NFPA No.

302

USAS Z120.1
1968

MOTOR CRAFT

(PLEASURE & COMMERCIAL)

1968

A USA Standard

$1.25

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston, Mass. 02110

10M-6-68-FP-SM
Printed in U.S.A.

National Fire Protection Association
International

Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations or that which is advised but not required.

APPROVED means acceptable to the authority having jurisdiction. The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of nationally recognized testing laboratories,* i.e., laboratories qualified and equipped to conduct the necessary tests, in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

*Among the laboratories nationally recognized by the authorities having jurisdiction in the United States and Canada are the Underwriters' Laboratories, Inc., the Factory Mutual Engineering Corporation, the American Gas Association Laboratories, the Underwriters' Laboratories of Canada, the Canadian Standards Association Testing Laboratories, and the Canadian Gas Association Approvals Division, and Yacht Safety Bureau.

LISTED: Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

LABELED: Equipment or materials to which has been attached a label of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling is indicated compliance with nationally recognized standards or the conduct of tests to determine suitable usage in a specified manner.

AUTHORITY HAVING JURISDICTION: The organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

Units of Measurements

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

Copyright and Republishing Rights

Fire Protection Standard for

Motor Craft

(Pleasure and Commercial)

NFPA No. 302 — 1968

USAS Z120.1 — 1968 (Rev. of Z120.1 — 1967)

1968 Edition of NFPA No. 302

This edition of the NFPA Fire Protection Standard for Motor Craft was adopted at the 1968 Annual Meeting of the Association. It supersedes the 1966 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.

This 1968 edition of NFPA No. 302 has been submitted to the United States of America Standards Institute and was approved as a USA Standard on September 9, 1968. The USASI designation is USAS Z120.1 — 1968.

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. Twelve successive editions were adopted between 1939 and 1964. The present text consists of amendments to the 1966 edition which includes a revision of Chapter 3.

Sectional Committee on Motor Craft

E. S. Terwilliger, *Chairman,*
Yacht Safety Bureau, Inc., 336 Old Hook Rd., Westwood, N. J. 07675

Donald E. Asay, Chubb & Son Inc.
W. L. Avrett, American Petroleum Institute.
PR/C Norris C. Barnard, AP., U. S. Power Squadrons.
Norman Beck, Internal Combustion Engine Institute.
Harry D. Bryan, National Assn. of Marine Surveyors, Inc.
Joseph E. Choate, National Assn. of Engine & Boat Manufacturers, Inc.
Henry F. Geils, Marine Electrical Consultant, New York.
Harper H. Hull, American Boat and Yacht Council, Inc.
Richard D. Jaeschke, United States Salvage Assn., Inc.
Irving D. Jakobson, Jakobson Shipyard Inc.
Ralph E. Lambrecht, Outboard Marine Corp.
John C. Loeser, Ridgewood, N. J.
Donald I. Reed, Boating Industry Assn.
Capt. Stanley H. Rice, U. S. Coast Guard.
R. H. Roy, Society of Automotive Engineers, Inc.
Capt. Howard Saffer, Fireman's Fund American Insurance Co.
William F. Warm, Marine Office ofAmerica.
Bliss Woodward, U. S. Coast Guard Auxiliary.
W. N. Zippler, Gibbs & Cox, Inc.

Alternates.

David Beach, Boating Industry Assn. (Alternate to Donald I. Reed.)
Richard Hanna, Internal Combustion Engine Institute. (Alternate to Norman Beck.)

SCOPE: To develop standards on fire prevention and protection of motor craft and to encourage their use by designers, builders, and owners.

Committee on Marine Fire Protection

Thomas M. Torrey, *Chairman,*
Insurance Co. of North America, 79 John St., New York, N. Y. 10038

Charles S. Morgan,† *Secretary,*
National Fire Protection Assn., 60 Batterymarch St., Boston, Mass. 02110

Capt. Hewlett R. Bishop, National Cargo Bureau, Inc.

H. O. Buchanan, Canadian Department of Transport.

Braxton B. Carr, The American Waterways Operators, Inc.

Joseph E. Choate, National Assn. of Engine & Boat Mfrs.

R. Cox, Fire Equipment Manufacturers Assn.

Frank W. Dunham, Jr., American Assn. of Port Authorities.

