-12.1* Three-wire Shore Grounded System.

8-12.1.1 The shore current-carrying conductors shall be connected from the shore connection (shore power inlet) through overcurrent protection devices, to the boat's AC electrical system.

8-12.1.2 Neither current-carrying conductor shall be grounded on the boat.

8-12.1.3 The shore grounding conductor shall be connected through the shore power receptacle directly to the boat and all non-current-carrying parts of the system without interposing switches or overload protective devices. The boat's ground alone shall not be considered adequate for purposes of grounding the non-current-carrying parts of the AC electrical system.

8-12.2* Isolation Transformer System.

8-12.2.1 The shore current-carrying conductors shall be connected from the shore power inlet, through overload protective devices in each conductor, to the primary windings of the isolation transformer.

8-12.2.2 The shore current-carrying conductors shall not be grounded on the boat.

8-12.2.3 If the shore power inlet is not readily accessible to serve as a shore power disconnect, a switch simultaneously disconnecting both current-carrying conductors, shall be provided between the shore power connection and the overload protective devices.

8-12.2.4 The shore grounding conductors shall be connected through the shore power inlet directly to the non-current-carrying parts of the isolation transformer which, in turn, shall be insulated from any contact, directly or indirectly, with the hull.

8-12.2.5 The secondary circuit of the isolation transformer shall be ungrounded throughout the system. However, a polarized system with one side of the circuit purposely held at boat ground potential may be used.

8-12.2.6 Approved devices employing isolation transformers, such as battery chargers, may be connected in the same manner as the boat system isolation transformer so as to be fed directly from the shore power or may be connected to the secondary side of the isolation transformer.

8-13 Isolation of Galvanic Currents.

8-13.1 Boats with metallic hulls or outdrives that will be subject to galvanic corrosion because of the shore grounding connection (green wire) shall use an isolation transformer or an isolator.

8-13.2 The isolator shall withstand the application of power from a test circuit capable of delivering 5000 amperes rms symmetrically at the test terminals when tested in series with a 25 ft length of shore cable and an approved circuit breaker that has the same nominal rating as the isolator.

8-13.3 The isolator shall not introduce a voltage drop exceeding 2.5 volts at 100 percent of the shore power cable amperage rating in addition to the voltage drop of the shore power cable and connections.

8-14 Circuit Protection for AC Circuits.

8-14.1 Circuit breakers shall be provided to simultaneously open all ungrounded main supply current-carrying conductors of the system.

8-14.2 Fuses shall not be used as primary overcurrent protection for main supply feeders.

8-14.3 Fuses shall not be used in the grounded conductor.

8-14.4 Overload protection shall be provided at the generator in all ungrounded conductors.

8-14.5 Branch Circuits.

8-14.5.1 Each ungrounded conductor of a branch circuit shall be provided with overcurrent protection at the point of connection to the main switchboard; the overcurrent protection shall be rated not to exceed the current rating of the smallest conductor between the fuse or circuit breaker and the load.

8-14.5.2 In branch circuits, circuit breakers and switches shall simultaneously open all grounded and ungrounded conductors in the system.

Exception: As provided in 8-14.5.3 and 8-14.5.4.

8-14.5.3 In branch circuits, switches, circuit breakers, or fuses may open only the ungrounded current-carrying conductors in the circuit if:

(a) the wiring from shore power inlets throughout the boat is polarized, including light fixtures, and a polarity indicator is installed to indicate polarity of the feed conductors between the shore power inlets and the main circuit breakers or

(b) the neutral leg of the secondary of an isolation transformer is grounded.

8-14.5.4 If circuits contain two or more ungrounded current-carrying conductors protected by fuses, means shall be provided to disconnect all energized legs of the circuit simultaneously or remove all fuses from the circuit simultaneously.

8-15* Ground-Fault Circuit Interrupters.

8-15.1* Ground-fault circuit interrupter (GFCI) breakers shall meet the requirements of UL 943, as applicable.

8-15.2* GFCI Receptacle Devices. GFCI receptacle devices shall meet the requirements of UL 943.

8-16 AC Generators.

8-16.1 AC generators shall be connected to the electrical distribution system through a selector switch preventing the same portion of the system from being energized by the generator and the shore power at the same time.

8-16.2 The power feeders from the AC generator shall be sized according to the maximum rated output of the generator.

8-16.3 The AC generator power feeders shall be protected by an overcurrent protection device located at the generator and rated in amperes at not more than 125 percent of the maximum rated output of the generator.

Chapter 9 Fire Protection Equipment

9-1 General Requirements.

9-1.1 All portable fire extinguishers and extinguishing systems shall be approved by the U.S. Coast Guard for marine use.

9-1.2 Brackets used to secure portable fire extinguishers shall be approved for marine use.

9-2 Equipment.

