NFPA No.
302

MOTOR CRAFT

(PLEASURE & COMMERCIAL)

1964

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National Fire Protection Association

International

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Fire Protection Standard for

Motor Craft

(Pleasure and Commercial)

NFPA No. 302 — 1964

1964 Edition of NFPA No. 302

This edition of the NFPA Fire Protection Standard for Motor Craft was adopted at the 1964 Annual Meeting of the Association held in Dallas, Texas, May 18–22. It supersedes the 1960 Edition. Currently, the standard is under the jurisdiction of the Sectional Committee on Motor Craft which reports to the Association through the NFPA Committee on Marine Fire Protection.

Origin and Development of NFPA No. 302

This Fire Protection Standard for Motor Craft represents the cumulative result of forty years of attention to fire safety of power boats by the NFPA. The first edition of this standard was adopted by the Association in 1925. Amended in 1926 and 1930, a revised edition was adopted in 1936. Eleven successive editions were adopted between 1939 and 1960. The present text is an extensive revision of the 1960 edition, incorporating many significant amendments.

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Fire Protection Standard for Motor Craft

(PLEASURE & COMMERCIAL)

NFPA No. 302 — 1964

INTRODUCTION.

There are few other uses of petroleum fuels by the public in which the fire and explosion hazards parallel those possible in motor craft. The purpose of this Standard is to provide guidance for the prevention of fuel leakage, the elimination of possible sources of vapor ignition from particularly dangerous locations, the provision of adequate means for keeping vital areas ventilated at all times, the avoidance of unnecessary use of combustible materials in exposed locations and the provision of proper fire extinguishing equipment.

This Standard indicates what is currently considered good practice toward making motor craft as free from the fire hazard as practicable. It is intended that it serves as a guide for that purpose. Where strict compliance results in practical difficulty, exception from literal interpretations may be made, if equivalent protection is otherwise secured.

An important part in effective fire protection for motor craft involves the avoidance of metal deterioration from corrosion. Most motor craft are operated under conditions highly conducive to electro-chemical corrosion and the importance of selecting materials resistant to that action is emphasized. In general, connected metals should be close together in the galvanic series and connected combinations of metals separated in the series must be avoided. Table 1 provides reference data on the galvanic series of metals.

Definitions.

SHALL OR MUST indicate provisions considered essential. SHOULD and PREFERRED indicate advisory provisions which may also be written as recommendations. Any question relative to such provisions should be referred to the authority having jurisdiction.

APPROVED — acceptable to the authority having jurisdiction.

ACCESSIBLE — capable of being reached for proper inspection, maintenance or removal without disturbance of permanent hull structure.

READILY ACCESSIBLE — capable of being reached quickly and safely for effective use under emergency conditions and reached conveniently under normal conditions.

Other definitions or explanations of terms having specific application are included in the various chapters.

Table 1.

GALVANIC SERIES OF METALS.

CORRODED END (*anodic, or least noble*)	
Magnesium	
Zinc	
Aluminum	
Cadmium	
Steel or Iron	
Cast Iron	
Chromium-iron (active)	
Lead-tin solders	
Lead	
Tin	
Nickel (active)	
Brasses	*
Copper	*
Bronzes	*
Copper-nickel alloys	*
Nickel-copper alloys	*
Silver solder	
Nickel (passive)	
Chromium-iron (passive)	
Silver	
Graphite	
Gold	
Platinum	
PROTECTED END (*cathodic, or most noble*)	

*The metals and alloys bracketed are considered the best to use together in marine application.

PART I — GASOLINE POWERED BOATS

CHAPTER 1. HULL

11. Arrangement.

111. The arrangement of the hull shall be such that all compartments are as accessible as practicable, and that escape hatches are unobstructed, readily accessible and adequate for the designed purpose. Extreme congestion of engine compartments is unsafe — for example, it should not be necessary to crawl over engines or auxiliaries for servicing purposes. Also, it is to be emphasized that ventilating requirements increase with the addition of auxiliary machinery.

(a) Engine compartments should be separated from the rest of the hull by bulkheads sufficiently tight to serve as effective fire breaks.

(b) Bilges of machinery and fuel tank spaces should be separated from bilges of accommodation spaces by tight bulkheads.

(c) Adequate provisions should be made for drainage of bilges. Sufficient drain outlets and bilge pump suctions should be installed to facilitate complete flushing and cleaning of bilges, whether hauled out or afloat.

(d) Access hatches to machinery and tank compartments shall not be obstructed by deck coverings, or secured furniture.

112. Passages through accommodation spaces should be as free from obstruction as possible and means for escape shall be provided both forward and aft.

113. The galley or area used for galley purposes within a multiple purpose compartment shall be so laid out as to assure adequate ventilation.

12. Finishing and Insulating Materials.

121. Materials used for acoustical or thermal insulation of compartments shall have a flame spread of 25 or less.

(a) Materials used for finishing interior surfaces should be fire retardant, or as a minimum, flame proofed.

122. Within the galley area fabrics used for decorative or other similar purposes shall be noncombustible.

123. The use of approved fire retardant paints and varnishes is recommended for engine, fuel tank, and galley compartments.

13. Ventilation.

For the purpose of this section, *Ventilation* is defined as induction of a directed current of air by natural or mechanical means in distinction from venting which only provides openings for escape without provision for induction. *Induction* as used above, means the creation of a current of air from outside to outside through the length of compartment and not mere turbulence.

131. Any compartment or space in which an engine or a fuel tank is located, particularly the lower portion and bilges, shall be provided with ventilation capable of preventing and effective to remove accumulation of flammable or explosive vapor.

132. The following provisions are recommended for compartment ventilation:

(a) Permanently open and unobstructed inlet and outlet ventilating ducts extending to bilges should be installed with two ducts serving as inlets leading to the wings at one end of the compartment and two ducts serving as outlets from the wings at the opposite end.

(b) Cross sectional areas of the individual ventilation ducts within a compartment should be the same. The aggregate inlet area and the aggregate outlet area should each be proportioned approximately to the beam of the boat with 2 square inches of aggregate inlet or outlet duct area per foot of beam as the minimum.

(c) Exterior terminations of all ventilating ducts should be provided with unobstructed cowls or equivalent fittings having minimum openings equal to the ducts. Flush or recessed inlets and transom louver outlets do not comply with this requirement.

(d) Exterior terminations of all ventilating ducts should be so located as to prevent the return of displaced vapors to any enclosed space, and to avoid the pickup of vapors from fuel filling operations.

(e) A preferred arrangement utilizes the after ventilating ducts as inlets and the forward ventilating ducts as outlets, with the cowls of the after (inlet) ducts trimmed forward and on a higher plane than the cowls of the forward (outlet) ducts which are trimmed aft. The relative difference in elevation between the inlet cowl opening and the outlet cowl opening should be a minimum of 4 inches.

133. The fitting of outlet ventilating ducts with wind actuated self trimming or rotary exhauster heads, or with power operated exhaust blowers is recommended.

(a) Power exhaust blowers shall be approved for marine use and installed as high above bilges as possible. Location of power exhaust blowers just under the deck at side is recommended with

inspection or repair access provided by easily removable panels or otherwise.

14. Lightning Protection.*

141. Metallic fittings at extremities of wooden masts and yards should be effectively grounded and all metallic structural parts or accessories of any appreciable size, installed on the spars, should be connected to the grounding conductor.

(a) The grounding conductor should have conductivity equal to or greater than No. 8 copper cable, should be essentially straight, terminate in a sharp point at least six inches above the mast, and be led as directly as practicable to a ground plate attached to the wetted surface of the hull.

(b) Metallic standing rigging, metal masts, and any continuous metallic track on masts or booms, should be grounded in accordance with the above.

NOTE: Lightning protection provisions are quite likely to receive scant attention and therefore their composition and assembly should be strong and materials used should be highly resistant to corrosion.

142. Radio antennas shall be equipped with transmitting type lightning arresters or with means for grounding during electrical storms.