F. J. Fee, Jr., National Automatic Sprinkler & Fire Control Assn.

Frank Grafton, U. S. Department of Commerce.

George A. Hale, Marine Chemists Assn.

Vice Admiral James A. Hirshfield, USCG (ret.), Lake Carriers' Assn.

Edwin M. Hood (ex-officio), Chairman, Sectional Committee on Shipbuilding, Repair and Lay-Up.

Jack R. Jones, Pacific Maritime Assn.

J. R. Lindgren, United States Salvage Assn., Inc.

George W. Morgan, Assn. of American Ship Owners.

Rear Admiral C. P. Murphy, United States Coast Guard.

Roy C. Petersen, (ex-officio), Chairman, Sectional Committee on Operation of Marine Terminals.

Rear Admiral H. C. Shepheard, USCG (ret.).

E. S. Terwilliger (ex-officio), Chairman, Sectional Committee on Motor Craft.

Pierre R. Vallet (ex-officio), Chairman, Sectional Committee on Marinas and Boatyards.

T. T. Wilkinson, American Petroleum Institute.

Alternates.

J. H. Birtwhistle, Canadian Dept. of Transport (Alternate to H. O. Buchanan.)

B. H. Lord, Jr., American Petroleum Institute (Alternate to T. T. Wilkinson.)

†Non-voting member.

SCOPE: This committee, together with the several sectional committees listed below, is organized to encourage the application of fire protection engineering to marine vessels and watercraft of all types and to develop such standards and recommendations as may be appropriate to this objective. The sectional committees are responsible for the initial development and revision of standards and recommendations dealing with their respective subjects and report to the Association through the Committee on Marine Fire Protection.

Fire Protection Standard for Motor Craft

(PLEASURE & COMMERCIAL)

NFPA No. 302 — 1968

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 should 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.

PERMANENTLY INSTALLED — securely fastened in place and not intended for ready removal.

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 to serve as effective fire breaks.

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

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

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 with each equal to one square inch per foot of beam as a 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.

(b) Each helm position should be placarded with a warning to operate blowers to free compartments of hazardous vapors before starting main or auxiliary engines.

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.

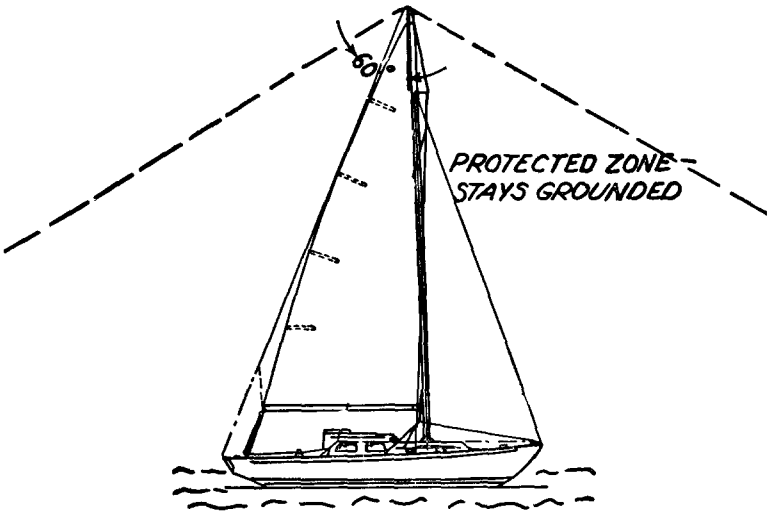
(b) Nonconducting antenna masts with spirally wrapped conductors are not considered suitable for lightning protection purposes.

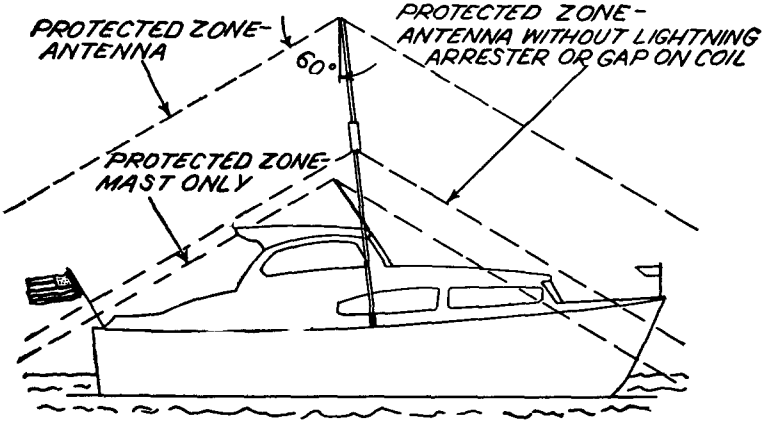
143. A metal hull provides an adequate ground, and if there is good metal to metal contact between hull and metal masts, no further protection from lightning is necessary.

