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W. N. Zippler, Cranford, NJ

Alternates

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(Alternate to D. I. Reed)
Walter H. Johnson, National LP-Gas Association
(Alternate to R. J. Taylor)
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Alternates

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(Alternate to J. E. Lindak)
J. G. Blackburn, Jr., American Petroleum Institute
(Alternate to L. J. Whitfill)
James T. Carniaux, Marine Chemists Assn.
(Alternate to F. I. Grunder & C. H. Eure)
William J. Finnerty, Texaco
(Alternate to Eugene Sweeney)

Raymond Gottlieb, Peck Iron and Metal Co.
(Alternate to L. D. Miller)
Kenneth H. Hubbard, Marine Chemists Assn.
(Alternate to J. Sansing & G.A. Hale)
Donald S. Mc Ginnis, Ashland Oil
(Alternate to R. L. Gray)
A. Oxendine, U.S. Department of the Navy
(Alternate to W. D. Holtgren)

This list represents the membership at the time the Committee was balloted on the two-part Technical Committee Report. Since that time, changes in membership may have occurred.

The Report of the Committee on Marine Fire Protection is presented in two parts.

Part I, prepared by the Technical Committee on Motor Craft, proposes for a complete revision of NFPA 302-1972, Motor Craft (Pleasure & Commercial). NFPA 302 is published in Volume 10 of the National Fire Codes and in separate pamphlet form.

Part I has been submitted to letter ballot of the Committee on Motor Craft which consists of 18 voting members, of whom 17 voted affirmatively on the report. Mr. Zippler did not return his ballot.

Part I has also been submitted to letter ballot of the Committee on Marine Fire Protection, which consists of 14 voting members, of whom 12 voted affirmatively on the report. Mr. Kay did not return his ballot and Capt. Sammis abstained.

Part II, prepared by the Technical Committee on Gas Hazards, proposes for a complete revision of NFPA 306-1975, Control of Gas Hazards on Vessels to be Repaired. NFPA 306 is published in Volume 10 of the 1979 National Fire Codes and in separate pamphlet form.

Part II has been submitted to letter ballot of the Committee on Gas Hazards on Vessels to be Repaired, which consists of 18 voting members, of whom 15 voted affirmatively on the report. Messrs. Grunder and March abstained, and Mr. Blanding voted negatively on the report, as he felt Section 1-6.5 was not acceptable due to inconsistencies with CFR requirements.

Part II has also been submitted to letter ballot of the Committee on Marine Fire Protection, which consists of 14 voting members, of whom 11 voted affirmatively on the report. Messrs. Moses and Sammis abstained and Mr. Kay did not return a ballot.

302-1 - (Entire Standard): Accept
SUBMITTER: Technical Committee on Motor Craft
RECOMMENDATION: *Revise the entire standard known as:*
NFPA 302-1972, Motor Craft (Pleasure & Commercial).
SUBSTANTIATION: The revisions are necessary to obtain the benefits from the many technological advances and improvements in design, material, and equipment available today. Also, to comply with current U.S. Coast Guard requirements.

Standard on Fire Protection for
Pleasure and Commercial Motor Craft

NFPA 302-1980

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.

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.

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.

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 1/3 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 60 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.

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.

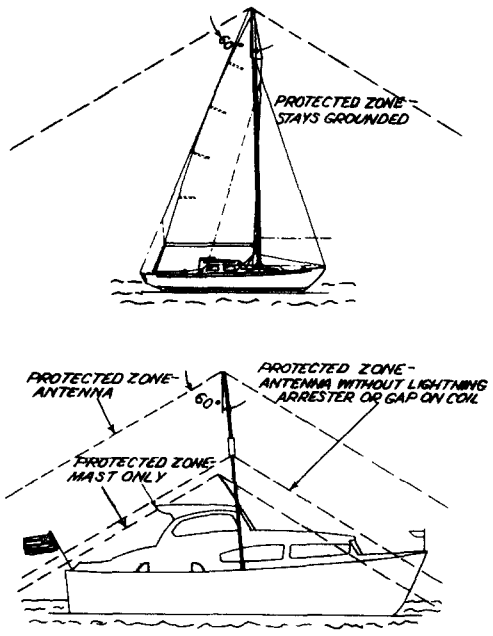


Figure 2-4.5.2

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.

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 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 2 1/2 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 2 1/2 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 -200F (-280C) to 185OF (850C).

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.

5-3.3 Metallic 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.

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.

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 oxyacetylene, 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.

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.

5-4.11 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 1 1/2 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 by capillary action.

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. Particular care shall be given to providing 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 1 1/4 in. (3.3 mm) (minimum hose diameter of 1 1/2 in. (3.8 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 1/2 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. (34 mm) 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.

6-3.2 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.

6-3.2 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 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 1/2 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 hot 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.

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 in machinery spaces, fuel tank spaces, or enclosed spaces containing joints, fittings, or other connections between 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 1 1/2 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% 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.	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
							Ft									
							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

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.	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
							Ft									
							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

7-10.2 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.

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 Definitions.

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 240oF (60oC). Where equipment is designed for use outside of machinery spaces in cabins or on decks, etc., the designed ambient temperature may be reduced to 104oF (40oC).

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 in machinery spaces, fuel tank spaces, or enclosed spaces containing joints, fittings, or other connections between fuel system components shall be ignition protected. (See Section 1-4, Grounding Conductor.)

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 1/4 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	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

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 screen.

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 receptacle is not readily accessible to serve as a shore power disconnect, a separate inlet, 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	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[2]
Boats 40-65 ft	B-I	4[1]	Engine compartment, helmsman's position, crew quarters, and galley[2]
Boats 65-75 ft	B-I	5[1]	Engine compartment, helmsman's position, crew quarters, and galley[2]
Boats 75-100 ft	B-I	6[1]	Engine compartment, helmsman's position, crew quarters, and galley[2]

[1]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.

[2]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 under the main deck or otherwise located so that the primary access is from above shall have a portable extinguisher or other approved fire-fighting device with provision for discharging the extinguishing agent from a position outside the engine compartment directly into the space immediately surrounding the engine without opening the primary access hatch.

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 For boats 26 ft and longer, the portable fire extinguisher 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 deck to avoid contact with moisture 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.

9-2.3.4 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

Appendix A

A-1-4 Ignition Protected. It is not the intent of this standard to require that electrical devices be "explosionproof", as defined in Article 100 of NFPA 70, National Electrical Code, or as defined in the Code of Federal Regulations, 46 CFR Part 110.

A-2-1.1 Extreme congestion of engine compartments is unsafe. For example, it should not be necessary to crawl over engines or auxiliary equipment for servicing purposes. Also, ventilating requirements may be increased with the addition of auxiliary equipment to an engine compartment.

A-2-1.5 The intent is to provide a sufficient quantity of air so as not to deplete oxygen levels in the accommodation spaces.

A-2-2.1 The use of marine fire retardant paints and varnishes is recommended for engine, fuel tank, and galley compartments.

A-2-3 Ventilation cannot be relied upon to remove all flammable vapors that are possible from fuel system failures (leakage). Accordingly, compliance with the ventilation requirements of this standard are only considered adequate when it has been determined that the entire fuel system complies with the requirements of Chapter 4.

A-2-4 For detailed information on protection of shore structures, see NFPA 78, Lightning Protection Code.

A-2-4.1 Grounding of a single shroud or stay to achieve lightning protection is not considered adequate due to the relatively poor conductivity of wire used in standing rigging.

A-2-4.3 Provisions for lightning protection are quite likely to receive scant attention and, therefore, their composition and assembly should be strong and materials should be highly resistant to corrosion.

A-2-4.5.3 Such a device is recommended.

A-3-1.8 Gravity fuel systems are prohibited by the provisions of Chapter 5.

A-5-4.14 Suitable galvanic barriers for this purpose are 300 series stainless steel, nonmetallic material meeting the fire test requirements, and galvanized steel fittings that have been galvanized after threading.

A-5-6.3.4 The identification should include the type of fuel used.