(a) The grounding of metal rod type radio antennas constitutes sufficient protection for wooden boats without masts and spars, provided a line drawn from the top of the antenna downward at an angle of 60 degrees to the vertical does not intercept any part of the boat. Antennas with loading coils are considered to end at a point immediately below the loading coil unless the coil is provided with a suitable gap for bypassing the lightning current.

(b) Nonconducting antenna masts with spirally wrapped conductors are not considered suitable for lightning protection purposes.

143. A metal hull provides an adequate ground, and if there is good metal to metal contact between hull and metal masts, no further protection from lightning is necessary.

(a) Ungrounded objects projecting above metal masts or metal superstructures should be bonded to them.

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*For detailed information on protection of shore structures, see the Lightning Code (NFPA No. 78), published by the National Fire Protection Assn.

CHAPTER 2. ENGINES

21. 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 marine load under such requirements without exceeding their designed limitations.

211. Engine head, block and exhaust manifold shall be water jacketed and cooled by water from a pump which operates whenever the engine is operating except as provided in Paragraph 218.

212. Carburetors shall be of an approved marine type.

(a) Except for the down-draft type, carburetors shall have integral or properly connected drip collectors of adequate capacity. Drip collectors shall be drained by a device for automatic return of all drip to engine intakes.

(b) Air intakes should be turned upward at approximately 45 degrees providing a substantial sump which will meet the requirement for integral drip collector.

(c) Air intakes must be fitted with an approved means of backfire flame control.

213. Engine electrical components shall comply with applicable parts of Chapter 5.

(a) Electrical components shall be so mounted on engines as to be well above bilges and as remote as practical from the fuel system.

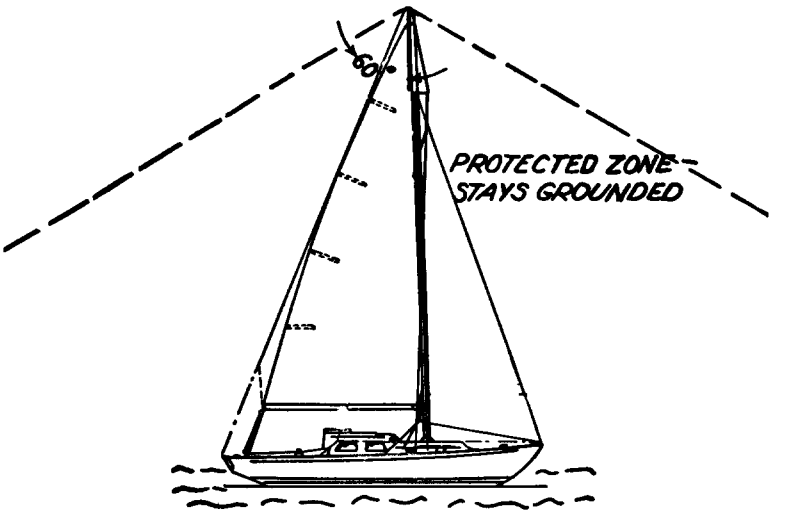
214. An approved marine type strainer in addition to the hull strainer should be installed in the circulating water intake line.

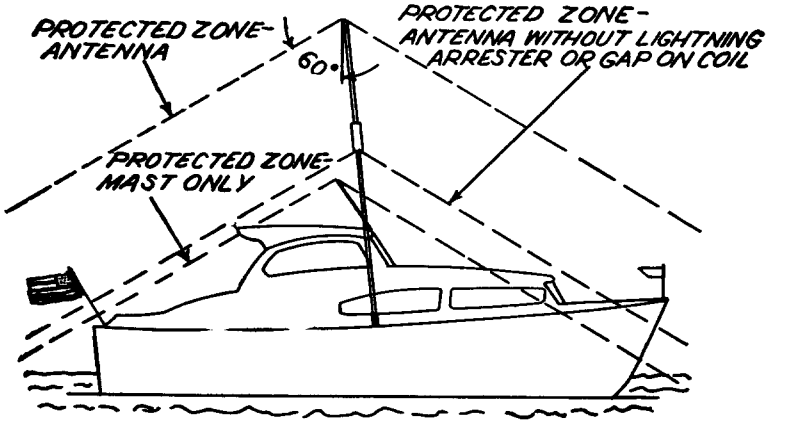
215. Gages to indicate cooling water discharge temperature shall be provided for all propulsion engines and be located so as to be in view of the operator.

(a) Gages to indicate lubricating oil pressure shall be provided for all propulsion engines having pressure lubricating systems and they shall be located so as to be in view of the operator.

216. Fresh water cooling of engines may be used provided exhaust is cooled in accordance with Section 23.

(a) Air cooled radiators for engine cooling water shall not be used.





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 the 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.

217. Crank cases shall have sufficient mass and rigidity for marine service.

(a) Cast iron or cast steel is recommended.

218. Air-cooled engines may be used for propulsion, provided:

(a) Carburetors and electrical components are in compliance with Paragraphs 212 and 213.

(b) The fuel system is in compliance with Chapter 3.

(c) The exhaust system complies with applicable parts of Section 23.

(d) A suitable audible or visual device is installed to warn of excessive engine temperature.

219. When air-cooled engines are enclosed, the following provisions shall also apply:

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

(b) Air used for engine cooling shall be discharged outside the hull by a duct system, designed and installed to prevent entry of water.

22. Auxiliary Engines.

Auxiliary engines and their accessory equipment shall comply with those provisions of Section 21 not inconsistent with this Section.

221. Air-cooled gasoline engines providing primary power for generators or other auxiliaries may be used under deck provided the installations comply with Paragraphs 218 and 219.

222. Permanently installed air-cooled engines with self-contained fuel systems may be used only on open decks outside coamings or on cabin tops, and any housing over such units shall be open whenever engine is in operation.

223. Portable engines shall be secured when in use, and when not in use shall be stowed so that fuels or vapors cannot reach interior spaces.

23. Engine Exhaust Pipe Systems.

231. Definitions.

(a) EXHAUST PIPE SYSTEM — A means by which the product of combustion is conducted from an engine exhaust manifold to an outboard terminus.

NOTE: This system may be comprised of either wet or dry exhaust pipe, metallic and nonmetallic pipe, including related accessories such as mufflers, silencers, spark arresters and all necessary connecting and supporting fittings.

(b) WET EXHAUST — The product of combustion into which cooling water has been injected.

(c) DRY EXHAUST — The product of combustion into which no liquid coolant has been injected.

(d) WET EXHAUST PIPE SYSTEM — A system designed to conduct wet exhaust products.

(e) DRY EXHAUST PIPE SYSTEM — A system designed to conduct dry exhaust products.

(f) SILENCER OR MUFFLER — A specially designed and baffled chamber installed in an exhaust system for purposes of noise attenuation.

232. General.

(a) Exhaust pipe systems shall be:

(1) Gastight to hull interiors.

(2) Designed and installed to prevent water, from the sea or the cooling system, returning to the engine.

(3) So accessible that they can be inspected and repaired throughout their length.

(4) Supported so as to prevent undue stresses that may cause fractures.

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

(c) Hangers, brackets, and other supporting components shall be of fire resistant materials and be installed so as to prevent transmission of heat to adjacent combustible materials.

(d) An audible or visual device shall be provided to warn of excess heat in any water-cooled exhaust pipe not served by engine or heat-exchanger circulating water pumps.

(e) A separate exhaust system shall be provided for each engine of multiple engine installations.

(1) A separate exhaust system for each exhaust manifold is recommended, except that a water-jacketed "Siamese" header may be used for dual manifold engines, providing that the cross sectional area of the pipe in which the exhaust gases blend is equal to twice the area of the exhaust manifold outlet to each bank of cylinders. The design of the unit shall be such that it does not create turbulence in that part of the system where the exhaust gases blend.

233. Materials.

(a) Materials used in engine exhaust pipe systems shall be of adequate strength and durability. They shall be resistant to gasoline, to products of combustion, to salt water corrosion and to the highest temperatures which may be encountered. Where materials are in contact, they shall be galvanically compatible.

(b) Where flexibility is necessary, corrugated or bellows-type metallic flexible exhaust pipe sections are preferred.