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

---

*For detailed information on protection of shore structures, see the Lightning Protection Code (NFPA No. 78 — USAC5.1 — 1965), published by the National Fire Protection Assn.





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.

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

(a) Carburetors shall have integral or properly connected drip collectors of adequate capacity which return all drip and overflow to the engine intake manifold.

(b) Carburetors shall be installed in such a manner as to prevent any drip or accumulation of fuel in the drip collector from escaping into the bilges or engine compartment.

(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 should be so mounted on engines as to be above the bilges and as remote as practical from the fuel system.

214. A 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 so located as to be readable by the operator at all helm positions.

(a) Gages to indicate lubricating oil pressure shall be provided for all propulsion engines having pressure lubricating systems. These gages shall be located so as to be readable by the operator at all helm positions.

(b) Warning lights may be used in lieu of gages provided that they are of a type that can be tested at any time by 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.

217. 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.

218. 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, turbo-chargers, 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. If a single exhaust system is used, it shall be so designed that any back pressure difference between manifolds and the total back pressure is within the limits set by the manufacturer's specifications.

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 suitable shielding.

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

(c) Provision shall be made to prevent any rain or sea water from entering the engine exhaust manifold.

CHAPTER 3. FUEL SYSTEMS

The recommendations and standards set forth in this chapter provide guidance for the design, construction, choice of materials and installation of fixed (permanently installed) fuel systems from the fuel fill opening(s) to the connection(s) at the main engine(s) or at auxiliary equipment. This chapter does not refer to portable fuel systems or the parts thereof. (See Part III, Section 312.)

30. General.

Fuel systems shall be liquid and vaportight with respect to hull interiors. Individual components of the system and the system as a whole shall be suitable for the purpose and so designed and installed as to withstand the stresses and exposure of marine service, such as pressure, vibration, shock, movement, grease, lubricating oil, bilge solvents, and corrosive environment. The system and all its components as installed in a boat shall be capable of withstanding exposure for 2½ minutes to free burning fuel of the type for which the system is designed, without failure resulting in leakage of liquid or vapor. The system and all its components shall also be capable of operation within an ambient temperature range of from −20° F. to 185° F. Electrical continuity shall be maintained from the fill plate on deck to the engine.

31. Fuel Tanks.

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

311. Materials.

Some materials suitable for fuel tanks with recommended minimum thicknesses are listed in Table 2. Any departure from these should be specifically approved. Fuel tanks having a capacity greater than 400 U.S. gallons shall be designed with a safety factor of four based on the ultimate strength of the material used and on a design head of not less than four feet of liquid above the top of the tank.

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.

TABLE 2

RECOMMENDED MINIMUM PLATE THICKNESS FOR FUEL TANKS

MATERIAL	SPECIFICATION	TANK CAPACITIES											
		1–30 gals.		1–80 gals.		30–80 gals.		80–150 gals.		80–200 gals.		200–400 gals.	
Nickel-Copper	B127–61 Class A	.031 in.	22G			.037 in.	20G			.050 in.	18 G	.062 in.	16G
Copper-Nickel	B122–60 Alloy–5			.045 in.	17G					.057 in.	15G	.072 in.	13G
Copper	B152–60 Type ETP			.057 in.	15G			.080 in.	12G				
Copper-Silicon	B97–55 Types A,B,C			.050 in.	16G					.064 in.	14G	.081 in.	12G
Steel	A415			.0747 in.	14G					.1046 in.	12G	.125 in.	11G

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 oxyacetylene, 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.

Note 6. Uncoated steel tanks must be galvanized inside and outside by the hot dip process except tanks for diesel fuel.

Note 7. Internal surfaces of copper tanks should be tin-coated.

(c) Tanks shall be so constructed that, as installed, exterior surfaces will not hold moisture.