A-5-6.3.5.2 The purpose of this requirement is to preserve the fuel tightness at either end of the flexible section.

A-5-6.4.1 The purpose of this requirement is to minimize the amount of pressurized piping when the pump is operating.

A-5-6.4.3 Anti-siphon protection can be afforded by keeping all parts of the fuel distribution lines above the tank top from tank to the engine or motor well connection, by installing an anti-siphon valve at the tank withdrawal fitting, or by installing an electrically operated valve connected to the ignition circuit at the tank withdrawal fitting.

A-6 Open flame devices are more liable to careless, unskilled, or ignorant operation 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-6-4 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. LP-Gases liquefy under moderate pressure; they readily vaporize to the gaseous state upon relief of the pressure. Advantage of these characteristics is taken in their usage. For convenience, they are shipped and stored under pressure as liquids. In the gaseous state, LPG presents a hazard comparable to any flammable natural or manufactured gas, except that LPG vapors are heavier than air. Although vapors tend to sink to the bottom of an enclosed compartment into which they are released, they will diffuse throughout the compartment and will not be readily dispelled by overhead ventilation. Safety requires the prevention or escape of any LPG; when mixed with air in certain proportions, LPG will explode if ignited.

A-6-4.4.4 The purpose of the pressure gage 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 This standard recognizes that shore power voltage will vary in different geographic areas. The selection of motor operated equipment should consider operation on the following standard nominal systems:

(a) 120/208 volts, 60 Hz AC single and three phase

(b) 120/240 volts, 60 Hz AC single and three phase.

A-8-7.1 It is recommended that the system voltmeter be marked with voltage limit markings based on the voltage limits of the equipment on board.

A-8-12.1 This system utilizes directly the shore grounded and ungrounded conductors, together with both the shore grounding wire and the boat's ground to keep the exposed non-current-carrying parts of the system at ground potential. This system may be used on any nonmetallic hulled boat with underwater hardware of metal alloys which are galvanically compatible with normal marine bronzes. It may also be used with metal hulled boats if no problems of galvanic corrosion are anticipated or if protection against galvanic corrosion is provided by means of a suitable cathodic protection system.

A-8-12.2 The isolation transformer system utilizes an isolation transformer to conductively separate the shore feeder conductors from the electrical load circuits on the boat. The shore grounding conductor is used to ground the non-current-carrying parts of the isolation transformer, but is conductively separated from the boat's ground. This system should be used on all metal hulled boats where galvanic corrosion may occur and where other suitable means of protection against galvanic corrosion is not provided.

A-8-15 GFCIs may be used on AC circuits to provide additional protection for personnel and equipment.

A-8-15.1 GFCI breakers may be installed as panelboard feeder breakers to protect all associated circuits, or they may be installed in individual branch circuits. GFCI breakers may be installed as the main breaker on the primary side of isolation transformers. This GFCI will provide ground-fault protection only for the primary winding of the transformer.

A-8-15.2 GFCI receptacle devices may be installed as part of a convenience outlet installation either in single outlet applications or in multiple "feed-through" installations.

A-9-2.2 Similar installations are recommended for all other under deck enclosed spaces.

A-9-3.2 NFPA 11, 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, are examples of applicable NFPA standards.

A-9-3.2.2 Dual manual controls, well separated, are recommended whether the system is designed for manual or automatic operation.

Appendix B Fire Extinguishers

B-1 Classification of Fires.

For all practical purposes, the four general classes of fire are:

Class A Fires. Fires in ordinary combustible material such as wood, cloth, paper, rubber, and many plastics, where the "quenching-cooling" effect of quantities of water or solutions containing large percentages of water is most effective in reducing the temperature of the burning material below the ignition temperature and is, therefore, of first importance.

Class B Fires. Fires in flammable liquids, oils, greases, tars, oil base paints, lacquers, and flammable gases, where the "blanketing-smothering" effect of oxygen-excluding media is most effective.

Class C Fires. Fires involving energized electrical equipment where the electrical nonconductivity of the extinguishing media is of prime importance. (When electrical equipment is de-energized, extinguishers for Class A or Class B fires may be used safely.)

Class D Fires. Fires in combustible metals such as magnesium, titanium, zirconium, sodium, or potassium.
No further reference will be made to Class D fires due to the general absence of such exposure in motor craft. Detailed information on portable fire extinguishers may be found in NFPA 10, Standard for Portable Fire Extinguishers.

B-2 Classification of Fire Extinguishers.

Based on the classification of fires described above and on fire extinguishing potential as determined by physical testing by organizations acceptable to the authority having jurisdiction, classifications have been established for portable extinguishers. The U.S. Coast Guard also classifies portable fire extinguishers based on the above classification of fires, but using a different method of indicating extinguishing potential. (See Title 46, Code of Federal Regulations.)
The relative extinguishing 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 suitable is represented by the letters shown 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 assure best value and 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.)

Table B-2 Fire Extinguishers

Type of Extinguisher	Fire Suitability A	B	C	Subject to Freezing	Annual Maintenance Required[1]	Operating Precautions
Carbon Dioxide	No	Yes	Yes	No	Weigh and tag	Smothering in high concentrations. Avoid contact with discharge horn.
Dry	No	Yes	Yes	No	Weight to manufacturer's instructions, verify pressure and seal integrity, tag	None
Multi-Purpose Dry Chemical	Yes	Yes	Yes	No	Weight to manufacturer's instructions, verify pressure and seal integrity, tag	None
Foam	Yes	Yes	No	Yes	Discharge, refill, and tag	Do not use on live electrical equipment.

[1]In addition to frequent inspection to detect tampering, obstruction of discharge orifice, or other condition. See NFPA 10, Portable Fire Extinguishers.

B-3 Although presently using a rating system based on size and weight of extinguishing agent, the U.S. Coast Guard also considers extinguisher performance on marine-type fires. Those of inadequate performance are not listed as approved by the Coast Guard. Table B-3 lists the Coast Guard classification and relative unit size for the minimum size approved portable and semiportable fire extinguisher for use on flammable liquid fires.

Table B-3 U.S. Coast Guard Classification of Fire Extinguishers

Classification		Foam	Carbon Dioxide	Dry Chemical
Type	Size	gal	lb	lb
B	I	1 1/4	4	2
B	II	2 1/2	15	10
B	III	12	35	20

Appendix C Operation and Maintenance

C-1 The fire and explosion hazards of inboard powered boats are emphasized because of basic design and construction requirements. While ventilation for the removal of heavier-than-air flammable vapors ashore is provided at floor level, similar provisions are obviously impossible for boats. Accordingly, the operation and maintenance recommendations included in this Appendix are intended to supplement the standard.

C-2 Hull.

C-2.1 The entire boat should be kept clean and shipshape.

C-2.1.1 Frequent flushing and cleaning of bilges is recommended.

C-2.1.2 Clean waste and rags should be stowed in metal containers or in metal-lined lockers. Waste and rags coated with oil, paint, paint remover, or polish should be immediately disposed of ashore and not stored aboard.

C-2.1.3 Foul weather clothing should be hung loosely in well-ventilated lockers.

C-2.1.4 Paint and varnish removers and the material they remove are generally highly flammable. Particular caution should be exercised during their use to see that there is ample ventilation, no open lights, no fires, no smoking, and that the resulting removed material is quickly disposed of ashore.

C-2.1.5 Naked lights and open flames, however small, should not be carried into compartments where gasoline vapor may be present.

C-2.1.6 Gasoline or other flammable solvents should not be used for cleaning purposes.

C-2.2 The ventilation system should be maintained at top efficiency.

C-2.2.1 Ventilation ducts should never be blocked off and any screening used in cowl or duct openings should be kept clear.

C-2.2.2 If power exhaust blowers are installed, they should be operated not less than four minutes to free compartments of hazardous vapors before starting main or auxiliary engines.

C-2.2.3 Vent (open) the entire boat long enough to free the compartment of hazardous vapors before operating any appliances.

C-3 Engines.