(c) Nonmetallic flexible tubing may comprise the major part of a wet exhaust system. Such tubing shall be approved for marine engine exhaust pipe usage.

234. Installation — Wet Systems.

(a) Water for cooling wet exhaust pipe shall be injected as near the engine exhaust manifold as practicable. Injection shall be sufficiently below the manifold and so directed as to prevent spray and steaming in the manifold.

(b) That part of the system between the point of cooling water injection and the engine exhaust manifold shall be water-jacketed or protected as provided for dry exhaust systems.

(c) Wet exhaust pipe piercing combustible bulkheads or partitions, should have a minimum clearance of two inches and if the bulkhead is classed as water-tight, glands with fire resistant packings should be used.

235. Installation — Dry Systems.

(a) Where dry exhaust pipe pierces combustible bulkheads, partitions or decks, a minimum clearance of nine inches shall be maintained around the exhaust pipe, or it shall be properly water-jacketed, insulated by fire resistant covering or such bulkheads, decks and partitions may be properly protected by adequate airspace and metallic shielding.

(b) Dry exhaust pipe systems shall be fitted with silencers or mufflers having spark arresting properties.

(c) Provision for removing rain or sea water that may enter a dry exhaust pipe should be made.

CHAPTER 3. FUEL SYSTEMS

30. Because of the fire and explosion hazards from leaking fuel in boats it is imperative that the materials used, the design, the construction and the installation of all parts of fuel systems be to the highest standards. Fuel systems shall be liquid and vapor-tight with respect to hull interiors.

31. Fuel Tanks.

Fuel tanks shall not be integral with the hull structure. They shall be approved and labeled for marine use.

311. Materials.

(a) All fuel tanks shall be constructed of materials of suitable mechanical characteristics to withstand the stresses and exposures of marine service.

(b) Recommended metallic materials with recommended minimum plate thicknesses for gasoline fuel tanks are listed in Table 2. Any departure from these should be specifically approved. Tanks having capacities larger than 150 gallons should be designed to withstand the maximum pressures to which they may be subjected, but in no case should the material thickness be less than recommended for tanks of 81 to 150 gallon capacities.

312. Design and Construction.

(a) For maximum strength, cylindrical tanks with convex or concave heads are preferable.

(b) Tanks shall have no openings in bottoms, sides or ends. Openings for fill, vent and feed pipes, and openings for fuel level gages where used, shall be on topmost surface of tanks. Cleanout plates shall not be installed.

(c) Tank top surfaces shall be so designed that they will not hold moisture.

(d) All connections to tank shall be liquid and vaportight and have sufficient flange area to provide good local reinforcement.

(e) Baffle plates shall be provided where necessary, for strength or to prevent excessive surge of contents.

(1) Baffles shall be of the same material as the tank walls and at least equal in strength.

(2) The attachment of baffles to tank walls shall be such as to prevent failure from flexing or vibration. For metal tanks the attachment shall be accomplished by a method recommended in Paragraph 312(f) for metal tank seams.

(f) Tank seams for metal tanks shall be ductile, pore free and made by one of the following methods:

(1) Fusion welded-metal arc (See Table 2, Note 3), shielded arc, atomic hydrogen, oxy-acetylene.

(2) Seam welded (Resistance Weld) — Continuous weld nuggets should have 5% to 20% overlap for gasoline-tight joint.

(3) Brazed — Silver or bronze solders.

(4) Riveted and brazed — Lap or lock seam with rivets of same composition as metal being joined and external heads and all joints brazed with silver or bronze solder.

(g) All tanks shall be fitted with a substantial bonding terminal.

313. Locations.

(a) Fuel tanks shall be accessibly located.

(b) Fuel tanks shall not be located within living quarters and should be separated therefrom by bulkheads as tight as practicable.

Table 2.

MINIMUM PLATE THICKNESS FOR GASOLINE FUEL TANKS.

MATERIAL	SPECIFICATION	TANK CAPACITIES	
		1 to 80 gal.	81 to 150 gal.
Nickel-copper	B127-61 Class A	.037 in 20 G	.050 in 18 G
Copper-nickel	B122-60 Alloy – 5	.045 in 17 G	.057 in 15 G
Copper	B152-60 Type ETP	.057 in. 15 G	.080 in. 12 G
Copper-Silicon	B97-55 Types A, B & C	.050 in. 16 G	.064 in. 14 G
Steel sheet	A93-59T	.0747 in. 14 G	.1046 in. 12 G

Note 1. Specifications are those of the American Society for Testing and Materials.

Note 2. Gages used above are U. S. Std. for nickel-copper, AWG. for copper, copper-nickel and copper-silicon, Mfrs. Standard for steel.

Note 3. No. 18 (U. S. Std.), .050 in. nickel-copper is the lightest recommended for metal arc welding.

Note 4. No. 20 (U. S. Std.), .037 in. nickel-copper is only recommended for oxy-acetylene, shielded arc, atomic hydrogen, and electric resistance seam welding, and brazed joints or riveted and brazed joints.

Note 5. No. 22 (U.S. Std.), .031 in. nickel-copper may be used for tanks up to 30 gallons capacity provided they are formed with electric resistance seam welds.

(c) Tank locations adjacent to engine compartments are preferable.

(d) Tanks shall not be integral or attached to engines except as permitted in Paragraph 222.

314. Installation.

(a) Installation of fuel tanks shall be such as to comply fully with the requirement of accessibility, and to permit examination, testing or removal for cleaning with minimum disturbance to hull structure.

(1) If tank locations are such as to prevent ready inspection of label plates, small hatches or deck plates shall be provided for that purpose.

(b) Tanks shall not be enclosed by sheathing nor shall they be set on tight flooring covering all bottom surface.

(c) Tanks shall be placed in a dry well ventilated location.

(d) Flat bottom tanks should be supported throughout their entire length.

(e) All fuel tanks shall be adequately supported and braced to prevent movement. Small tanks may be suspended from deck beams.

(f) Contact between fuel tanks and other structure should be limited to the necessary supports in order to permit free circulation of air. 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.

(g) All fuel tanks shall be electrically bonded to the common ground.

32. Fuel Pipes and Related Accessories.

For the purpose of this section *Fuel pipes* shall mean all pipe lines, tubing or hose that are conductors of fuel from the deck filling plate to the engine connection. *Related accessories* shall include any attachments to fuel pipes, such as valves, strainers, pumps, connecting fittings, etc.

321. General.

(a) Fuel pipes shall be accessible. Fuel pipe connections and accessories shall be readily accessible.

(b) Fuel pipes shall be adequately secured against excessive movement or vibration.

(c) Outlets for drawing gasoline below deck for any purpose shall be prohibited.

(d) When making up threaded pipe connections an approved sealing compound, resistant to gasoline, shall be used.

(e) When making flared tube connections, it is essential that tubing be cut squarely and be truly flared by tools designed for those purposes. Tube ends shall be annealed before flaring.

322. Materials.

(a) All fuel pipes, fuel vent lines and related accessories shall be of such composition as to be highly resistant to corrosion and capable of withstanding approximately 1800°F (free-burning gasoline) for 2½ minutes.

(b) Fuel pipes of copper, nickel-copper, or copper-nickel, shall be seamless annealed tubing with minimum wall thickness of .035 inches.

(1) Where flexibility is desired, approved flexible hose especially designed for high resistance to salt water, petroleum oils, heat and vibration may be used.

(2) Fill pipes associated with galvanized steel fuel tanks may be of galvanized steel pipe.

(c) Fuel line connections including those in vent lines shall be made with fittings approved for marine fuel system use.

(d) Valves, strainers and other accessories shall be approved for marine fuel system use.

(e) Clips or straps for securing fuel pipes shall be of materials complying with Paragraph 322(a) and have no rough surfaces or sharp edges in contact with the piping.

323. Installation of Fill and Vent Pipes.

(a) Fill and vent pipes shall be so arranged that overflow of liquid or vapor cannot escape to inside of hull, cabin or coamings and will flow overboard.