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

Threaded fittings shall be in accordance with the following table:

I.P.S.	Minimum Length of Thread Engagement
¼ in.	⅜ in.
⅜ in.	⅜ in.
½ in.	½ in.
¾ in.	9/16 in.
1 in.	11/16 in.
1½ in.	11/16 in.
2 in.	¾ in.

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

(1) The attachment of baffles to tank walls shall be such as to prevent failure from flexing or vibration.

(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 metal tanks shall be fitted with a substantial bonding terminal.

(h) Indentations for labeling or other identification shall not be such as to weaken the fuel tank.

(i) All fuel tanks shall bear a legible, permanent label located so as to be visible for inspection after installation providing the following information:

(1) Manufacturer's name

(2) Year of manufacture

(3) Capacity in U. S. gallons

(4) Construction material and thickness

(5) Fuel for which tank is intended

(6) Maximum test pressure.

(j) All fuel tanks shall be tested by the manufacturer or boat builder for fuel tightness at 3 psig or 1½ times the maximum head to which it may be subjected in service, whichever is greater.

313. Installation.

(a) Fuel tanks shall be so installed as to be accessible.

(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) Metal tanks shall be placed in a dry, well-ventilated location.

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

(d) 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 non-abrasive and nonabsorbent material.

(e) 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, fuel pipe connections and accessories thereto shall be accessible.

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

(c) Outlets for drawing fuel from the system shall be prohibited except for filter bowl plugs provided for the purpose of servicing only.

(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.

322. Materials.

(a) Where flexible hose is used it shall be of a type approved for marine use with high resistance to salt water, petroleum oils, heat and vibration and should be so listed or labeled.

(b) Fuel line and vent line connections shall be made with fittings approved for marine fuel system use and should be so listed or labeled.

(c) Valves, strainers and other accessories shall be approved for marine fuel system use and should be so listed or labeled.

(1) Manually operated valves shall be designed with positive stops in the open and closed positions or shall clearly indicate their open and closed positions.

(d) Clips or straps for securing fuel pipes shall 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 1½ inches I.D. 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 closable 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 flange plate which should indicate the type of fuel to be used.

(c) Where a nonmetallic hose is used as a flexible section of the fill pipe, it shall be tightly secured at each end. The flexible section shall be accessible and as near the upper end of the fill 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. [See also Par. 513(c)]

(2) Clamps depending solely on the spring tension of the metal and clamps having a metal width of less than ½ inch shall not be used.

(3) On smooth pipe or spud connections, the clamp shall be not less than 1 inch from the end of such connections and not less than one clamp width from the end of the hose. Where the connection is to a flare, bead, serration, or other nonslip spud configuration, the clamp shall be beyond the bead or flare or fully on the serrations and not less than one clamp width from the hose end.

(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 minimizing 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 inside diameter of the vent pipe shall be 9/16 inch.

(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 the independent electric pump systems may be used provided that they are energized only when the engine is turning over.

(1) Electric fuel pumps, where used, shall be located at the engine end of the fuel line.

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

(1) Where possible, 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) Where fuel tanks are located in a compartment other than the engine compartment, an approved manual stop valve shall be installed at the engine end of the fuel line to stop fuel flow when servicing the engine. Such valves should be listed or labeled for marine use.

(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 and which should be so listed or labeled. 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.

(1) Locked-in torsional stresses shall be avoided in the fuel line.

(2) The flexible section shall be of sufficient length in excess of the proper distance between the points of connection to assure its proper function.

(3) Where it is reasonable to provide for use of continuous reinforced nonmetallic hose between the fuel tank shutoff valve and the engine connection, such may be used prcvided the fuel line is accessible throughout its entire length.

(e) All accessories, not including fittings, installed in the fuel line shall be adequately 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 stoves shall be effectively insulated with noncombustible materials 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 approved for marine use and should be so listed or labeled.

(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 U. S. Department of Transportation (DOT) 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 DOT 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 shut-off 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 with each 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) The outlet termination 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 with pilot lights, glow plugs, switches, etc., shall have them 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 material; 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 waterline.

(3) Installation of gas equipment in lockers or housings shall be such that when the means of access to the lockers or housings

is open, the container valves can be conveniently and quickly operated and the system pressure gage dials are 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 nonabrasive 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 master 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 U. S. Department of Transportation.

