NFPA No.
302
File: 300 *Series*
Marine

Fire Protection Standards for MOTOR CRAFT

May
1960

Fifty Cents*

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston 10, Mass.

10M-6-60 R&S-RP *Discount for quantities Printed in U.S.A.

National Fire Protection Association

International

Executive Office: 60 Batterymarch St., Boston 10, Mass.

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes two hundred national and regional societies and associations (list on outside back cover) and nearly eighteen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This is one of a large number of publications on fire safety issued by the Association; a complete list is available without charge on request. All NFPA standards adopted by the Association are published in the **National Fire Codes** which are re-issued annually. The standards, prepared by the technical committees of the NFPA and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the Association to participate in the development of the standards and to secure impartial consideration of matters affecting them. Complete information on Committees will be found in the NFPA Year Book.

Official NFPA Definitions

SHALL is intended to indicate requirements.

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

APPROVED refers to approval by the authority having jurisdiction.

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 = 24.50 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The suitability of devices and materials for installation under these standards is indicated by the listings of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, the Factory Mutual Laboratories and the American Gas Association (gas devices) test devices and materials for use in accordance with the appropriate standards, and publish lists which are available on request.

Fire Protection Standards for Motor Craft.

(PLEASURE & COMMERCIAL)

NFPA No. 302-1960

Foreword.

This 1960 edition of "Fire Protection Standards for Motor Craft" adopted by the National Fire Protection Association May 16-20, represents the cumulative result of thirty-five years of attention to fire safety of pleasure and commercial power boats by the National Fire Protection Association. Under the title "Appendix D" of "Regulations Governing Marine Fire Hazards", the first edition of these standards was adopted by NFPA in 1925. Following amendments in 1926 and 1930, a revised edition was adopted in 1936 which was superseded in 1939 and again in 1948. This in turn was completely revised two years later and the following revised text is that of the 1950 edition incorporating the amendments adopted each year 1950-55, 1957, 1959 and 1960. Part III on outboard powered boats was added in 1957. This text was prepared by the Committee on Motor Craft and Marinas, endorsed by the Committee on Marine Fire Protection and adopted by the Association in annual meeting.

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 these Standards 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.

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

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

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TABLE I.

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.

Definitions.

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

APPROVED—acceptable to the authority having jurisdiction.

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

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

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

PART I.—GASOLINE POWERED BOATS.

CHAPTER 1. HULL.

11. Arrangement.

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

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

(b) Bilges of machinery and fuel tank spaces should be separated from bilges of accommodation spaces by tight bulkheads of double diagonal wood, marine plywood, steel plate, or equivalent construction.

(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. Combustible materials shall not be used for acoustical or thermal insulation of compartments.

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

123. Combustible fabrics should not be used for finishing interior surfaces such as cabin ceilings and sidings.

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 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.

(a) Fuel tank compartments should have similar ventilation provisions.

132. The following provisions are recommended for compartment ventilation:

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

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

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

(d) 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. Where engines and/or tanks are not in closed compartments, at least one ventilating duct should be installed in the fore part of the boat and one in the after part, both provided with exterior fittings as per Sec. 132 (c).

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

(a) If power exhaust blowers are used, motors shall be installed outside of ducts and as high above the bilge as possible. Location of power exhaust blowers just under the deck at side is recommended with inspection or repair access provided by easily removable panels or otherwise.

14. Lightning Protection.*

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

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

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

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*For detailed information on protection of shore structures, see Code for Protection Against Lightning (NFPA No. 78) published in National Fire Codes, Vol. V and in separate pamphlet by the National Fire Protection Assn.

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° 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.

144. 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.

CHAPTER 2. ENGINES.

21. Main Engines. Main engines shall be suitable in type and design for propulsion requirements of the hull in which they are installed and capable of operating at constant marine load under such requirements without exceeding their designed limitations.

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

212. Carburetors shall be of an approved marine type.

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

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

(c) Air intakes must be fitted with an approved backfire flame arrester.