C-3.1 Engines, including their fuel, electric, and cooling systems, should always be maintained in satisfactory operating condition in accordance with the manufacturer's instructions.

C-3.1.1 Before starting any engine:

(a) ventilate engine compartment

(b) open hatches to any compartment to which vapors may flow and make particular use of nose and eyes to detect fuel leaks

(c) check to see that lubrication oil reservoir is full

(d) check to see that engine cooling water intakes are open

C-3.1.2 When engine starts:

(a) check oil pressure

(b) make certain of cooling water circulation (e.g. check exhaust discharge)

C-3.1.3 During operation, make frequent observation checks of oil pressure and cooling water temperature.

C-4 Fuel Systems.

C-4.1 Gasoline vapors are heavier than air and will not escape from low lying pockets, such as bilges, unless drawn or forced out. An atmospheric concentration of gasoline vapor as low as 1.25 percent is sufficient to create a mixture which may be exploded by a slight spark.
The entire fuel system, tanks, piping (including tank vent line), and accessories should be frequently checked for leaks or evidence of corrosion.

C-4.1.1 All connections should be maintained tight at all times.

C-4.1.2 Fuel carried onboard outside of a fixed fuel system should be in an approved container or in a portable tank as provided for outboard engines and should be safely stowed outside of engine or living compartments.

C-4.2 Utmost care shall be exercised during fueling operations.

C-4.2.1 Fueling should never be done at night except under well-lighted conditions.

C-4.2.2 During fueling operations, smoking should be forbidden on board or anywhere nearby.

C-4.2.3 Before opening tanks, the following precautions should be observed:

(a) shut down engines, motors, and fans

(b) extinguish all open flames, including open pilot lights (see 6-4.6.2)

(c) close all ports, windows, doors, and hatches

(d) determine the quantity of fuel to be taken aboard in advance of fueling operations

C-4.2.4 The fuel delivery nozzle should be put in contact with the fill pipe before the flow of fuel is begun and this contact should be continuously maintained until fuel flow has stopped. There is a serious hazard from static discharge unless this rule is observed.

C-4.2.5 Tanks should be completely filled. Allow a minimum of 2 percent of tank space for expansion. The space allowance should be 6 percent if the fuel taken aboard is 32°F (0°C) or lower in temperature.

C-4.2.6 After fuel flow has stopped:

(a) tightly secure the fill cap

(b) wipe up any spillage completely and dispose of the rags or waste on shore

(c) ventilate all spaces and check for gasoline vapors before starting any engines or operating any appliances

C-5 Cooking, Heating, and Auxiliary Appliances.

C-5.1 All flame operated equipment should be kept clean and maintained in accordance with the manufacturer's instructions.

C-5.1.1 Gasoline should not be used for priming alcohol or kerosene burners, nor should gasoline or other flammable liquid be used for lighting-off coal, charcoal, or wood stoves.

C-5.1.2 Keep alcohol, kerosene, and fuel-oil burner tips clean to avoid choking, extinguishment, and consequent flooding.

C-5.1.2.1 Burners should not be primed when hot.

C-5.1.2.2 Limit reserve fuel to minimum needs, carried only in approved containers stowed in a safe location outside the engine compartment.

C-5.2 Printed instructions and labeled diagrams for the operation and maintenance of LPG systems should be available on board for ready reference.

C-5.2.1 Only the kind and specification of gas for which the system is designed should be used. The gas should be obtained from sources authorized by the manufacturer of the system.

C-5.2.2 Particular care should be taken against snuffing a flame from boilover, gusts of wind, or any other cause.

C-5.2.3 Changing of cylinders should be in accordance with the instructions which follow and under the supervision of licensed personnel when such officers are on board or by other responsible persons when no such officers are on board.

C-5.2.3.1 For single cylinder systems:

(a) close stop valves on cylinder and burn out gas content in line by light-all burners

(b) when burners go out, shut them off -- this is important

(c) disconnect empty cylinder leaving stop valve closed, and connect the full cylinder

C-5-2.3.2 For multicylinder systems:

(a) close both the cylinder stop valve and the stop valve in the line to the regulator

(b) burn out gas content in low pressure lines and proceed with cylinder change as described in C-5-2.3.1(c)

C-5-2.3.3 For both types of systems:

(a) after turning on the full cylinder, light all burners and allow to burn for a sufficient length of time to ensure that there is no air in the lines to interrupt a continuous flow of gas

(b) shut off burners and cylinder stop valve and test for leaks with soap suds

C-5.2.4 Frequent (at least twice monthly) tests of the entire system at service pressure should be made by closing cylinder valves and observing the gauge. If tight, there should be no noticeable drop in ten minutes. Trial for location of leaks should be made with soapy water solution - never with flame.

C-5.2.5 Empty cylinders should be kept closed by the means provided (stop valves or plugs) whether or not connected. Unconnected empties should be put ashore as soon as practicable.

C-6 Electrical System. Frequent inspection should be made of all electrical equipment and wiring to ensure against deterioration and faulty conditions such as loose connections, insulation failure, burned switch contacts, fuse replacements, bonding effectiveness, etc.
Battery terminals should be kept clean of corrosive deposits.

C-7 Fire Extinguishers -- Maintenance.

C-7.1 All fire extinguishers should be examined at regular intervals several times each year to make certain that they have not been tampered with and have not suffered corrosion or damage. Seals should be inspected to determine that the extinguishers have not been operated since last being charged. This examination can be carried out by most boat owners or operators; however, for more than a casual inspection for obvious deficiencies, it is recommended that a qualified fire extinguisher repairman service fire extinguishers at least once a year and after each use.

C-7.2 Foam-type extinguishers should be discharged, cleaned, inspected for mechanical defects or serious corrosion, and recharged annually.

C-7.3 Dry chemical fire extinguishers should be kept full with specified weight of chemical at all times. Cartridges 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. Those provided with gages should be recharged when pressure falls below prescribed operating limits.

C-7.3.1 Extinguishers of this type should be refilled after each use, even though only partly discharged.

C-7.3.2 Before recharging, the discharge hose should be cleaned of all chemical.

C-7.3.3 Extinguishers of this type should be manually shaken at least every six months to avoid packing that may develop.

C-7.4 Carbon dioxide fire extinguishers should be reweighed semiannually and cylinders in fixed carbon dioxide systems should be reweighed at least annually but preferably every six months. If found to be lighter than the weight indicated on the nameplate, cylinders should be tightened and recharged.

C-7.4.1 Extinguishers of this type should always be recharged after each use, even though only partly discharged.

C-7.4.2 Extinguishers of this type and cylinders in fixed systems should be provided with tags showing date weighed, weight found, and weigher's signature.

C-7.5 Portable extinguishers should be hydrostatically tested in accordance with the requirements of NFPA 10, Standard for Portable Fire Extinguishers.

C-8 Fire Extinguishers -- Operation.

C-8.1 For Class A fires, such as those in bedding, cushions, acoustic materials, and wood, carbon dioxide and dry chemical extinguishers may be used to temporarily keep the fire under control. However, water is the best means of extinguishment. The fire should be drenched and material should be opened up to expose burning embers and drenched again until extinguished or smoldering material can be thrown overboard. Alcohol fuel galley fires can also be extinguished with water.

C-8.2 For Class B fires in flammable liquids such as gasoline, diesel fuel, or kerosene, carbon dioxide, Halon 1211, Halon 1301, dry chemical, or foam extinguishers are the most effective means of extinguishment.

C-8.2.1 Foam fire extinguishers are carried to the fire in the vertical position, inverted, and set in operation at the fire. If the fire involves a flammable liquid, the operator should stand back to allow the foam to fall on the fire without much force, since flames may otherwise be unnecessarily spread. While primarily intended for use on Class B fires, foam extinguishers are also effective on Class A fires, in which case the full force of the stream may be used.