(b) Fill pipe shall be not less than ½ inches I.P.S. It shall be made tight to tank top and to deck plate located outside of coaming.

(1) Fill pipe should run as directly as possible, preferably in a straight line from deck plate or other closeable plate to tank top spud and may extend to near bottom of tank provided it is suitably supported.

(2) Fuel fill shall be identified by a permanent marking on the deck plate flange.

(c) Where a flexible fill pipe section is necessary, an approved metallic type is recommended. When a nonmetallic section is used, it shall be in accordance with Paragraph 322(b)1. It shall be tightly

secured at each end by two suitable clamps of corrosion-resistant metal. Flexible section shall be accessible and as near the upper end of the filling pipe as practicable.

(1) When the flexible section is a nonconductor of electricity the metallic sections separated thereby shall be joined by a conductor for protection against static spark when filling.

(d) When, because of offset, sounding of tanks through fill pipes is impossible, other methods of indicating fuel level must be used provided Paragraph 312(b) is complied with and provided they are so arranged as not to expose the liquid or vapor in cabin, cockpit, or underdeck, or to permit vapor to drift below.

(e) Vent pipe should terminate as remotely as practicable from any hull opening, and have provision for preventing intake of water without resisting release of vapor.

(f) Vent pipe connection shall be from highest point of tank as installed in boat, under conditions of normal trim.

(1) Vent pipe shall not be tapped into the fill pipe.

(g) The minimum internal diameter of the vent pipe shall be $\frac{9}{16}$ inches and if the fill pipe extends to near the tank bottom, the minimum internal diameter should be $1\frac{1}{16}$ inches.

(h) Vent pipe outlets shall have removable flame screens. Screens shall be of corrosion resistant wire of at least 30 x 30 mesh, and of such size and design as not to reduce the net vent area.

324. Installation of Fuel Feed Lines and Accessories.

(a) Engine-driven mechanical fuel systems shall be used except that independent electric pump systems may be used provided they are energized only when engine ignition is on.

(b) Fuel lines shall be run with as few connections as practicable and shall be protected from mechanical injury.

(1) Fuel lines should be run and secured so that in event of a break there will be no siphoning of fuel.

(c) A shutoff valve shall be installed to close against fuel flow directly at the tank connection. This valve may be electrically or manually operated. If electrically operated it shall be energized only when engine ignition is on and have provision for manual override. If a manual type is used, an arrangement shall be provided for operating it from outside the compartment in which tanks are located, preferably from above deck.

(1) A manually operated service stop valve shall be installed at engine end of fuel line to stop fuel flow when servicing accessories.

(d) That part of the fuel feed line secured to hull members shall be separated from that part secured to the engine by a flexible section approved for marine fuel system use. That flexible section should maintain metallic contact between the connected parts of the fuel line. If such contact is not maintained, the fuel tank shall be specifically grounded.

(e) All accessories, not including fittings, installed in the fuel line shall be independently supported.

CHAPTER 4. COOKING, HEATING AND AUXILIARY APPLIANCES

40. Open flame devices are more liable to promiscuous, 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.

41. Cooking Equipment.

411. 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 consuming appliance, where it may be readily read.

(a) Stoves shall be installed in adequately ventilated areas to comply with Paragraph 113.

(b) Stoves shall be securely fastened when in use and when stored.

(c) Any burner system that may affect safety by reason of motion of the boat shall not be used.

(d) All woodwork or other combustible materials above stove tops and all woodwork or combustibles immediately surrounding the deck effectively insulated with a noncombustible material or sheathing.

412. Coal, Charcoal and Wood Burning Stoves.

(a) Installation of this type of stove should preferably be on a hollow tile base. If not, it must be mounted on legs providing clearance of at least 5 inches between stove bottom and deck, and the deck effectively insulated with a noncombustible material or sheathing.

(b) Stove sides and back must have a minimum clearance of 4 inches from the insulation provided in accordance with Paragraph 411(d).

(c) Smoke pipes or stacks shall maintain a minimum clearance of 5 inches from all woodwork. They shall be equipped with suitable water-irons where they pierce decks and shall be insulated in accordance with Paragraph 411(d).

(d) Smoke pipes or stacks shall terminate with approved smokeheads designed to prevent water entry, spark emission, and back draft.

(e) Fuel shall be stowed in a ventilated metal-lined locker or bin.

413. Alcohol, Fuel Oil and Kerosene Stoves.

(a) Either pressure or gravity fed burners are permissible.

(b) Fuel supply tanks shall be constructed of corrosion resistant metal with welded or brazed joints and fittings.

(1) Pressure tanks integrally installed with stoves shall withstand a test pressure of at least 200 pounds per square inch gage.

(2) Pressure tanks integrally installed with stoves shall be effectively protected from the heat of the burners.

(3) Pressure tanks for remote installation shall be approved and be able to withstand a test pressure of at least 100 pounds per square inch gage.

(4) Pressure tanks remotely installed shall be rigidly secured in an accessible location permitting convenient filling and pump operation.

(5) Gravity tanks shall be substantially secured and should be remote from stoves. In any event, 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 burners.

(6) No gravity tank shall have a capacity exceeding 2 gallons. Tanks of larger capacity shall be in accordance with Section 31.

(7) Gravity tanks should have provision for filling and venting outside galley space.

(c) When 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.

(d) If solidified fuel is used, the containers shall be properly secured on a fixed base to prevent sliding or overturning in a sudden roll of the vessel.

414. Gasoline Stoves.

Stoves using liquid gasoline for fuel shall not be used aboard boats.

42. Liquefied Petroleum Gas Systems.

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. Under moderate pressure the gases liquefy; upon relief of the pressure they are readily converted into the gaseous state. Advantage of this characteristic is taken in their usage, and for convenience they are shipped and stored under pressure as liquids. In their gaseous state they present a hazard comparable to any flammable natural or manufactured gas, except that they are heavier than air. Although the vapors tend to sink to the bottom of an enclosed compartment into which they are released, they will diffuse throughout, and are not readily dispelled by overhead ventilation. Safety requires the prevention of escape of any liquefied petroleum gases, for when mixed with air in certain proportions they will explode if ignited.

NOTE: Attention is invited to U. S. Coast Guard regulations which prohibit the use of liquefied petroleum gas on certain vessels.

421. Definitions.

(a) LIQUEFIED PETROLEUM GAS(ES) — The terms "liquefied petroleum gases," "LPG," and "LP-Gas" as used herein shall mean and include any product predominantly composed of any of the following hydrocarbons: propane, propylene, butanes (normal butane or isobutane), and butylenes, or a mixture thereof.

(b) SYSTEM(S) — for purposes of this section shall mean all component parts including gas consuming appliances.

422. General.

(a) Liquefied petroleum gas systems shall be designed and installed in accordance with provisions outlined herein and shall be subject to inspection and approval of the authority having jurisdiction.

(b) Only systems of the vapor withdrawal type are permitted. Containers designed or installed so as to admit liquid gas into any other part of the system are prohibited.

(c) 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.

(d) 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 concentration in air of not over one-fifth the lower limit of combustibility.

(e) All component parts of systems other than containers and low pressure distribution tubing between regulators and appliances shall be listed for marine use by a nationally recognized testing agency.

(f) All component parts of systems, subject to container pressures shall have a rated working pressure of at least 250 pounds per square inch gage.

(g) With each liquefied petroleum gas system installed on a boat, at least two of the signs required by Paragraph 411 shall be provided. These signs shall include:

CAUTION

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 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.

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 liquid detergent or soapy water solution at all connections. Repeat test for each container in multi-container system. NEVER USE FLAME TO CHECK FOR LEAKS.

(h) The required caution signs shall be installed in plainly visible locations, (1) on the outside of each container enclosure and (2) adjacent to each consuming appliance.

423. Containers.

(a) Containers shall be constructed, tested, marked, maintained, requalified for continued service, and refilled:

(1) In accordance with the regulations of the Interstate Commerce Commission for containers for LP-Gas service, or

(2) In accordance with equivalent specifications or regulations determined by the authority having jurisdiction.

(b) 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.