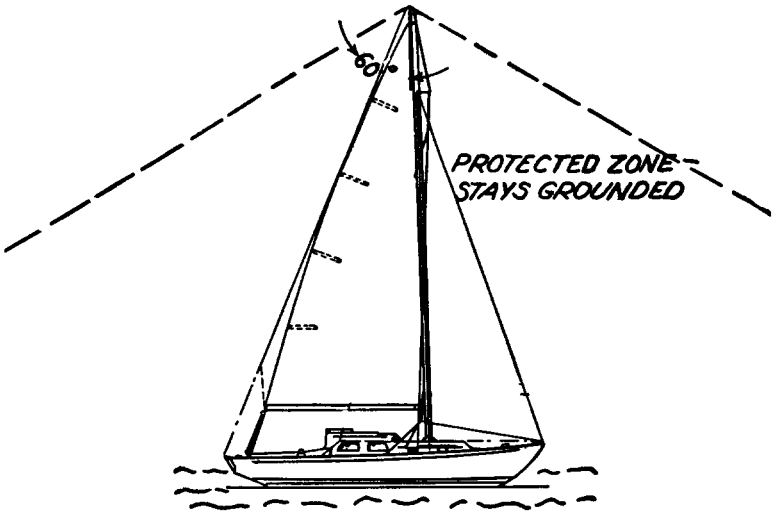
(d) Carburetor should be constructed completely of corrosion resistant metals.

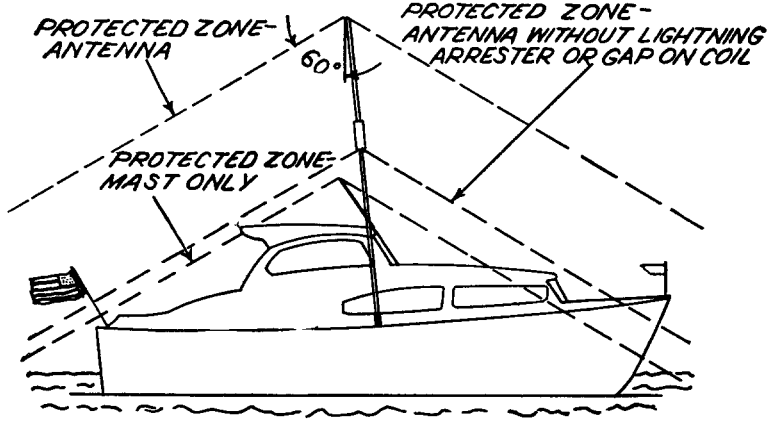
213. Starting motors, generators and any spark producing device shall be mounted as high above the bilges as practicable.

(a) Open end generators shall have effective flame arresting provisions.

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

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





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.

(a) When engine is fresh-water cooled and exhaust pipe is cooled by a separate water cooling system, a suitable warning, visible or audible at the operating station, shall be provided to indicate any failure of water flow in the exhaust system.

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. **Pressed steel crank cases should not be used.**

218. Air-cooled engines may be used for propulsion of an open boat only, 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 is water cooled and installed in accordance with Paragraph 232.

(d) A suitable audible warning alarm or automatic engine cutoff is installed to indicate any failure of water flow in the exhaust system.

219. When air-cooled engines are enclosed or decked over in an open boat the following provisions shall 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:

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

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

(c) Engine exhaust system is water cooled and installed in accordance with Para. 232.

(d) A suitable audible warning alarm or automatic engine cutoff is installed to indicate any failure of water flow in the exhaust system.

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 Exhausts.

231. MATERIALS.

(a) Cast or wrought iron piping is recommended for exhaust lines.

(b) Copper tubing may be used provided its nominal wall thickness is not less than the following:

2 in. O.D.	.083 in.	No. 14 B.W.G.
4 in. O.D.	.109 in.	No. 12 B.W.G.
6 in. O.D.	.134 in.	No. 10 B.W.G.