C-8.2.2 Dry chemical fire extinguishers are provided with a nozzle or horn for spraying the dry chemical in a dense cloud from about 5 to 15 ft from the extinguisher for small fires and from farther away for larger fires. 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, working toward the far edge. For running or dripping fires from leaks in fuel tanks or lines, extinguishment should be started at the lower part of the fire, working upwards. Leakage should be stopped as quickly as possible. For use on obstructed fires, such as in engine rooms, the discharge must be applied near the base of the fire to be effective. Such applications are not always possible.

C-8.2.3 Carbon dioxide fire extinguishers are provided with a horn for applying the discharge close to the base of the flames. For open fires in flammable liquids, the discharge should be applied in a slow sweeping motion to the near edge of the flames at their base, working toward the far edge. For running or dripping fires from leaks in fuel lines or tanks, extinguishment should be started at the lower part of the fire, working upwards. Leakage should be stopped as soon as possible.

C-8.2.4 Fixed carbon dioxide fire extinguishing systems are provided for either manual operation or for combined manual and automatic operation. The manual release should be used without waiting for the automatic release to operate if a fire occurs aboard an attended vessel. Persons should not remain below during or after discharge of the system as the effects can be dangerous to life. All hatches, ports, doors, or other openings to areas covered by a fixed system should be closed prior to release, if possible.

C-8.3 For Class C fires involving electrical equipment, circuits should be de-energized first by opening main switches, pulling shore line plugs, etc. Use dry chemical, carbon dioxide, Halon 1211, or Halon 1301 extinguishers. Do not use water or foam extinguishers due to danger of electrical shock to the operator or shorting of the electrical circuits.

C-9 Emergency Equipment. Pyrotechnics should be stored in a dry place in a suitable waterproof container and should be inspected frequently for signs of deterioration. Any sign of deterioration should be cause for replacement.

Appendix D Referenced Publications

D-1 This portion of the Appendix lists publications referenced within this NFPA document...and thus is considered part of the requirements of this document.

D-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

NFPA 11A-1976, Standard for High Expansion Foam Systems (Expansion Ratios from 100:1 to 1000:1)

NFPA 12-1977, Standard on Carbon Dioxide Extinguishing Systems

NFPA 12A-1977, Standard on Halogenated Fire Extinguishing Agent Systems -- Halon 1301

NFPA 17-1975, Standard for Dry Chemical Extinguishing Systems

NFPA 70-1978, National Electrical Code

NFPA 701-1977, Standard Method of Fire Tests for Flame-Resistant Textiles and Films

D-1.2 Other Publications.

ANSI C73, Dimensions of Attachment Plugs and Receptacles, American National Standards Institute, 1430 Broadway, New York, NY 10018.

IEEE Standard 45, Recommended Practice for Electric Installations on Shipboard, Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854

SAE Standard J378B, Marine Engine Wiring, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096

SAE Standard J557, High-tension Ignition Cable, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096

SAE Standard J1127, Battery Cable, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096

SAE Standard J1128, Low-tension Primary Cable, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096

UL 83, Thermoplastic-Insulated Wires, Underwriters Laboratories Inc., 33 Pfingsten Road, Northbrook, IL 60062

UL 943, Ground-Fault Circuit Interrupters, Underwriters Laboratories Inc., 33 Pfingsten Road, Northbrook, IL 60062

D-2 This portion of the Appendix lists publications which are referenced within this NFPA document for information purposes only...and thus is not considered part of the requirements of the document.

NFPA 10-1978, Standard for Portable Fire Extinguishers

NFPA 78-1977, Lightning Protection Code

Code of Federal Regulations, 46 CFR Part 110

306-1 - (Title): Accept
SUBMITTER: Technical Committee on Gas Hazards
RECOMMENDATION: Delete "To be Repaired" from the title.
SUBSTANTIATION: NFPA 306 covers entry into hazardous compartment spaces for reasons other than repairs.
COMMITTEE ACTION: Accept.

306-2 - (Entire Standard): Accept
SUBMITTER: Technical Committee on Gas Hazards
RECOMMENDATION: Completely revise NFPA 306, title as indicated below:
NFPA 306-1975, Control of Gas Hazards on Vessels To Be Repaired.
SUBSTANTIATION: 1-1.5 The Committee considered it necessary to more specifically spell out entry into all hazardous compartment spaces on all marine vessels.
2-1.3 Residues from previous cargoes have caused serious casualties when not recognized and/or considered.
2.2 - 2-4.2 The Committee considered it necessary to more completely spell out the purpose, intent and requirements of the Marine Chemist Survey Certificate.
Chapter 5 In view of the advent of the Marine Flammable Cryogenic Liquid Carriers, the committee considers it necessary to add standards for this operation to NFPA 306.

Standard for the Control of Gas Hazards on Vessels
NFPA 306-1980

NOTICE

An asterisk (*) following the number designating a subdivision indicates explanatory material on that subdivision in Appendix A.

Chapter 1 General

1-1 Scope.

1-1.1 This standard applies to vessels carrying or burning as fuel flammable or combustible liquids. It also applies to vessels carrying or having carried flammable compressed gases, chemicals in bulk, or other products capable of creating a hazardous condition.

1-1.2 This standard describes the conditions required before a space may be entered or work may be started on any vessel under construction, alteration, repair, or for shipbreaking.

1-1.3 This standard applies to cold work, application or removal of protective coatings, and work involving riveting, welding, burning, or like fire-producing operations.

1-1.4 This standard applies to vessels while in the United States, its territories, and possessions, both within and outside of yards for ship construction, ship repair, or shipbreaking.

1-1.5 The standard applies specifically to those spaces on vessels which are subject to concentrations of combustible, flammable, and toxic liquids, vapors, gases, and chemicals as hereinafter described. This standard is also applicable to those spaces on vessels which may not contain sufficient oxygen to permit safe entry.

1-2 Purpose. The purpose of this standard is to provide minimum requirements and conditions for use by the Marine Chemist in determining that a space or area on a vessel is safe for entry or work.

1-3* Emergency Exception. Nothing in this standard shall be construed as prohibiting the immediate drydocking of a vessel whose safety is imperiled, as by being in a sinking condition or by having been seriously damaged, making it impracticable to clean and gas free in advance.

1-4* Governmental Regulations. Nothing in this standard shall be construed as superseding existing requirements of any governmental or local authority. Attention of owners, repairers, and chemists is directed to the "Rules and Regulations for Tank Vessels" and other rules and regulations for vessel inspection of the United States Coast Guard and the "Occupational Safety and Health Standards" of the United States Department of Labor which prescribe an inspection prior to making repairs involving riveting, welding, burning, or similar fire-producing operations and prior to entering spaces where oxygen deficiency may exist. Those standards provide, under the conditions stated therein, for inspection by a Marine Chemist certificated by the National Fire Protection Association or, alternatively, inspection by certain other persons.

1-5 Definitions. Unless expressly stated elsewhere, the following terms shall, for the purpose of this standard, have the meanings indicated below.

Chemical. A chemical is any compound, mixture, or solution in the form of a solid, liquid, or gas, which may be hazardous by virtue of its properties other than or in addition to flammability or by virtue of the properties of compounds which might be evolved from hot work or cold work.

Flammable Compressed Gas. Any flammable gas which has been compressed and/or liquefied for the purpose of transportation and has a Reid vapor pressure exceeding 40 psia.

Hollow Structures. Rudders, rudder stocks, skegs, castings, masts and booms, rails, and other attachments to a vessel which enclose a void space.

Marine Chemist. The holder of a valid Certificate issued by the National Fire Protection Association in accordance with the "Rules for Certification of Marine Chemists" establishing him as a person qualified to determine whether construction, alteration, repair, or shipbreaking of vessels, which may involve hazards covered by this standard, can be undertaken with safety.
Activities of a Marine Chemist, as defined in this subsection, are limited to the inspection and certification procedures described in this standard and consulting services connected therewith.

Marine Chemist's Certificate. A written statement issued by a Marine Chemist in the form and manner prescribed by this standard. It states the conditions which the Marine Chemist found at the time of his inspection.

Materials.

(a) Flammable Liquid. Any liquid having a flash point (closed cup) below 80°F (26.6°C) and having a vapor pressure not exceeding 40 psi absolute (2068.6 mm Hg) at 80°F (26.6°C).