(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 with pilot lights, glow plugs, switches, etc., shall have them so protected as to prevent ignition of external vapors or addition of further combustible material to those vapors.

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 with pilot lights, glow plugs, switches, etc., shall have them 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) Heating boilers shall be of types approved for marine use.

(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. DIRECT CURRENT 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 liquidtight tray of adequate capacity to retain normal spillage or boilover of the electrolyte. It shall be constructed of, or lined with materials resistant to deterioration by the electrolyte.

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

526. 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 practical. The switch control shall be so located 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
¼	.250	8, 10 Awg
5/16	.3125	6 Awg
⅜	.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.).

(c) Wiring leading to engine-mounted electrical components may be formed into a coil so as to minimize the effect of vibration.

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.

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

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

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.

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

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

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. ALTERNATING CURRENT ELECTRICAL SYSTEMS

NOTE: The recommended practices and standards in this section are intended as a guide for the design and installation of single phase Alternating Current (AC) Electrical Systems operating at potentials under 300 volts on boats.

60. Definitions.

601. GROUND — Applies to the potential of the earth's surface and is established by a conducting connection (intentional or accidental) with the earth, including any conductive part of the wetted surface of a hull.

602. GROUNDED CONDUCTOR — A current-carrying conductor connected to the side of the source which is intentionally maintained at ground potential.

603. 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.

61. Circuit Arrangement.

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

62. General.

621. It is recommended that the AC system be designed for a nominal system voltage of 115/230 VAC. However, boats confined to a specific geographic location may be designed for the available nominal system voltage in the area.

622. A frequency of 60 cycles per second will be considered standard for AC powered systems on boats.

623. Motors, generators and other electrical equipment intended to be installed in machinery spaces shall be designed for operation in an ambient temperature of no less than 50°C (122°F). Where equipment is designed for use outside of machinery spaces in cabins or on deck, etc., the designed ambient temperature may be reduced to 40°C (104°F).

624. All component parts of the system shall be designed, constructed and installed so as to perform with safety under the environmental conditions of continuous exposure to vibration, shock, corrosion in salt atmosphere and high humidity.

625. The system shall be permanently installed in such a manner as to provide a maximum protection against electrical shock for persons on the boat, persons in the water in contact with the boat, and persons in contact with the boat and a grounded object on shore.

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

63. Equipment.

631. All appliances and fixed AC electrical equipment used on boats shall be so designed 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, depending on the location of the device and its intended usage.

(a) The frames of all electrical appliances and equipment shall be grounded to the hull of metallic boats or to the bonding system of non-metallic boats.

632. Electrical equipment 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.

633. Shore power polarity devices should not be used with the systems recommended by this standard since the systems on the boat are not polarized and the device itself could introduce an artificial ground.

634. All switches and circuit breakers used in the circuit shall be of an approved type that will simultaneously disconnect both

current-carrying conductors, except that switches which are an integral part of permanently installed cabin lighting fixtures may be of the single pole type.

64. Electrical Meters.

641. A system voltmeter installed to read input voltage from shore and/or the output voltage of on-board AC generators, shall be provided and mounted in a readily visible location, except that a voltmeter need not be provided for simple systems with straight resistive loads (lighting and heating, etc.).

(a) It is recommended that the system voltmeter be marked with voltage limit markings plus and minus ten (10) per cent of the designed nominal system voltage.

65. Receptacles and Plugs.

651. All receptacles and matching plugs shall be of the grounding type and shall conform to the configurations described in USA Standard C73 for the voltage and current to be used.

(a) Receptacles provided on the boat for purposes of connecting the boat's shore power cable shall be of the reverse service type.

(b) Receptacles located on deck, in cockpits or other exposed areas shall have self-closing water-tight caps.

(c) It is recommended that receptacle boxes be of an approved non-metallic type.

652. A shore power cable, compatible with the shore power receptacle and the power rating of the boat shall be provided by the manufacturer of the boat.

66. Recognized Types of Circuit.

661. THREE WIRE SHORE GROUNDED SYSTEM — This system utilizes directly the shore grounded and ungrounded conductors, together with both the shore grounding wire and boats ground to keep the exposed non-current-carrying parts of the system at ground potential. This system may be used on any non-metallic 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 where no problems with galvanic corrosion are anticipated or where protection against galvanic corrosion is provided by means of a suitable cathodic protection system.