1. Copper tubing with nominal wall thickness of .065 in., No. 16 B.W.G. may be used up to 3 in. O.D., in open boats or runabouts, if extreme lightness is essential.

(c) A non-metallic flexible section may be used in the exhaust piping if necessary to compensate for vibration.

1. Non-metallic tubing so used shall be especially adapted to resist action of oil, acid and heat, and have a wall thickness sufficient to prevent collapsing or panting.

(d) Full length non-metallic exhaust piping may be used. Such piping shall be especially constructed for internal combustion engine exhaust line use and so labeled. It shall have a built-in reinforcing spiral round wire winding located in the outer half of the tubing wall, and shall have soft attachment cuffs 4 in. in length for exhaust sizes up to and including 4 in. I.D. and 6 in. in length for exhaust piping of larger diameters.

232. INSTALLATION.

(a) Water for cooling the exhaust pipe shall be injected into the exhaust system as near to the engine manifold as practicable, and pass through its entire length. Water shall be obtained from the engine cooling system or a separate engine-driven pump which shall not be used for any other purpose.

(b) That part of the exhaust system between the point of cooling water injection and the engine manifold shall be water-jacketed.

(c) All parts of the exhaust system shall be adequately supported.

(d) Exhaust piping shall be led to the point of escape without traps and with a minimum number of bends or elbows. Ninety-degree elbows or bends of less than five diameters' radius shall not be used. The exhaust piping shall be so arranged as to prevent back-flow of water from reaching engine exhaust ports under any condition.

(e) Where exhaust piping pierces non-watertight bulkheads, or partitions, it shall have a minimum clearance of 2 inches. Where it passes through watertight bulkheads, non-combustible packings shall be used in the gland.

(f) Where a non-metallic flexible section is installed, or where full length non-metallic piping is used:

1. A substantial length of the exhaust system, cooled in accordance with Para. 232(a) and 232(b) shall be between the exhaust manifold and the point of attachment of the flexible section or full length tubing.
2. The flexible section or full length piping shall not be bent sufficiently to stress unduly or crimp inner or outer linings, or to permit local impingement of exhaust gases.
3. The ends shall overlap metallic tubing connections by the full length of the soft attachment cuffs provided in accordance with Para. 231(d). They shall be tightly secured by two suitable corrosion-resistant metal clamps at each end.

(g) In vertical exhaust systems the exhaust piping between the engine manifold and the silencer shall be water-jacketed. The silencer shall be properly lagged with fire resistant material and supported by suitable steel hangers.

1. A clearance of at least 9 in. shall be maintained between the silencer and any woodwork.

2. Adequate spark arresting equipment shall be provided within the silencer.

CHAPTER 3. FUEL SYSTEMS.

30. Because of the fire and explosion hazards from leaking fuel in boats it is imperative that the materials used, the design, the construction and the installation of all parts of fuel systems be to the highest standards.

31. Fuel Tanks

311. MATERIALS.

(a) All fuel tanks shall be constructed of corrosion-resistant metals and alloys, or of iron or steel both of which shall be galvanized completely inside and outside by the hot dip process.

(b) Materials and minimum nominal sheet thickness shall be in accordance with Table II or equal. Tanks larger than 150-gallon capacity shall be constructed of material not less than the minimum thickness indicated for tanks of 81-150-gallon capacities and the design of such tanks must be suitable for the larger capacity.

312. CONSTRUCTION.

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

(b) Tanks of rectangular or specially shaped sections should have rounded edges. Slightly crowned surfaces are recommended.

1. Edges should be rounded to an inside radius of not less than twice the thickness of the bent sheet.

(c) Tanks with flanged-up top edges, that may trap and hold moisture, shall not be permitted.

(d) 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.

(e) Tanks shall be fitted with a substantial bonding terminal welded or brazed to the tank at the fill pipe connection.