9-2.1 All boats shall be equipped with portable fire extinguishers at least to the extent of the minimum requirements of Table 9-2.1 and the requirements of this section.

On boats having galley stoves, one of the required extinguishers of suitable types shall be readily accessible thereto.

Table 9-2.1 Number and Distribution of Fire Extinguishers

Type of Boat	Class of Extinguishers[1]	Minimum Required	Recommended Locations
Open boats under 16 ft	B-I	1	Helmsman's position
Open boats over 16 ft	B-I	2	Helmsman's position and passenger space
Boats under 26 ft	B-I	2	Helmsman's position and cabin
Boats 26-40 ft	B-I	3	Engine compartment, helmsman's position, and galley[3]
Boats 40-65 ft	B-I	4[2]	Engine compartment, helmsman's position, crew quarters, and galley[3]
Boats 65-75 ft	B-I	5[2]	Engine compartment, helmsman's position, crew quarters, and galley[3]
Boats 75-100 ft	B-I	6[2]	Engine compartment, helmsman's position, crew quarters, and galley[3]

Notes to table on following page

Notes to Table 9-2.1:

[1]One of the required extinguishers shall additionally have the capability of extinguishing Class A fires.

[2]If more than three B-I units are recommended, the extinguishing capacity may be made up of a smaller number of larger units, provided each recommended location is protected with an extinguisher readily accessible, e.g., 3 B-II units may be used in lieu of 4, 5, or 6 of the smaller B-I units.

[3]Extinguishers recommended for "engine compartment" should not be located inside such compartment but near an entrance to the compartment unless someone is normally present in the compartment.

9-2.2* All inboard-powered boats with the engine compartment enclosed shall have provisions for discharging the extinguishing agent directly into the space immediately surrounding the engine without opening the primary access. Where portable equipment is to be used, a small, suitably labeled, readily accessible port to the enclosure shall be provided for this purpose.

9-2.2.1 If the above extinguisher is portable and readily removable from its fixed mounting, it may also be credited as one of the extinguishers required in Table 9-2.1.

9-2.2.2 Portable fire extinguishers required for the engine compartment shall be a gaseous type.

9-2.2.3 If carbon dioxide is used as the extinguishing agent for fixed systems, the quantity of gas required shall comply with Table 9-2.2.3.

Table 9-2.2.3 Required Weight of Carbon Dioxide

Volume of Space (cu ft net)	Carbon Dioxide in lb
90 (or less)	5
140	10
220	15
300	20
375	25
525	35
800	50
1,200	75
1,600	100

and up to 4,500 cu ft at the rate of 1 lb of gas per 18 cu ft of space and above 4,500 cu ft at 1 lb per 20 cu ft. (*See NFPA 11A, Standard for High Expansion Foam Systems; NFPA 12, Standard on Carbon Dioxide Extinguishing Systems; NFPA 12A, Standard on Halogenated Fire Extinguishing Agent Systems — Halon 1301; and NFPA 17, Standard for Dry Chemical Extinguishing Systems.*)

9-2.2.4 If Halon 1301 is used as the extinguishing agent, the system shall be installed in accordance with the manufacturer's U.S. Coast Guard approved installation specifications and NFPA standards and shall incorporate the following:

(a) a means of indicating that the system has discharged

(b) if an automatic shutdown is provided, an easily operable engine restart feature

(c) for systems not incorporating automatic shutdown, a warning label advising the operator to immediately shut down engines when the system discharges.

9-2.2.5 If bilges are open or communicating to more than one space, such spaces, together with the bilge, shall be considered as one in determining the capacity of the system.

9-2.2.6 Systems may be manually or automatically operated. Automatically operated systems which are installed to protect accommodation compartments or to protect engine compartments which are normally attended shall be equipped with a predischarge alarm.

9-3 Installation.

9-3.1 Portable fire extinguishers shall be placed so that they are readily accessible from outside the compartment which they are intended to serve.

Extinguishers shall be secured with a marine bracket to permit immediate release.

9-3.2* Fixed extinguishing systems shall be installed in accordance with the manufacturer's U.S. Coast Guard approved installation procedures and with applicable NFPA standards.

9-3.2.1 Extinguishing agent cylinders shall be mounted a minimum of 2 in. above moist or wet surface to reduce danger of corrosion.

9-3.2.2* Manual controls shall be placed so they are readily accessible outside the spaces served by the systems.

9-3.2.3 Spaces to be protected by such systems shall be enclosed except for ventilation openings, means of access, and closable ports.

9-3.2.4 Systems shall be designed for one of the following modes of application (*see 9-2.2.5*). Modes (a) and (b) are preferred.

(a) Independent systems installed to cover the various spaces required.

(b) Single system of sufficient capacity for all required spaces simultaneously.

(c) Single system of sufficient capacity for the largest required space, distributed by valves at the controls.