424. Valves and Safety Relief Devices.

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

(b) All containers shall be provided with safety relief devices as required by ICC regulations or equivalent thereto.

(c) Container valves and safety relief devices shall have direct connection with the vapor space of the cylinder.

(d) 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.

(e) Discharge of the safety relief valves shall be vented away from the container(s) into the open atmosphere, if practicable, but in all cases so as to prevent impingement of escaping gas onto the container.

425. Reducing Regulator.

(a) Each system shall be provided with a regulating device, so adjusted as to deliver gas to the distributing tubing at a pressure not in excess of 18 inches water column, approximately 0.653 pounds per square inch gage.

(b) A low pressure relief valve shall be integral to the regulator; it shall be set to start to discharge at not less than two times and not more than three times the delivery pressure.

(c) The relief valve and the space above regulator and relief valve diaphragms shall be vented to the atmosphere. This may be accomplished through a common outlet, vented to a point at least two feet distant (and farther if possible) from any part of an opening to the cabin or hull interior or from an engine exhaust which is below the level of such discharge.

(d) Outlet terminations shall be turned downward to prevent water entering the discharge line.

(e) Each reducing-regulator shall be fitted with a pressure gage. This gage shall be on the high pressure side of the regulator. The purpose of the pressure gage is to provide a convenient and quick means of testing the system, from the container valve to and including the appliance valves, for leakage. It is recommended that this test be made at least once every two weeks and after any emergency. No leakage, even of a seeping character, shall be tolerated.

426. Piping and Fittings.

(a) All low pressure distribution tubing between regulator and appliances shall be copper tubing of standard type K or L or equivalent. All high pressure tubing between containers and regulators shall be type K or equivalent.

(b) Flexible sections used to allow free swing of gimbaled stoves shall be approved for marine use.

(c) Tube connecting fittings shall be in accordance with Paragraph 322(c); or connections may be soldered or brazed with a material having a melting point in excess of 1000°F.

427. Appliances.

(a) All gas consuming appliances shall be approved for marine use.

(b) Cooking stoves, service water heaters, cabin heaters, etc., shall comply with applicable provisions of Sections 41–43, and the following:

(1) All appliances designed for operation while unattended shall have all possible sources of vapor ignition (such as pilot lights, glow plugs, burning elements, switches, etc.) so protected as to prevent ignition of external vapors or addition of further combustible material to those vapors.

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

(c) A master packless shutoff valve, controlling all burners simultaneously is required at the manifold of each appliance.

428. Location and Installation.

(a) Containers, regulating equipment and safety equipment shall be substantially secured, readily accessible, and so located that escaping vapor cannot reach the bilges, machinery space, accommodations or other enclosed spaces.

(1) Such locations are confined to open deck, or cabin top, outside of cockpits or semienclosures and equipment so placed shall be protected from climatic extremes by a housing or housings vented to open air near the top and bottom.

(2) If construction or design prevents compliance with locations specified above, the container, regulating equipment and safety equipment may be mounted in a locker or housing,

vapor-tight to the hull interior, located above the waterline in an open cockpit provided the locker or housing is constructed of or lined with corrosion resistant metal; opens only from the top, with cover seated on gasket and tightly latched but so as to be conveniently and quickly opened for operation of container valves and testing of system for leakage; and is vented at the bottom by a pipe of at least ½ inch I.D., led outboard without pockets through the hull sides to a point lower than the locker or housing bottom but above the water line.

(3) Installation of gas equipment in lockers or housings shall be such that the container valves can be conveniently and quickly operated and the pressure gage dial must be fully visible.

(4) 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.

(b) Storage provisions for unconnected reserve containers, filled or empty, shall be the same as the provisions above for containers in use. Valves to containers, even those considered empty, shall be kept tightly closed.

(c) Distribution lines shall be protected from physical damage and be readily accessible for inspection.

(1) Lines shall be substantially secured against vibration by neat-fitting soft nonferrous metal clips with no sharp edges in contact with the tubing.

(2) Lines shall be protected by close-fitting ferrules of non-abrasive material wherever they pass through decks or bulkheads, and where passing through decks the connections shall be vaportight.

(3) Lines shall be continuous lengths of tubing from regulator to shutoff valve at appliance manifolds except for connections to other appliances.

(d) After installation, distribution tubing shall be tested prior to its connection to regulator and appliance by an air pressure of not less than 5 pounds per square inch gage. The container valve should 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 to the system. After these tests and when appliances and high pressure equipment have been connected, the whole system shall be subjected to the following: With appliance valves closed, the master shutoff valve on the appliance open, and with one container valve open, note the pressure on the gage. Close container valve. Pressure should remain constant for at least

10 minutes. If pressure drops, locate leakage by application of liquid detergent or soapy water solution at all connections.

NEVER USE FLAME TO CHECK FOR LEAKS.

429. Precautions.

(a) A container shall not be charged with fuel unless it bears the proper markings of the code under which it was fabricated and also its water weight capacity and tare weight in pounds.

(b) 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 the requirements of the Interstate Commerce Commission.

(c) Container valves and safety devices must be tested for leaks before the charged container is shipped from the filling plant and it shall not be shipped with leaking fittings.

43. Heating Equipment.

431. Service Hot Water Heating Units.

(a) Open flame heating units shall be installed within the galley area only, well above accommodation flooring and in compliance with applicable provisions of Sections 41 and 42.

(b) A vent stack should be fitted at the top of each heating unit and led outboard through the deck with an effective integral attachment for preventing flame extinguishment or flareback from back draft.

(1) Dampers shall not be installed in vent stacks.

(c) Heating units designed for operation while unattended shall have all possible sources of vapor ignition (such as pilot lights, glow plugs, burning elements, switches, etc.) so protected as to prevent ignition of external vapors or addition of further combustible material to those vapors. Such units shall have suitable automatic safety controls of the complete shutoff type.

432. Cabin Heaters.

(a) Cabin heating equipment shall comply with applicable provisions of Sections 41 and 42.

(1) Burners and burner feed arrangements shall be such that operation is not affected by motion of the boat insofar as safety is concerned.

(2) Heaters shall be permanently secured.

(3) Heaters designed for operation while unattended shall have all possible sources of vapor ignition (such as pilot lights,

glow plugs, burning elements, switches, etc.) so protected as to prevent ignition of external vapors or addition of further combustible material to those vapors. Such units shall have suitable automatic safety controls of the complete shutoff type.

(4) Gasoline shall not be used for fuel in open flame liquid or vapor burners.

(b) Hot water heating boilers shall be of types approved by the U. S. Coast Guard.

(c) Sealed combustion chamber heaters burning gasoline or fuel oil may be used provided they comply with applicable parts of Paragraph 411.

(1) Installation of this type heater shall be in accordance with approved standards which the manufacturer shall include in the required instructions covering installation, operation and maintenance.

44. Auxiliary Appliances.

441. Lamps and Lanterns.

(a) Oil lamps and lanterns shall be of types approved for marine use.

(1) Gasoline shall not be used for fuel.

(b) Oil lamps shall have metal bodies and be hung in gimbals.

(1) Oil lamps shall not be located directly over galley stoves or heating units.

(2) Metal shields shall be secured above chimneys.

(c) Oil lanterns, when suspended, shall be secured by clips or lashings.

(1) Lanterns not in use should be stowed in a metal lined locker or lockers.

442. Refrigeration and Air Conditioning Equipment.

(a) Refrigerators and air conditioners shall be types approved for marine use.

(1) Installation of these appliances shall be in accordance with applicable provisions of this Chapter and Chapter 5.

CHAPTER 5. ELECTRICAL SYSTEMS

NOTE: This chapter refers specifically to electrical installations on boats operating at potentials under 50 volts. Systems operating at potentials over 50 volts shall comply with the electrical requirements of the U. S. Coast Guard, CG 323, "Rules and Regulations for Small Passenger Vessels." Nevertheless, it is to be recognized that low voltage installations do not warrant the use of substandard materials or workmanship, particularly in motor craft where the possible presence of flammable or explosive vapors renders a spark or incandescence liable to serious consequences.