(f) Tank seams shall be joined by one of the following methods:

(1) Fusion welded-metal arc (See Table II, 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) Welders employed in the construction of gasoline tanks should be experienced and be capable of producing ductile and pore free welds. It is highly important that welders, resistance welding machines and procedures be qualified at regular intervals to be certain that high quality standards are maintained. Finished welds should be of the same general composition as metal being joined.

(h) Galvanizing of ferrous metal tanks shall be done after fabrication to assure a complete and uniform interior coating free from dirt and dross.

(i) Pipe connections shall be threaded spuds, welded or brazed to the tank. Spuds must have sufficient flange area to afford good local reinforcement of tank opening.

(j) Where fuel level gages are used the flange to which gage fittings are attached, shall be welded or brazed to the tank.

(k) Tanks exceeding 18 inches in any horizontal dimension shall be fitted with vertical baffle plates at intervals not exceeding 18 inches.

1. Baffle plate flanges, separate from baffle plates, may be used.
2. Baffles shall be of the same material as the tank walls and at least equal in strength.

TABLE II.

MINIMUM PLATE THICKNESS FOR GASOLINE FUEL TANKS.

MATERIAL	SPECIFICATION	TANK CAPACITIES	
		1 to 80 gal.	81 to 150 gal.
Nickel-copper	B127-49T Class A	.037 in. 20 G	.050 in. 18 G
Copper-nickel	B122-48T Alloy ※5	.045 in. 17 G	.057 in. 15 G
Copper	B152-48T Type ETP	.057 in. 15 G	.080 in. 12 G
Copper-Silicon	B97-47T Types A, B & C	.050 in. 16 G	.064 in. 14 G
Steel sheet	A93-46	.0747 in. 14 G	.1046 in. 12 G

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

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

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

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

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

3. Flanges shall be bent to an inside radius not less than twice the thickness of the flanged sheet.

4. Flanges of similar baffle plates shall be of proportionate lengths, and attachments shall be such as to equalize stresses on the tank walls. The aggregate attachment of baffle flanges shall extend not less than 75 per cent of the dimension of the tank wall at the line of contact.

5. Baffle flanges shall be welded or brazed to tank walls. Baffle plates shall be welded, brazed or riveted to flanges.

(l) Fuel tanks shall be designed and constructed to withstand an internal pressure of 3 pounds per square inch without deformation or leakage. Each shall be tested to that pressure by the manufacturer for joint and fitting leakage as determined by liquid detergent or soapy water solution, applied to all joints or by an equivalent means of leak detection. Tanks should also be tested by the boatbuilder prior to installation.

(m) All fuel tanks shall bear a legible, permanent label, located close to the feed pipe spud, signifying compliance with these standards and including the following:

(1) Manufacturer's name and address.
(2) Date of construction.
(3) Tank wall thickness in decimals of one inch and capacity in U. S. gallons.
(4) Material of construction designated NC (nickel-copper), CN (copper-nickel), C (copper), CS (copper-silicon), and GS (galvanized steel).

313. LOCATION.

(a) Fuel tanks shall be accessibly located.

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

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

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

314. INSTALLATION.

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

1. If tank locations are such as to prevent ready inspection of label plates [Para. 312(m)], small hatches or deck plates shall be provided for that purpose.

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

(c) Flat bottom tanks shall be installed on wooden platforms, slatted to prevent moisture accumulation, and supporting the entire length of the tank.

(d) Tanks, other than flat bottom types, shall be set in chocks or cradles, securely fastened to hull structural frame, and of sufficient size and number for proper support. Small tanks may be suspended from deck beams.

(e) Adequate support and bracing to prevent any movement of tanks shall be provided. Design of tanks should permit the placing of braces and supports in the same plane with tank baffle plates.

(f) All wood or metal surfaces of tank supports and braces shall be effectively insulated from contact with tank surfaces by a non-abrasive and non-absorbent material. Rubber impregnated heavy cotton fabric or acid and oil resistant plastics, are recommended.

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

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

321. GENERAL.

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

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

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

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

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

322. MATERIALS.

(a) All fuel pipes and related accessories shall be of such composition as to be highly resistant to corrosion.