(a) The shore current-carrying conductors shall be connected from the shore connection (reverse service receptacle) through overload protective devices to the boat's AC electrical system. Where the shore power receptacle is not readily accessible to serve as a shore power disconnect, a disconnect switch complying with Paragraph 634 shall be provided between the shore power connection and overload protective devices.

(b) Neither current-carrying conductor shall be grounded on the boat.

(c) 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 will not be considered adequate for purposes of grounding the non-current-carrying parts of the AC electrical system.

662. Isolation Transformer System — This 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 ground. The isolation transformer 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) The shore current-carrying conductors shall be connected from the shore connection (reverse service receptacle) through overload protective devices in each conductor to the primary windings of the isolation transformer.

(b) The shore current-carrying conductors shall not be grounded on the boat.

(c) Where the shore power receptacle is not readily accessible to serve as a shore power disconnect, a separate disconnect complying with Paragraph 634 shall be provided between the shore power connection and the overload protective devices.

(d) The shore grounding conductor shall be connected through the shore power receptacle 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.

(e) It is recommended that the secondary circuit of the isolation transformer be ungrounded throughout the system. However, a polarized system with one side of the circuit purposely held at boat ground potential may be used.

(f) 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.

67. Circuit Protection for AC Circuits.

671. Each current-carrying conductor from the shore-power inlet receptacle to the main AC switchboard or panel, except the grounded neutral of a three-wire, single phase 115/230 VAC service, shall be protected from excessive current by circuit breakers or fuses having a rating equal to no more than 125 per cent of the total normal load.

672. Where port and starboard shore-power inlet receptacles are provided, overload protection shall be provided for each receptacle.

673. Overload protection shall be provided at the generator in all ungrounded conductors.

674. Fuses or trip-free circuit breakers shall be provided at the main AC switchboard for all current-carrying conductors to distribution panels. Where a main disconnect switch is provided for the panel in the main switchboard, the overload protection shall be located between the switch and panel.

675. All current-carrying conductors of branch circuits shall be provided with suitable overload protection at their points of connection to the main switchboard or distribution panel bus. Each fuse or trip-free circuit breaker used for this purpose shall be rated according to either the current rating of the smallest feeder wire between the overload protection device and the load or the maximum current rating of the device being served, whichever is less. Up to four 115-volt AC outlets rated at 15 amperes each may be serviced in the same circuit provided that the circuit is fused at 15 or 20 amperes, depending on the current-carrying capacity of the complete circuit (wiring, connectors, etc.). Special-purpose, 115-volt AC outlets rated above 15 amperes shall be wired separately and, provided that the circuit capacity is adequate, each shall be fused at the rating of the receptacle. Thermal overload devices without manual controls should not be used at the power source.

676. Each circuit supplying a motor or motor-operated device shall be protected by an overload device that is responsive to the motor current. The overload device shall not be rated at more than 125 per cent of the motor full load current rating.

CHAPTER 7. FIRE EXTINGUISHING EQUIPMENT.*

70. Introductory Information.

701. 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.

702. 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.

(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

---

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

Table 8.

FIRE EXTINGUISHERS

Type of Extinguisher	Fire Suitability			Subject to Freezing	Annual Maintenance Required*	Operating Precautions
	A	B	C			
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.

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.

71. General.

711. 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.

72. Equipment.

721. 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.

722. 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.

73. Installation.

731. 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.

732. 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.

(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.

---

*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.

(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 8. OPERATION AND MAINTENANCE.

80. 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.

81. Hull.

811. The entire boat should 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.

812. 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 long enough to free compartment of hazardous vapors before starting main or auxiliary engines.

(c) Vent (open) the entire boat before operating any appliances.

82. Engines.

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

(a) Before starting any engine.

(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.

83. Fuel Systems.

831. 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.

832. 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 container or in a portable tank as provided by manufacturers of outboard engines and shall be safely stowed outside of engine or living compartments.

833. 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) Extinguish all open flames.

(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) Vent (open) the entire boat as recommended in Paragraph 812 before starting any engines or operating any appliances.

84. Cooking, Heating and Auxiliary Appliances.

841. 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 containers, stowed in a safe location outside engine compartment.

842. 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 personnel 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.