50. Circuit Arrangement.

501. It is recommended that power for starting and ignition of main and auxiliary engines be drawn from a source independent of that used for other purposes, unless an auxiliary method for starting propulsion engines is provided.

502. Wiring should be installed in a manner that will minimize magnetic interference, particularly in the area of the compass and automatic pilots.

503. In designing the electrical system, the inclusion of spare circuits of sufficient capacity to permit the addition of ordinary accessories is recommended.

51. Types of Systems.

All systems shall be of the two wire type with insulated feed and return conductors in accordance with Paragraph 511 or 512.

511. Ungrounded System.

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 ground throughout the system. The use of an ungrounded system is recommended for any voltage.

512. Grounded System.

The term grounded system applies to any two wire system which utilizes the common ground point of the boat only as a means to maintain the return conductors of one side of the system at ground potential. Except for engine mounted accessories, which may use the engine block as a common ground return, all electrical circuits shall be of the two wire type with insulated conductors to and from the power source. The grounded side of the system should be of the negative polarity.

513. Bonding System.

All boats with fixed electrical systems should be equipped with a bonding ground system to: (1) prevent stray current corrosion by confining stray current leakage inside the hull, (2) provide a low resistance path to ground for voltages that may be considerably in excess of those for which the system is designed such as lightning and (3) minimize radio interference.

(a) On boats with grounded electrical systems, the bonding ground and systems ground connections shall be made at one point.

(b) The bonding system shall be independent of the electrical system ground conductors except at the common ground point.

(c) The bonding system may use bare or insulated conductors. It is recommended that all conductors in the system be at least equivalent to a No. 6 Awg wire. The use of tinned or lead alloy coated wire is recommended.

52. Batteries.

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

522. Batteries shall be so located that gas generated in charging will be readily dissipated by natural or mechanical ventilation.

523. Batteries shall be accessibly located, provided with suitable supports, and secured against shifting with the motion of the boat.

524. Acid batteries shall be located in a tray of lead, fiberglass or other suitable material resistant to the deteriorating action of the electrolyte.

525. A nonconductive, perforated cover or other suitable means shall be provided to prevent accidental shorting of battery terminals.

526. Alkaline batteries with metal cell containers shall be assembled in nonconductive trays having suitable insulating cell supports. Provision shall be made to prevent other conductive materials that could cause a short circuit from coming in contact with the cell containers.

53. Equipment.

531. All electrical devices and accessories should be approved for motor craft use.

532. Electrical and electronic devices containing potential sources of ignition of flammable vapors, installed in machinery spaces or other areas where flammable vapors may be present, shall be so designed, enclosed, or protected to prevent ignition of external flammable vapors.

NOTE: It is not the intent of this requirement to require such devices to be "explosion proof" as that term is defined in the National Electrical Code of the NFPA pertaining to shore systems. It is intended that the protection provided be generally equivalent to that of wiring permitted by this standard wherein a definite short or break would be necessary to produce an open spark.

533. All electrical equipment intended for fixed installation shall be mounted and secured independently of all electrical or other service connections.

534. The electrical circuits of all equipment shall be insulated from the exposed metallic parts.

535. Engine mounted electrical components shall comply with requirements of Chapter 2.

536. Electrical devices not specifically designed for submersible operation or operation in wet areas shall be so located and mounted that they are:

(a) accessible
(b) protected from overhead drip or spray
(c) protected from bilge splash
(d) adequately ventilated.

537. Switches intended to be used in machinery spaces or other areas which may contain flammable vapors shall comply with Paragraph 532.

54. Circuit Protection.

541. Circuit breakers shall be of the proper voltage rating and shall be of the manual reset type with instantaneous short circuit protection capable of repeatedly opening the circuit in which they are used without failure.

(a) Self-resetting circuit breakers shall not be considered acceptable as circuit overload protective devices.

542. Fuses of the proper rating may be used for circuit protection, but should be used in conjunction with a switch located between the fuse and source of power. The master battery switch may be used for this purpose.

(a) Fuse holders shall be suitable for use in sea atmospheres.

543. An approved master battery switch capable of carrying the maximum current of the system (including starter circuits) shall be provided in each ungrounded conductor as close to the battery terminal connection as possible. The switch control shall be located outside the fuel tank and engine spaces so as to be readily accessible in case of an emergency.

(a) Battery switches in systems using diode rectified alternators or third brush generators shall incorporate means for breaking the field circuit when the battery load is removed from the system.

544. A fuse or manual reset type circuit breaker shall be provided in each ungrounded power feed to the power distribution panel exclusive of starting and ignition systems.

545. A fuse or manual reset type circuit breaker shall be provided at the main switchboard in all ungrounded conductors to any subdistribution panels.

546. Each ungrounded conductor of circuits supplying lights, motors or electrical accessories shall be protected against overload at the distribution panel or switchboard serving as the source of power. No two items of equipment shall be protected by the same overcurrent device except general lighting fixtures. It is recommended that the navigation light circuit be protected by a single overcurrent device.

547. Where for any reason the gage of wire is reduced at a junction, the circuit overload protective device shall be based on the current carrying capacity of the smallest gage conductor. Short connections to individual fixtures will be exempt from this requirement.

548. The conductors supplying motors and motor-operated appliances shall be protected by a separate overcurrent device which is responsive to motor current. The device shall be rated or set at not more than 115 per cent of the motor full-load current rating for enclosed motors and not more than 125 per cent of the rating for open motors.

549. Generators and alternators shall be fully protected against overload. Overcurrent protection of third brush type generators and diode rectified alternators shall open the field circuit except that no protection is required for generators and diode rectified alternators having an output rating of 250 watts and less.

55. Connectors and Terminals.

551. Terminal connections shall be of a type that will insure a good mechanical and electrical joint capable of withstanding the vibration and movement encountered in normal service.

(a) Metal alloys used shall be corrosion resistant and galvanically compatible with copper conductors.

(b) Terminal lugs should be of the solderless type with ring type ends. Formed and soldered terminal connections shall not be used. Plug connectors may be used in accordance with Paragraph 556.

(c) Terminal connectors should be of the correct size for the terminal stud.

552. Minimum terminal stud sizes for various wire gages shall be in accordance with Table 3.

Table 3

MINIMUM STUD SIZES FOR TERMINAL STUDS

Normal Stud Size	*Minimum Stud Diameter*	*Conductor Size**
6	.138	not recommended
8	.164	16 Awg
10	.190	14, 12 Awg
1/4	.250	8, 10 Awg
5/16	.3125	6 Awg
3/8	.375	4 Awg

*Based on the use of 4 conductors to each terminal stud.

553. No more than 4 conductors shall be connected to any terminal stud. Where more than 4 conductors are to be connected, two or more terminal studs should be inter-connected.

554. All wiring connections shall be made in such a manner as to relieve strain from the terminal connections.

555. Battery connections shall be of the soldered lug type with sufficient soldered contact lengths to provide a mechanically strong joint.

556. Single or multi-wire plug connectors, when used, shall be designed to withstand the vibration, shock and corrosion encountered in marine service.

(a) Where soldered plug connections are used, the conductor shall be firmly supported adjacent to the soldered joint to prevent failure from vibration.

(b) Plug connections should be sealed or covered to prevent the accumulation of water around the connection.

(c) In multi-wire plug connections, a separator or sleeving shall be provided to assure separation of individual conductors.

56. Wiring Installations.

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

562. Individual wires and harnessed wires should be supported with clamps or straps at least every 14 inches to fixed structural

members of the boat. Staples should not be used for this purpose.

(a) Metal clamps shall be tight fitting, free of sharp edges and of adequate width.

(b) Nonmetallic clamps or straps subject to failure in a fire should not be used where such failure could cause an additional hazard (wiring over engines or moving shafts, etc.).

563. Exposed wiring subject to mechanical damage shall be protected by loom, or other equivalent means.

564. Where wiring passes through bulkheads or other structural members, it shall be adequately protected against chafing.

57. Conductors.

571. Conductors used for general wiring throughout the boat, other than wiring which forms an integral part of an electrical device or accessory, shall be of a type suitable for the service conditions.