(b) Fuel pipes shall be of copper, nickel-copper or copper-nickel with minimum nominal thickness of 0.049 inch except:

1. Where flexibility is desired, approved flexible hose especially designed for high resistance to salt water, petroleum oils, heat and vibration may be used.
2. Fill pipes associated with galvanized steel fuel tanks may be of galvanized steel pipe.

(c) Fuel line connections shall be drawn or forged metal of the flared type in accordance with *Specifications for Refrigeration and Marine* of the Society of Automotive Engineers, or of the flared types listed for use with hazardous liquids by Underwriters' Laboratories.

1. Types of connections depending solely on compression against outside of tube for tightness shall not be used.

(d) Valves shall be of the packless type or equivalent, approved for marine use, and marked or otherwise arranged to indicate open or closed position.

1. Open end cocks of any type shall not be used in fuel lines.

(e) Strainers shall be of a type approved for marine use with bolted, dogged, bale, or compression gland bonnets.

(f) Straps for securing fuel pipes must be of a soft metal with no sharp edges.

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.P.S. It shall be made tight to tank top and to deck plate located outside of coaming.

1. Fill pipe should run as directly as possible, preferably in a straight line from deck plate or other 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 the marking "FUEL" on the deck plate flange.

(c) Where a flexible fill pipe section is necessary, an approved metallic type is recommended. When a non-metallic section is used, it shall be in accordance with Para. 322(b)1. Such hose must overlap metallic pipe ends at least 1½ times the pipe diameter. It shall be tightly secured at each end by two suitable clamps of corrosion-resistant metal. Flexible section shall be accessible and as near the upper end of the filling pipe as practicable.

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

(d) When, because of offset, sounding of tanks through fill pipes is impossible, other methods of indicating fuel level must be used provided Para. 312(d) 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 termination should be as remote as practicable from any hull opening. The discharge end of the vent pipe shall have provisions preventing intake of water without restricting the continuous 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) Vent pipe shall be not less than ⅝-inch O. D. copper tubing. If fill pipe extends to near tank bottom the vent pipe should be not less than ¾-inch O. D. copper tubing.

(h) Vent pipe outlets shall have removable flame arresters as protection against flash-back from outside source of ignition and arrester screens should be kept clear by cleaning or renewal as necessary. Any device used must not reduce net vent area.

324. INSTALLATION OF FUEL FEED LINES AND ACCESSORIES.

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

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

1. It is recommended that the fuel line be run at the level of tank top to a point as close to the engine connection as practicable.

(c) A shut-off valve shall be installed to close against fuel flow directly at the tank connection. Arrangement shall be provided for operating this valve from outside the compartment in which tanks are located, preferably from above deck.

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

(d) That part of the fuel feed line secured to hull members shall be separated from that part secured to the engine by a short length of approved metallic-reinforced flexible tubing with approved connection fittings. This flexible connection shall meet the requirements of Para. 322(b)1 and should maintain metallic contact between the sections of the fuel feed line connected. If such contact is not maintained the fuel tank shall be specifically grounded.

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

CHAPTER 4.

COOKING, HEATING AND AUXILIARY APPLIANCES.

40. Open flame devices are more liable to promiscuous, unskilled or ignorant operation than any other boat equipment involving fire risk. It is therefore imperative that such items be selected and installed with the aim of minimizing personal and physical hazards.

41. Cooking Equipment.

411. Galley stoves shall be manufactured, approved and labeled for marine use. Printed instructions for proper installation, operation and maintenance shall be furnished by the manufacturer. A durable and permanently legible instruction sign covering safe operation and maintenance shall be provided by the manufacturer and installed adjacent to the consuming appliance.

(a) Burner assemblies of stoves using liquid fuels shall be easily demountable and stoves so placed as to facilitate this operation.

(b) For liquid burners where wet priming is used a liquid tight catch pan not less than ¾ in. deep shall be inside the frame of the stove and immediately beneath all burners.