1. Grade A. Any flammable liquid having a Reid vapor pressure of 14 lb or more.

2. Grade B. Any flammable liquid having a Reid vapor pressure under 14 lb and over 8 1/2 lb.

3. Grade C. Any flammable liquid having a Reid vapor pressure of 8 1/2 lb or less and a flash point of 80°F (26.6°C) or below.

(b) Combustible Liquid. Any liquid having a flash point (open cup) at or above 80°F (26.6°C).

1. Grade D. Any combustible liquid having a flash point below 150°F (65.5°C) and above 80°F (26.6°C).

2. Grade E. Any combustible liquid having a flash point of 150°F (65.5°C) or above.

(c) Toxic Materials. Any liquid whose properties contain the inherent capacity to produce injury. This is dependent on concentration, rate, method, and site of absorption, general state of health, and individual differences.

Repair Classifications.

(a) Hot Work. Any construction, alteration, repair, or shipbreaking involving riveting, welding, burning, or similar fire-producing operations. Grinding, drilling, sand or shot blasting, or similar spark-producing operations shall be considered hot work except when circumstances do not necessitate such classification.

(b) Cold Work. Any construction, alteration, repair, or shipbreaking which does not involve heat, fire, or spark-producing operations.

(c) Work Below Deck. Work in or on enclosed spaces surrounded by shell, bulkheads, and overheads.

(d) Work in the Open. Work performed from open decks or in spaces from which the overhead has been completely removed.

Secured. Closed in such a manner as to avoid accidental opening or operation.

Shipbreaking. The breaking down of a vessel's structure for the purpose of scrapping the vessel; includes the removal of gear, equipment, or any component part of a vessel.

Tanker Designations.

(a) Tank Vessels. Any vessel especially constructed or converted to carry liquid bulk cargo in tanks.

(b) Tank Ship. Any tank vessel propelled by power or sail.

(c) Tank Barge. Any tank vessel not equipped with a means of self-propulsion.

Vessel. Includes every description of watercraft used, or capable of being used, as a means of transportation on water.

1-6 Standard Safety Designations. The following standard safety designations shall be used where applicable in preparing Marine Chemist's Certificates, cargo tank labels, and other references.

1-6.1 Safe for Men. Means that in the compartment or space so designated:

(a) The oxygen content of the atmosphere is at least 19.5 percent by volume; and that,

(b)* Toxic materials in the atmosphere are within permissible concentrations; and that,

(c)* The residues are not capable of producing toxic materials under existing atmospheric conditions while maintained as directed on the Marine Chemist's Certificate.

1-6.2 Safe for Hot Work. Means that in the compartment so designated:

(a) The oxygen content of the atmosphere is at least 19.5 percent of volume, with the exception of inerted spaces; and that,

(b)* The concentration of flammable materials in the atmosphere is below 10 percent of the lower flammable limit; and that,

(c) The residues are not capable of producing a higher concentration than permitted by 1-6.2(b) under existing atmospheric conditions in the presence of fire, and while maintained as directed on the Marine Chemist's Certificate; and, further, that,

(d) All adjacent spaces have been cleaned sufficiently to prevent the spread of fire, are satisfactorily inerted, or, in the case of fuel tanks, have been treated in accordance with the Marine Chemist's requirements.

1-6.3 Safe for Shipbreaking. Means that the compartment so designated:

(a) Shall meet the requirements of 1-6.2(a) through (d).

(b) The residual combustible materials designated are not capable of producing fire beyond the extinguishing capabilities of the equipment on hand.

1-6.4 Inerted. Means that one of the following procedures has been completed in the compartment or space so designated:

(a)* Carbon dioxide or other nonflammable gas acceptable to the Marine Chemist has been introduced into the space in sufficient volume to maintain the oxygen content of the atmosphere of the enclosed space at or below 8.0 percent.

(b) The space has been flooded with water, provided that any hot work is performed at least 3 ft below the water level and, further, provided that the gas content of the atmosphere above the water does not exceed 10 percent of the lower flammable limit and such procedure is approved by a Marine Chemist.

(c) The kind of gas and the safe disposal or securing gas inerting media shall be noted on the Marine Chemist's Certificate by the Marine Chemist upon completion of repairs. Closing and securing of hatches and other openings, except vents, may be considered as "safe disposal" by the Marine Chemist.

1-6.5 Inerted for Flammable Compressed Gas. Means that individual pressure tanks with a working pressure of 50 psi or more are considered in a safe condition for such work not directly involving these tanks or their pipelines when a positive pressure is maintained on the tanks by the flammable vapors remaining after the cargo has been discharged.

Chapter 2 Minimum Requirements Precedent to the Issuance of Marine Chemist's Certificate - - Applicable in All Cases

2-1 The Marine Chemist Shall Personally Determine Condition. Before a Marine Chemist may issue a Certificate setting forth in writing that the prescribed work to a vessel can be undertaken with safety, the Marine Chemist shall personally determine that the applicable minimum requirements have been complied with to his satisfaction.

2-1.1 The calibration of all instruments used by the Marine Chemist shall be checked before and after each day's use. A record shall be maintained on all calibration checks.

2-1.2 The Marine Chemist's determination shall include a visual internal inspection and tests of the spaces to be certified and adjacent spaces thereto.

2-1.3 The Marine Chemist's determination shall include such tests as are appropriate to designations of Section 1-6, and determinations shall include:

(a) The three previous cargoes carried

(b) The nature and extent of the work

(c) Starting time and duration of the work

(d) Tests of cargo and vent lines at manifolds and accessible openings

(e) Assurance that cargo valves are tagged and secured in such a manner as to avoid accidental opening or operation

(f) Tests of cargo heating coils at the main deck level.

2-1.4 Tanks that have carried Grade E liquids whose flash point is 200°F (93.3°C) or above may be partially cleaned for minor hot work. Such spaces and adjacent spaces directly affected shall be cleaned back a sufficient distance from the work to meet the requirements of 1-6.2(d). The remainder of the space and adjacent spaces shall meet the requirements of 1-6.2.(a), 1-6.2.(b), and 1-6.2.(c).

2-2 Preparation of Certificates. When the Marine Chemist is satisfied that the requirements of this standard and any other requirements necessary in order that the prescribed work can be undertaken with safety have been carried out, a Marine Chemist's Certificate shall be prepared in form and manner prescribed by this standard.

2-2.1 The Certificate shall include the frequency and type of such additional tests, inspections, qualifications, and other instructions as the Marine Chemist specifies.

2-2.2 The Certificate shall state conditions under which the Marine Chemist should be consulted or recalled.

2-2.3 Such qualifications and requirements shall include precautions, including protective equipment and devices, necessary to eliminate or minimize hazards that may be present from protective coatings or residues from cargoes.

2-3 Issuance of Certificates.

2-3.1 The Marine Chemist's Certificate shall be completed and a signature for receipt of the Certificate shall be obtained, signifying the understanding of the conditions and limitations under which it is issued, before any hot work may commence.

2-3.2 It is the responsibility of the person in charge of repairs or his representative to securely post the Certificate in a conspicuous place aboard the vessel.

2-3.3 All Certificates shall be issued within 24 hours prior to the time the prescribed work is commenced, unless otherwise noted on the Marine Chemist's Certificate.

2-4 Responsibility for Obtaining Certificate.

2-4.1 It is the responsibility of the vessel repairer or shipbreaker to retain the services of the Marine Chemist, to secure copies of his Certificate, and to provide the master of the vessel and the representatives of the vessel owner with copies of such Certificate. Receipt and understanding of the Certificate shall be acknowledged by signature.

2-4.2 Throughout the course of repairs or alterations, safe conditions shall be maintained on the vessel by full observance of all qualifications and requirements listed by the Marine Chemist.

Chapter 3 Mandatory Requirements for Vessels

3-1 Vessels to Be Repaired.

3-1.1 Tank Vessels.