572. Conductors may be bunch, concentric or rope stranded with the minimum number of strands in accordance with Table 7.

Table 4

CONDUCTOR INSULATION AND APPLICATION

Type	*Insulation*	*Maximum Operating Temperature*	*Use*
RW	Moisture Resistant Rubber with Oil Resistant Neoprene Jacket	60°C 140°F	General use except machinery spaces
RH-RW	Moisture and Heat Resistant Rubber with Oil Resistant Neoprene Jacket	60°C 140°F	General use except machinery spaces
		75°C 167°F	General use General use
RHW	Moisture and Heat Resistant Rubber with Oil Resistant Neoprene Jacket	75°C 167°F	General use
TW	Moisture Resistant Thermoplastic Flame Retardant	60°C 140°F	General use except machinery spaces
THW	Moisture and Heat Resistant Thermoplastic Flame Retardant	75°C 167°F	General use

573. It is recommended that all conductors be tinned or lead alloy coated copper.

574. No single conductor smaller than No. 16 Awg shall be used.

575. The insulation of marine conductors used for general wiring shall have the dielectric strength, dielectric retention, heat resistance, resistance to sun exposure and resistance to gasoline oil and grease, etc., suitable for the application. Table 4 lists National Electrical Code wire types considered acceptable for general use aboard boats.

576. Ignition wire shall be of a grade suitable for marine use, fitted with tight-fitting caps at the distributor and at the spark plugs.

577. Flexible cords shall be of a hard service type suitable for marine use, such as National Electrical Code types SO and ST.

Table 5

LENGTH OF CONDUCTOR IN FEET FROM SOURCE OF CURRENT TO MOST DISTANT FIXTURE AND RETURN

AWG WIRE SIZES BASED ON A 10 PER CENT VOLTAGE DROP

Total Current on Circuit in Amps.	Feet															
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
	6 Volts															
5	14	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	14	14	14	14	14	14	14	14	12	12	12					
10	14	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	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
10	14	14	14	14	14	14	14	14	14	14	14	12	12	12	12	12
15	14	14	14	14	14	14	14	12	12	12	12	10	10	10	10	10
20	14	14	14	14	14	12	12	12	10	10	10	10	10	10	8	8
25	14	14	14	12	12	12	10	10	10	10	10	8	8	8	8	8
30	14	14	14	12	12	10	10	10	10	8	8	8	8	8	8	6

58. Conductor Sizes.

581. Conductor sizes used for cabin lighting and other circuits where voltage drop is not critical may be determined according to Table 5 based on 10 per cent voltage drop.

582. 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 per cent voltage drop and may be determined according to Table 6.

583. Conductor sizes not covered in Tables 5 and 6 may be calculated by means of the following formula. Reference is made to Table 7 for conversion of CIRCULAR MIL areas to Awg wire

Table 6

LENGTH OF CONDUCTOR IN FEET FROM SOURCE OF CURRENT TO MOST DISTANT FIXTURE AND RETURN

AWG WIRE SIZES BASED ON A 3 PER CENT VOLTAGE DROP

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

gages. When the calculated CIRCULAR MIL area is less than a given value in Table 7, the next larger size conductor is to be used.

$$cm = \frac{K \times I \times L}{E}$$

Where: cm = CIRCULAR MIL area of conductor

K = 10.8 (constant representing the MIL-Foot resistance of copper)

I = Load current in amperes

L = Length of conductor from source of current to fixture and return in feet.

E = Voltage drop at load in volts.

Table 7

Conductor Size, AWG	Nominal CM Area	Number of Strands	Resistance OHMS Per 1000 Ft. at 25°C
16	2,583	19	4.09
14	4,107	19	2.58
12	6,530	19	1.62
10	10,380	19	1.02
8	16,510	19	0.641
6	26,250	37	0.410
4	41,740	61	0.253
2	66,370	127	0.162
1	83,690	127	0.129
1/0	105,500	127	0.102
2/0	133,100	127	0.0811
3/0	167,800	259	0.0642
4/0	211,600	418	0.0509

59. Switchboards and Distribution Panels.

591. Switchboards and electrical distribution panels shall be located in accessible well-ventilated locations protected from rain and spray. Where necessary, panels shall be provided with a drip shield.

592. Switchboards or other electrical panels or junction boxes located adjacent to weather decks or open cockpits shall be enclosed or protected from deck wash.

593. Totally enclosed switchboards and distribution panels of the dead front type are recommended. Wooden enclosures may be

used for panels carrying light loads providing the terminals and all electrical connections are suitably insulated from contact with the wood and the exposed wooden surfaces are suitably protected with a nonabsorbent, fire resistant insulating material. Panels and enclosures used for circuits carrying loads of 15 amperes or more shall be of metal or other non-combustible material.

594. All wiring connections should be made in junction boxes by means of junction blocks.

CHAPTER 6. FIRE EXTINGUISHING EQUIPMENT.*

60. Introductory Information.

601. Classification of Fires.

For all practical purposes there are three general classes of fires:

Class A fires, defined as fires in ordinary combustible materials such as wood, cloth and paper 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, defined as fires in flammable petroleum products or other flammable liquids, greases, etc., where the "blanketing-smothering" effect of oxygen-excluding media is most effective.

Class C fires, defined as fires involving electrical equipment where the electrical nonconductivity of the extinguishing media is of first importance.

602. Classification of Fire Extinguishers.

Based upon the preceding classification of fires and also upon fire extinguishment potentials as determined by physical testing of fire extinguishers by Underwriters' Laboratories, Inc., classifications have been established for portable fire extinguishers. The United States Coast Guard also classifies portable fire extinguishers based upon the preceding classification of fires but using a different method of indicating extinguishment potentials.

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*More detailed information on portable fire extinguishers may be found in the *Standard for the Installation, Maintenance and Use of Portable Fire Extinguishers (NFPA No. 10)*. Published by the National Fire Protection Association.

Table 8.

FIRE EXTINGUISHERS

Type of Extinguisher	Fire Suitability A	B	C	Subject to Freezing	Annual Maintenance Required*	Operating Precautions
CARBON DIOXIDE**	No	Yes	Yes	No	Weigh and tag.	Smothering in high concentrations. Avoid contact with discharge horn.
DRY CHEMICAL**	No	Yes	Yes	No	Weigh and tag to manufacturer's instructions.	None.
FOAM	Yes	Yes	No	Yes	Discharge, refill and tag.	Do not use on live electrical equipment.

*In addition to frequent inspection to detect tampering, obstruction of discharge orifice, or other condition.

**May be useful in controlling small Class A surface fires.

(a) The relative extinguishment potential of various sizes and types of extinguishers as determined by Underwriters' Laboratories, Inc., is expressed by the numeral in the U. L. Classification while the letter indicates the class of fire for which the particular agent is suitable. Size or weight alone does not necessarily indicate the effectiveness and this should be understood when purchasing an extinguisher to assure that one gets the best value or maximum protection.

(b) Although presently using a system of ratings based on size and weight of extinguishing agent, the U. S. Coast Guard also considers their performance on marine type fires and those of minimum performance are not listed as approved by the Coast Guard. Minimum sizes approved in pounds or gallons of agent content are:

Carbon Dioxide	— 4 lbs.
Dry Chemical	— 2 lbs.
Foam	— 1¼ gals.

61. General.

611. All portable fire extinguishers and extinguishing systems shall be of approved types as listed by the Underwriters' Laboratories, Inc., or other nationally recognized authorities, and shall be approved by U. S. Coast Guard for Merchant Vessels.

62. Equipment.

621. All boats shall be equipped with fire extinguishers at least to the extent of the minimum recommendations given in Table 9.

(a) On boats having a galley stove, one extinguisher of suitable type shall be convenient thereto.

622. In addition to the recommended portable fire extinguisher equipment, a fixed carbon dioxide extinguishing system is recommended for machinery spaces, separate compartments for fuel tanks, bilges and galleys.