(c) Stoves shall be permanently and securely fastened in place, and in compliance with Para. 113.

1. Stoves should not be located in the same compartment with machinery. Where location in the machinery compartment is unavoidable, stoves should be located as remote as practicable from engines.

(d) All woodwork above stove tops and all other woodwork within 18 in. surrounding stoves shall be effectively protected with a noncombustible material. A recommended means is the use of a ⅛-in. asbestos board covered with sheet metal with an air space of at least ¼-in. between the protected woodwork and the asbestos board.

412. Coal, Charcoal and Wood Burning Stoves.

(a) Installation of this type of stove should preferably be on a hollow tile base. If not they must be mounted on legs providing clearance of at least 5 in. between stove bottom and deck and set on metal covered asbestos board.

(b) Stove sides and back must have a minimum clearance of 4 in. from the woodwork protection provided in accordance with Para. 411(d).

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

(d) Smoke pipes or stacks shall terminate with an approved smokehead 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. Bubble feed, wick type burners, or any system which may be affected by motion of the vessel shall not be used.

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

1. Pressure tanks shall be able to withstand an internal pressure of at least 200 pounds per square inch.
2. Pressure tanks may be installed integrally with stoves provided they are effectively protected from the heat of the burners.
3. If not installed integrally with stoves, pressure tanks must be rigidly secured in an accessible location permitting convenient filling and pump operation.
4. Gravity tanks shall be substantially secured remote from stove.
5. Gravity tanks should not exceed 2 gallons capacity. Tanks of larger capacity shall be in accordance with Section 31.
6. Gravity tanks should have provision for filling and venting outside galley space.

(c) Fuel lines for all stoves must be continuous from tank to stove manifold.

1. For gravity feed a stop valve shall be installed at the tank and if, as is preferred, tank is outside of galley space, a stop valve is also required at the stove.

(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. *Gasoline stoves shall not be used on boats.*

42. Liquefied Petroleum Gas Systems.

421. GENERAL.

(a) The term "liquefied petroleum gas(es)" as used herein shall mean and include any product predominantly composed of any or a mixture of the following hydrocarbons: propane, propylene, butanes (normal butane or isobutane), and butylenes. For the purposes of this section, the term "system(s)" shall mean all component parts including gas-consuming appliances.

(b) 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,

but upon relief of the pressure 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. Their vapors may tend to sink to the bottom of an enclosed compartment into which they are released, 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 can be explosive if ignited.

(c) 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.

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

(e) 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.

(f) 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.

(g) All component parts of systems other than cylinders and low pressure distribution tubing between regulators and appliances shall be listed by Underwriters' Laboratories, Inc., or other recognized testing laboratory and so labeled.

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

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

CAUTION

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

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

3. Always apply match or flame to burner and then open burner valve.

4. Close master valve whenever consuming appliance is not in use.

5. Test system for leakage at least bi-weekly and after any emergency in accordance with the following procedure:

With appliance valves closed, the master shut-off valve on the appliance open, and with one cylinder valve open, note pressure on the gage. Close cylinder 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. Never use flame to check for leaks. Repeat test for each cylinder in multi-cylinder system.

(j) The required caution signs shall be installed in plainly visible locations on the outside of the cylinder enclosure and adjacent to the consuming appliance.

422. CYLINDERS.

(a) Cylinders shall be constructed, tested, marked, maintained and requalified in accordance with the regulations of the Interstate Commerce Commission. Additionally, cylinders intended for marine service shall be marked to indicate compliance with these standards. No cylinder shall continue in marine service unless it has been requalified by hydrostatic test in a water jacket to original specifications within 12 years of its manufacture and at intervals of not greater than 5 years thereafter. Visual inspection of cylinders in accordance with I.C.C. requirements shall be made at each recharging and at the time of each testing. Before each requalification, every cylinder shall be cleaned to bare metal, removing all paint, corrosion, and any foreign substance, by sandblasting, caustic solvents or any other method that best accomplishes the desired purpose.