3-1.1.1 Tank vessels may be repaired when cleaned or cleaned and inerted in accordance with the provisions in 3-3.1 or 3-3.2 respectively. A Marine Chemist's Certificate to this effect shall be required. Repairs or alterations involving hot work shall not be undertaken unless specifically authorized by the Marine Chemist's Certificate.

Exception No. 1: Tank vessels may enter a repair yard for examination afloat or in dry dock, provided that all bulk cargo compartments and cofferdams are kept closed.

Exception No. 2: Tank vessels may enter a repair yard for scraping, washing down, and painting, afloat or in dry dock, provided that all bulk cargo compartments and cofferdams are kept closed.

Exception No. 3: Tank vessels may enter a repair yard for work (hot or cold) to be performed outside of the vessel, afloat or in dry dock, on the propeller, tailshaft, or rudder or for work to be performed off the vessel, such as on the anchors or chains, provided that all bulk cargo compartments and cofferdams are kept closed.

Exception No. 4: Tank vessels may enter a repair yard, afloat or in dry dock, for work within boiler and machinery spaces and/or other locations provided that, where hot work is to be undertaken, a Marine Chemist's Certificate shall be required. This Certificate shall set forth each specific location for which hot work is approved. All bulk cargo compartments, cofferdams, and/or other areas where the flammable content of the atmosphere is above 10 percent of the lower flammable limit shall be kept closed and secured. The securing of the compartments, cofferdams, and other areas shall be noted on the Marine Chemist's Certificate.

Exception No. 5: Tank vessels which proceed to a dry dock or special berth selected with due regard to the hazards of the location and to hazards to adjacent property may undergo specific limited repairs of a local nature when the compartments or spaces involved and the adjacent compartments or spaces are prepared in accordance with the provisions of 3-3.3 and 3-3.4.

3-1.2 Requirements for Use of a Special Berthing Area for Cleaning, Gas Freeing, or Inerting.

3-1.2.1 Vessels which have not been cleaned, gas freed, or inerted shall proceed to a special berth, selected and set apart with due regard to the hazards of the location and to hazards to adjacent property.

3-1.2.2 The degassing, cleaning, or inerting of vessels at such special berths shall be carrried out in accordance with the requirements of 3-3.1 or 3-3.2 before they are shifted to other berths. No repairs involving hot work, other than in boiler or machinery spaces when specifically certified by a Marine Chemist, shall be undertaken on any vessel in such special berth until it has been degassed and cleaned or inerted in accordance with the requirements of 3-3.1 or 3-3.2 nor shall such repairs be then undertaken if another vessel, which has not complied with these requirements, is in the special berth at the same time.

3-1.3 Vessels Carrying Flammable Compressed Gas. On any vessels which have carried flammable compressed gas in bulk, no repairs or alterations involving hot work shall be made unless the provisions of 3-1.1.1 have been complied with, provided, however, individual pressure tanks, inerted in accordance with 1-6.5, are considered in a safe condition for such work not directly involving these tanks or their pipelines.

3-1.4 Vessels Other than Tank Vessels.

3-1.4.1 On any vessels which have carried flammable or combustible liquid in bulk as fuel or cargo, or cargoes which may produce hazardous atmospheres (including, but not limited to, those of decomposition or reaction with oxygen from the atmosphere), no repairs involving hot work shall be made in and on the external boundaries (shell, tank top, or deck) of cargo tanks, fuel tanks, oil pipelines, and heating coils or hollow structures, unless such compartment and pipelines, deemed necessary by the Marine Chemist, have been cleaned or inerted to meet the appropriate designation requirements of Section 1-6 and 1-6.4. Repairs and alterations shall not be undertaken until a Marine Chemist's Certificate is obtained.

3-2 Electric Welding Operations. For all electrical welding operations, grounded cables shall be connected to the ship's structure, as close as possible to the point of welding, with a safe current-carrying capacity equal to or exceeding the specified maximum output capacity of the unit which it services.

3-3 Minimum Requirements for Issuance of a Marine Chemist's Certificate.

3-3.1 Where a Safe Condition Is to Be Obtained Entirely by Cleaning. (See Appendix B.)

3-3.1.1 All steam supplied cargo heater coils shall be made safe by steaming, flushing with water, blowing with air, or inerting.

3-3.1.2 All cargo pumps, cargo lines, piped cargo fire extinguishing systems, and vent lines shall have been flushed with water, blown with steam or air, or inerted.

Exception: Coils in cargo tanks that have been used for chemicals that may react with water or steam shall be cleaned in accordance with the requirements of 4-3.2.

3-3.1.3 For coiled vessels using thermal heating oils (FP 500°F+ (260°C+)) or above, the condition of the heater coils shall be verified by pressure testing of coils under the heater's normal operating conditions.

3-3.1.4 Compartments concerned shall be so cleaned that the atmosphere in all cargo compartments and other spaces subject to gas accumulation is in accordance with 1-6.1 and/or 1-6.2, as applicable.

Exception: Spaces covered by 2-1.4.

3-3.1.5 The residue in all compartments concerned (with the exception of tanks containing Grade E liquids whose flash point is 200°F (93.3°C) or above) shall be such that the conditions of 1-6.1 and/or 1-6.2, as applicable, shall be met.

3-3.1.6 Satisfactory compliance with all the foregoing requirements shall be noted on the Marine Chemist's Certificate.

3-3.2 Where a Safe Condition Is to Be Obtained by Both Cleaning and Inerting or Entirely by Inerting. (See Appendix B.)

3-3.2.1 The Marine Chemist shall approve the use of the inerting medium and shall personally supervise introduction of the inerting medium into the space to be inerted, except in situations where an inerting medium has been introduced prior to the vessel's arrival at the repair facility. A Marine Chemist, in all cases, shall personally conduct tests to determine that the oxygen content of the inerted space is at or below 8 percent. The Marine Chemist shall be immediately available during the entire period of work, and he shall determine that the oxygen level in the inerted space is maintained at or below 8 percent. A Marine Chemist shall supervise the safe disposal or securing of the inerting medium following completion of the repair work on the inerted space and adjacent spaces.

3-3.2.2 All steam supplied cargo heater coils shall be made safe by steaming, flushing with water, blowing with air, or inerting. All piped cargo fire extinguishing systems within the cargo tanks and vent lines, except those in the inerted spaces, shall have been flushed with water, blown with steam or air, or inerted. (All valves to the inerted spaces shall be tagged and secured in such a manner as to avoid accidental opening or operation.) All cargo pumps and cargo lines shall have been flushed with water, blown with steam or air, or inerted.

Exception No. 1: Coils in cargo tanks that have been used for chemicals which may react with water or steam shall be cleaned in accordance with the requirements of 4-3.2.

Exception No. 2: For coiled vessels using thermal heating oils (FP 500°F+ (260°C+)), the condition of heater oil shall be verified by pressure testing of coils under the heater's normal operating conditions.

3-3.2.3 All spaces to be inerted shall be sufficiently intact to retain the inerting medium. All valves, hatches, and other openings to the inerted spaces, except those controlling the inerting medium, shall be closed and secured.

3-3.2.4 All access openings to an inerted space shall be appropriately labeled with a warning sign "Not Safe for Men", which shall remain in place throughout the course of repairs.

3-3.2.5 Compartments or spaces in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of 3-3.1 and all other spaces (with the exception of tanks containing Grade E liquids with a flash point of 200°F (93.3°C) or above) shall be inerted in accordance with the requirements of 1-6.4.

3-3.2.6 Compartments or spaces on which external repairs or alterations are to be undertaken on the external boundaries (deck or shell) may be inerted by gas instead of being cleaned as described in 3-3.2, and all other spaces (with the exception of tanks containing Grade E liquids with a flash point of 200°F (93.3°C) or above) shall be inerted in accordance with the requirements of 1-6.4.

3-3.2.7 Satisfactory compliance with all the foregoing requirements shall be noted on the Marine Chemist's Certificate.

3-3.3 Where a Safe Condition Is to Be Obtained Entirely by Cleaning Certain Compartments and by Securing the Other Compartments. (See Appendix B.)