(a) The quantity of gas required for such systems by Underwriters' Laboratories, Inc., is:

Volume of Space (cu. ft. net)	*Carbon Dioxide in lbs.*
140	10
220	15
300	20
375	25
500	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 at 1 lb. per 20 cu. ft.

(b) Where bilges are open or communicating to more than one space, such spaces together with bilge shall be considered as one in determining the capacity of the system.

(c) Systems may be manually or automatically operated. Automatically operated systems should not be installed to protect accommodation compartments where persons may be sleeping or to protect engine compartments which are normally attended.

63. Installation.

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

(a) Securing provisions must permit ease of release compatible with the requirement of ready accessibility.

632. Fixed carbon dioxide extinguishing systems shall be installed in accordance with the *Standard for Carbon Dioxide Extinguishing Systems* (*NFPA No. 12**) insofar as they apply, and comprehensive printed instructions with labeled diagrams covering details of proper installation shall be furnished by the manufacturer.

*Published by the National Fire Protection Association.

Table 9.

NUMBER AND DISTRIBUTION OF FIRE EXTINGUISHERS

Note: All boats over 16 ft. shall carry at least one bucket with lanyard attached with which to fight Class A fires.

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

*Where more than three 1-B 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., three 2-B units may be used in lieu of 4, 5 or 6 of the smaller 1-B units.

**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.

(a) Carbon dioxide cylinders shall be mounted so as to avoid contact with moisture or wet surface to reduce danger of corrosion.

(b) Manual controls shall be placed so they are readily accessible from outside the spaces served by the system.

(c) Dual manual controls, well separated, are recommended irrespective of whether system is designed for manual or automatic operation.

(d) Spaces to be protected by such systems should be enclosed and contain only the usual number of ports, companionways and door openings.

(e) System may be designed for any one of the following plans of application, of which plans (1) and (2) are preferred:

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

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

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

CHAPTER 7. OPERATION AND MAINTENANCE.

70. The fire and explosion hazards possible in inboard powered boats are emphasized because of basic design and construction requirements. While ventilation for the removal of heavy hazardous vapors ashore is provided at floor level, similar provisions are obviously impossible for boats. Accordingly, the operation and maintenance recommendations included in this chapter are intended to supplement the foregoing standard.

71. Hull.

711. The entire boat shall be kept clean and shipshape.

(a) Frequent flushing and cleaning of bilges is recommended.

(b) Clean waste and rags should be stowed in metal containers or metal lined lockers. Similar receptacles shall be provided for waste and rags coated with oil, paint, paint remover, or polish; and such accumulation shall be kept to a minimum by frequent disposal ashore.

(c) Foul weather clothing should be hung loosely in well-ventilated lockers.

(d) Paint and varnish removers are generally highly flammable and particular caution should be exercised during use of such to see that there is ample ventilation and no open lights, fires or smoking.

(e) Naked lights (open flames), however small, shall not be carried into compartments where gasoline vapor may be present.

(f) Gasoline or other flammable solvents shall not be used for cleaning purposes.

712. The ventilation system must be maintained at top efficiency.

(a) Ventilation ducts should never be blocked off and any screening used in cowl or duct openings should be kept clear.

(b) If power exhaust blowers are installed they should be operated at least five minutes before starting engines or main auxiliary engines.

(c) Ventilate (open) entire boat before starting.

72. Engines.

721. Engines should, at all times, be maintained in the best operating condition in accordance with the producer's instructions.

(a) Before starting engines:

(1) Ventilate engine compartment.

(2) See that lubricating oil reservoir is full.

(3) See that engine cooling water intakes are open.

(b) When engine starts:

(1) Check oil pressure.

(2) Make certain of cooling water circulation — e.g., check exhaust discharge.

(c) During operation make frequent observation checks of oil pressure and cooling water temperature gages.

73. Fuel Systems.

731. Gasoline vapors are heavier than air and will not escape from low lying pockets, such as bilges or tank bottoms unless drawn or forced out. An atmospheric concentration of gasoline vapor as low as 1¼ per cent is sufficient to create a mixture which may be exploded by a slight spark.

732. The entire fuel system, tanks, piping (including tank vent line) and accessories shall be frequently checked for leaks or evidence of corrosion.

(a) All connections shall be maintained tight at all times.

(b) Fuel carried on board outside of fixed fuel system shall be in an approved safety container or in a portable tank as provided by manufacturers of outboard engines and shall be safely stowed outside of engine or living compartments.

733. Utmost care shall be exercised during fueling operations.

(a) Fueling should never be undertaken at night except under well lighted conditions.

(b) During fueling operations, smoking shall be forbidden on board or anywhere nearby.

(c) Before opening tanks the following precautions shall be observed:

(1) All engines, motors, fans shall be shut down.

(2) Galley stoves shall be extinguished. (Coal fires shall be banked.)

(3) All ports, windows, doors and hatches shall be closed.

(4) Quantity of fuel to be taken aboard shall be determined in advance of fueling operations.

(d) The fuel delivery nozzle shall be put in contact with the fill pipe before the flow of fuel is commenced and this contact shall be continuously maintained until the flow has stopped. There is a serious hazard from static discharge unless this rule is observed.

(e) Tanks shall not be completely filled. Allow a minimum of 2 per cent of tank space for expansion. This space allowance should be 6 per cent if the fuel being taken aboard is 32°F or below in temperature.

(f) After fuel flow has stopped:

(1) Fill cap shall be tightly secured.

(2) Any spillage whatsoever shall be wiped up completely.

(3) Entire boat shall be opened and allowed to ventilate for at least five minutes before starting any engines or lighting galley fires.

74. Cooking, Heating and Auxiliary Appliances.

741. All flame-operated equipment shall be kept clean and maintained in accordance with the manufacturer's instructions.

(a) Gasoline shall not be used for priming alcohol or kerosine burners, nor shall gasoline or other flammable liquid be used for lighting-off coal, charcoal or wood stoves.

(b) Alcohol, kerosine and fuel-oil burner tips shall be kept clean to avoid choke, extinguishment and consequent flooding.

(c) Burners shall not be primed while hot.

(d) Reserve fuel shall be limited to minimum needs and carried only in approved safety containers, stowed in a safe location outside engine compartment.

742. Printed instructions and labeled diagrams for the operation and maintenance of liquefied petroleum gas systems shall be available on board for ready reference.

(a) Only the kind and specification of gas for which the system is designed shall be used. The gas should be obtained from sources authorized by the manufacturer of the system.

(b) Particular care shall be taken against snuffing a flame from boilover, gust of air or any other cause.

(c) Changing of cylinders shall be in accordance with the instructions which follow and under the supervision of licensed per-

sonnel when such officers are carried, or by other responsible person when no such officers are carried.

For single cylinder systems:

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

(2) When burners go out shut them off — *This is imperative.*

(3) Disconnect empty cylinder, leaving stop valve closed and connect the full one.

For multi-cylinder systems:

(1) Close both the cylinder stop valve and the stop valve in the line to the regulator.

(2) Burn out gas content in low pressure lines and proceed with cylinder change as in single cylinder system.

For both types of systems:

(1) After turning on a full cylinder, it is recommended that all burners be lighted for sufficient time to insure that there is no air in the lines to interrupt a continuous flow of gas; then shut off burners and cylinder stop valve and test for leaks with soap suds.

(d) Frequent (at least twice a month) tests of the entire system at service pressure shall be made by closing cylinder valves and observing the gage. If tight, there should be no noticeable drop in ten minutes. Trial for location of leaks shall be made with liquid detergent or soapy water solution and *never with flame.*

(e) Empty cylinders shall be kept closed by the means provided (stop valves or plugs) whether or not connected and unconnected empties put ashore as soon as practicable.

75. Electrical System.

751. Frequent inspection should be made of all electrical equipment and wiring to insure against deterioration and faulty conditions such as loose connections, insulation failure, burned switching contacts, fuse replacements, bonding effectiveness, etc.

(a) Battery terminals should be kept clean of corrosive deposits.

76. Fire Extinguishers.

MAINTENANCE

761. All fire extinguishers should be examined at regular intervals several times a year to make certain that they have not been tampered with and have not suffered corrosion or damage. Seals should