3-3.3.1 Nonadjacent spaces containing atmospheres exceeding 10 percent of lower flammable limit shall be secured, and those spaces noted on the Marine Chemist's Certificate.

3-3.3.2 All steam supplied cargo heater coils to the spaces involved shall have been made safe by steaming, flushing with water, blowing with air, or inerting; all piped cargo fire-extinguishing systems and vent lines to the spaces involved shall have been flushed with water, blown with steam or air, or inerted, and the valves to all other compartments closed and secured. All cargo pumps and cargo lines shall have been

flushed with water, blown with steam or air, or inerted, and the valves closed and secured in such a manner as to avoid accidental opening or operation.

Exception: Coils in cargo tanks that have been used for chemicals which may react with water or steam shall be cleaned in accordance with the requirements of 4-3.2.

3-3.3.3 Compartments or spaces in which internal repairs or alterations are to be undertaken and all adjacent compartments, including those diagonally adjacent thereto, shall be cleaned to comply with the applicable requirements of 3-3.1. All other applicable spaces shall be closed and secured in such a manner as to avoid accidental opening or operation.

3-3.3.4 Satisfactory compliance with all the foregoing requirements shall be noted on the Marine Chemist's Certificate.

3-3.4 Where a Safe Condition Is to Be Obtained by Both Cleaning and Inerting or Entirely by Inerting Certain Compartments and by Securing the Other Compartments. (See Appendix B.)

3-3.4.1 All steam supplied cargo heater coils to the spaces involved, except those to the inerted spaces, shall have been made safe by steaming, flushing with water, blowing with air, or inerting; all piped cargo fire extinguishing systems and vent lines to the spaces involved, except those to the inerted spaces, shall have been flushed with water, blown with steam or air, or inerted; and the valves to all other compartments closed and secured in such a manner as to avoid accidental opening or operation. All cargo pumps and cargo lines shall have been flushed with water, blown with steam or air, or inerted, and the valves closed and secured in such a manner as to avoid accidental opening or operation.

Exception: Coils in cargo tanks that have been used for chemicals which may react with water or steam shall be cleaned in accordance with the requirements of 4-3.2.

3-3.4.2 Nonadjacent spaces containing atmospheres exceeding 10 percent of lower flammable limit shall be closed and secured in such a manner as to avoid accidental opening or operation, and those spaces noted on the Marine Chemist's Certificate.

3-3.4.3 Compartments or spaces in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of 3-3.1 and all adjacent compartments, including those diagonally adjacent thereto, shall be inerted to comply with the applicable requirements of 1-6.4 and all other compartments shall be closed and secured in compliance with 3-3.3.1.

3-3.4.4 Compartments or spaces on which external repairs or alterations are to be undertaken on the external boundaries (deck or shell) may be inerted by gas instead of being cleaned as described in 3-3.1. All adjacent compartments, including those diagonally adjacent thereto, shall be inerted or cleaned to comply with applicable requirements of 3-3.2. All other applicable spaces shall be closed and secured in compliance with 3-3.3.1.

3-3.4.5 Satisfactory compliance with all the foregoing requirements shall be noted on the Marine Chemist's Certificate.

Chapter 4 Additional Requirements for Bulk Chemical Cargo Tanks

4-1 Scope.

4-1.1 This section describes the conditions required before making repairs in spaces that have carried or have been exposed to chemicals in bulk. The remaining spaces in the vessel shall comply with the applicable provisions in Section 3-1.

4-1.2 The definitions set forth in Section 1-5 shall also apply to this chapter.

4-2 Minimum Requirements.

4-2.1 All minimum requirements for issuance of the Marine Chemist's Certificate set forth in Chapter 2 of this standard are applicable to spaces that have carried or have been exposed to chemicals in bulk.

4-2.2 The designation "Safe for Men" shall not be used for spaces that have carried material of unknown chemical hazards.

4-2.3 Results of chemical hazard tests shall be noted on the Marine Chemist's Certificate.

4-3 Minimum Conditions.

4-3.1 Minimum conditions which shall prevail prior to the issuance of a Marine Chemist's Certificate for spaces that have contained chemicals in bulk shall be as set forth in Section 3-3, insofar as they are applicable, and as set forth in this section.

4-3.2 All pipelines, including heating coils, fire extinguishing systems, and vents, together with the cargo pumps and cargo lines serving the chemical-carrying spaces, shall be initially dealt with to the satisfaction of the Marine Chemist. Care shall be exercised in the selection of methods and materials used for cleaning or inerting to avoid noncompatibility with previous cargoes.

4-3.3 Compartments having carried chemicals in bulk and which are to be cleaned shall be so cleaned that the atmosphere in those compartments is in accordance with 1-6.1 and 1-6.2 as applicable.

4-3.4 The residues in the compartments concerned shall be such that the conditions of 1-6.1 and 1-6.2, as applicable, will be met.

Chapter 5 Additional Requirements for Liquefied Natural Gas Carriers

5-1 Scope.

5-1.1 The design and operational characteristics of tank, cargo-handling, and related systems on vessels carrying flammable cryogenic liquid cargoes must be fully appreciated by the Marine Chemist in making the determinations required by Section 2-1 of this standard. This chapter describes the conditions required before making repairs in spaces that have carried or have been exposed to flammable cryogenic liquid cargoes in their liquid or vapor form.

5-1.2 This chapter supplements the factors to be considered prior to issuance of the Marine Chemist's Certificate in accordance with Section 2-1.

5-1.3 Special Endorsement Attesting to Marine Chemist's Qualifications. Only those Marine Chemists who have evidenced the required additional experience, training, and knowledge shall be authorized to issue certificates under the requirements of this chapter. Such Chemists shall receive a special endorsement on the Marine Chemist's Certificate issued them by the National Fire Protection Association.

5-2 Definitions.

5-2.1 The definitions set forth in Section 1-5 shall also apply to this chapter.

5-2.2 The following additional definitions are applicable:

Cargo Area. That part of the ship which contains the cargo containment system and cargo pump and compressor rooms and includes deck areas over the full beam and length of the ship above the foregoing. Where fitted, the cofferdams, ballast, or void spaces at the after end of the aftermost hold space or the forward end of the forwardmost hold space are excluded from the cargo area.

Cargo Containment System. The arrangement for containment of cargo including, where fitted, a primary and secondary barrier, associated insulation, and any intervening spaces and adjacent structure if necessary for the support of these elements. If the secondary barrier is part of the hull structure it may be a boundary of the hold space.

Cryogenic Liquid. A refrigerated liquefied gas having a boiling point colder than -130°F (-90°C).

Gas-Dangerous Space or Zone:

(a) A space in the cargo area which is not arranged or equipped in an approved manner to ensure that its atmosphere is at all times maintained in a gas-safe condition

(b) An enclosed space outside the cargo area through which any piping which may contain liquid or gaseous products passes or within which such piping terminates, unless approved arrangements are installed to prevent any escape of product vapour into the atmosphere of that space

(c) A cargo containment system and cargo piping

1. A hold space where cargo is carried in a cargo containment system requiring a secondary barrier

2. A hold space where cargo is carried in a cargo containment system not requiring a secondary barrier

(d) A space separated from a hold space described in (c) 1, above, by a single gas-tight steel boundary

(e) A cargo pump room and cargo compressor room

(f) A zone on the open deck, or semienclosed space on the open deck within 9.84 ft (3 m) of any cargo tank outlet, gas or vapour outlet, cargo pipe flange, cargo valve, or entrances and

ventilation openings to cargo pump rooms and cargo compressor rooms

(g) The open deck over the cargo area and 9.84 ft (3 m) forward and aft of the cargo area on the open deck up to a height of 7.88 ft (2.4 m) above the weather deck

(h) A zone within 7.88 ft (2.4 m) of the outer surface of a cargo containment system where such surface is exposed to the weather

(i) An enclosed or semienclosed space in which pipes containing products are located

(j) A compartment for cargo hoses

(k) An enclosed or semienclosed space having a direct opening into any gas-dangerous space or zone.

Hold Space. The space enclosed by the ship's structure in which a cargo containment system is situated.

Interbarrier Space. That between a primary and secondary barrier, whether or not completely or partially occupied by insulation or other material.

Primary Barrier. The inner element designed to contain the cargo when the cargo containment system includes two boundaries.

Secondary Barrier. The liquid-resisting outer element of a cargo containment system designed to afford temporary containment of any envisaged leakage of liquid cargo through the primary barrier and to prevent the lowering of the temperature of the ship's structure to an unsafe level.

5-3 Minimum Requirements.

5-3.1 All minimum requirements for issuance of the Marine Chemist's Certificate as set forth in Chapter 2 of this standard shall be met prior to commencement of hot work or entry in spaces that have carried or been exposed to flammable cryogenic liquids or their vapors.

5-3.2 Special Safety Designation. The special safety designation "Safe for Repair Yard Entry" applies only to flammable cryogenic liquid carriers and describes vessels whose compartments and spaces have been tested by sampling at remote sampling stations, and results indicate the atmosphere tested to be above 19.5% oxygen and less than 10% of the lower flammable limit or are inerted in accordance with 1-6.4. Issuance of a Marine Chemist's Certificate bearing this designation does not impinge upon requirements of Section 1-4 of this standard as applicable.

5-3.3 Vessels whose cargo containment systems have not met the criteria of 5-3.2 may undergo specific limited repairs in locations outside the "gas-dangerous spaces or zones." However, such repairs or alterations shall not be undertaken until a Marine Chemist's Certificate is obtained.

5-3.3.1 When undergoing repairs in accordance with 5-3.3 the vessel shall be berthed in a special location selected with due regard to the hazards of the location and to hazards to adjacent property. Should the Marine Chemist have reason to question the safety of any aspect of the site selection he shall consult the proper governmental authorities.

5-3.4 Interbarrier spaces or insulation may contain pockets of cargo vapors which can be released over varying time periods. The Marine Chemist shall inspect for gas concentration and combustible materials before work in or on the boundaries of such places is begun.

5-3.5 The following information shall be used by the Marine Chemist as a guide for making his inspection:

(a) Description and schematic arrangement of provisions for inerting cargo tanks, hold spaces, or interbarrier spaces, as applicable

(b) Description and instruction manual for calibration of the cargo leak detector equipment

(c) Schematic plan showing locations of leak detector(s) and sampling points

(d) Schematic plan(s) of liquid and vapor cargo piping

(e) U. S. Coast Guard Letter of Compliance and Certificate of Fitness for foreign flag vessels or the Certificate of Inspection and Certificate of Fitness for U.S. flag vessels

(f) The recent history of cargoes handled with special reference to outturn and any pertinent unusual incidents encountered.

5-4 Minimum Conditions.

5-4.1 Minimum conditions which shall prevail prior to the issuance of a Marine Chemist's Certificate for spaces that have contained or been exposed to flammable cryogenic liquids or their vapors shall be as set forth in Section 3-3, insofar as they are applicable, and as set forth in this section.

5-4.2 When vessels are undergoing repairs, no venting of cargo tanks, systems, or other spaces which may contain inert gas or flammable vapors shall take place without approval of the Marine Chemist. Any other activity which may similarly alter the atmosphere in the vicinity of the repair work may only be undertaken with such approval.

5-4.3 Vessels that are capable of burning cargo boil-off as a fuel for their main propulsion system or for other purposes shall be inspected to assure that gas supply lines to the fire room or other spaces have been properly secured, inerted, or otherwise properly treated, prior to repairs to this system.

5-4.4 Prior to the opening of cargo machinery or systems for repairs, such equipment shall have been adequately purged and ventilated to remove cargo vapor or inert gas.

Appendix A

This Appendix is not a part of the requirements of this NFPA standard ... but is included for information purposes only.

A-1-3 In all emergency situations, all necessary precautionary measures should be undertaken as soon as practical to provide safe conditions satisfactory to the Marine Chemist.

A-1-4 All applicable regulations, requirements, and standards should be consulted.

A-1-6.1(b) Refer to Threshold Limit Values for Chemical Substances and Physical Agents, American Conference of Governmental Industrial Hygienists, Cleveland, OH, 1977.

A-1-6.1(c) See A-1-6.1(b) above.

A-1-6.2(b) The terms "lower flammable limit" and "lower explosive limit" are used synonymously. Refer to NFPA 325M, Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids, National Fire Protection Association, Boston, MA, 1977.

A-1-6.4(a) The improper introduction of an inerting gas can generate sufficient static electricity for ignition.

REVISED 4/5/79

(LETTERHEAD)

MARINE CHEMIST SURVEY CERTIFICATE

Survey Requested by	Owner or Agent	Certificate Serial No.
Vessel	Type of Vessel	Date
Location of Vessel		Test Method
Last Three (3) Cargoes		Time Survey Completed

In the event of any physical or atmospheric changes adversely affecting the gas-free condition of the above spaces, or if in any doubt, immediately stop all work and contact the undersigned.

QUALIFICATIONS: Transfer of ballast or manipulation of valves or closure equipment tending to alter conditions in pipe lines, tanks or compartments subject to gas accumulation, unless specifically approved in this Certificate, requires inspection and endorsement or reissue of Certificate for the spaces so affected. All lines, vents, heating coils, valves, and similarly enclosed appurtenances shall be considered "not safe" unless otherwise specifically designated.

STANDARD SAFETY DESIGNATIONS

SAFE FOR MEN. Means that in the compartment or space so designated: (a) The oxygen content of the atmosphere is at least 19.5 percent by volume; (b) Toxic materials in the atmosphere are within permissable concentrations; and (c) The residues are not capable of producing toxic materials under existing atmospheric conditions while maintained as directed on the Marine Chemist's certificate.

SAFE FOR HOT WORK. Means that in the compartment so designated: (a) The concentration of flammable materials in the atmosphere is below 10 percent of the lower flammable limit; and that, (b) The residues are not capable of producing a higher concentration than permitted by 1-6.2.1 under existing atmospheric conditions in the presence of fire and while maintained as directed on the Marine Chemist's certificate; and further, (c) All adjacent spaces have either been cleaned sufficiently to prevent the spread of fire, are satisfactorily inerted, or, in the case of fuel tanks, have been treated as deemed necessary.

CHEMIST'S ENDORSEMENT: This is to certify that I have personally determined that all spaces in the foregoing list are in accordance with NFPA No. 506 Control of Gas Hazards on Vessels and have found the condition of each to be in accordance with its assigned designation.

This Certificate is based on conditions existing at the time the inspection herein set forth was completed and is issued subject to compliance with all qualifications and instructions.

Signed _____

Marine Chemist Certificate No.

The undersigned acknowledges receipt of this certificate and understands the conditions and limitation under which it was issued.

Signed _____

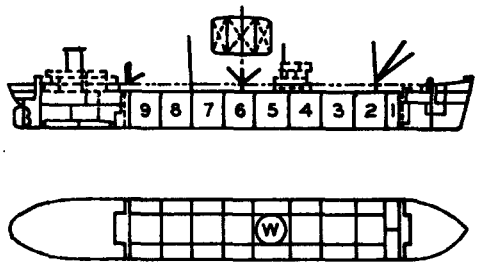
Company *Date* *Time*

NOTE: THIS CERTIFICATE IS VALID ONLY ON MARINE VESSELS

Appendix B

This appendix is not a part of the requirements of this NFPA standard ... but is included for information purposes only.

These illustrations are examples of safe conditions discussed in this standard. Although the single plane drawings show horizontal separations only, vertical compartmentation should be similarly treated.



3-3.1 Safe Condition Obtained Entirely by Cleaning.

3-3.2 *Safe Conditions Obtained by Cleaning and Inerting.*

3-3.3 Safe Condition Obtained Entirely by Cleaning and Securing.

3-3.4 Safe Conditions Obtained by Cleaning, *Inerting and Securing.*