(b) Cylinder markings shall include the following: the I.C.C. specification under which the cylinder was fabricated followed by the service pressure in pounds (for example, I.C.C. 4B 240); the serial number and the registered identifying symbol of the purchaser, user, or manufacturer of the cylinder; the dates (month and year) indicating compliance with I.C.C. requirements for requalification; the water weight capacity and the tare weight in pounds (including all attached fittings, but not including the protective cap).

(c) Prescribed cylinder markings shall be maintained in a legible condition. Particular attention shall be paid to the cleaning out of all rust pits, gouges or digs anywhere on the cylinder body and crevices around foot rings and head rings, and to determine the depth of such imperfections. Cylinders shall be maintained free from corrosion, and those returned to service properly coated for such protection.

(d) Each cylinder that has become due for requalification shall bear a date followed by the appropriate letter as required by I.C.C. Regulations [refer to I.C.C. Section 73.34 (j)], indicating that it is in compliance with the requirements of the Interstate Commerce Commission.

(e) Regardless of the date of the previous test, a cylinder must be condemned and withdrawn from service when it leaks; when corrosion, denting, bulging or other evidence of rough usage exists to the extent that the cylinder is likely to be weakened appreciably; when it has lost more than 5 percent of its tare weight, or when it has been involved in a fire.

(f) Cylinders shall be charged with gas in accordance with the Regulations of the Interstate Commerce Commission as follows:

1. The liquid portion, if any, of the gas must not completely fill a cylinder at 130° F.

2. The pressure in the cylinder at 70° F. must not exceed the service pressure marked on the container.

423. VALVES AND SAFETY RELIEF DEVICES.

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

(b) All cylinders shall be equipped with safety relief devices, approved by the Bureau of Explosives, and found to prevent explosion of the normally charged cylinder when it is placed in a fire. These devices shall be a shut-off valve with integral spring loaded safety relief valve and a supplementary fusible plug.

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

(d) In addition to the valve required at the cylinder, a dual cylinder system shall be provided with a two-way positive shut-off valve of manually operated type at the manifold.

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

424. REDUCING-REGULATOR.

(a) All systems shall be provided with a regulating device, so adjusted as to release 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 the regulator; it shall be set to start to discharge at not less than two times and not more than three times the delivery pressure.

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

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

(e) All reducing-regulators 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 cylinder valve to and including the appliance valves, for leakage. It is recommended that this test be made at least bi-weekly and after any emergency. No leakage, even of a seeping character, should be tolerated.

425. PIPING AND FITTINGS.

(a) All low pressure distribution tubing between regulator and appliances shall be copper tubing of the standard grade K or L or equivalent and shall have a minimum wall thickness of 0.032 inches. All high pressure tubing between cylinders and regulators shall have a minimum wall thickness of 0.049 inches.

(b) Tube connecting fittings shall be of drawn or forged yellow metal, of flared type, listed for use with gas or hazardous liquids by Underwriters' Laboratories, Inc., or other recognized testing laboratory; or connections may be soldered or brazed with a material having a melting point in excess of 1000° F.

426. APPLIANCES.

(a) All gas consuming appliances shall have their correctness as to design, construction and performance, in liquefied petroleum gas service, certified as follows:

1. Determined by a nationally recognized testing agency, adequately equipped and competent to perform such services, which shall be evidenced by the attachment of its seal or label to such gas appliances. This agency shall be one which maintains a program of national inspection of production models of gas appliances at least once each year on the manufacturer's premises. Approval by the American Gas Association Laboratories, as evidenced by the attachment of its Listing Symbol or Approval Seal to gas appliances and a certificate or letter certifying under the above mentioned requirements, or Listing by Underwriters' Laboratories, shall be considered as constituting compliance with the provisions of this section.

2. Such appliances must also be approved for *marine use* by the authority having jurisdiction and comply with applicable parts of Section 411.

(b) A master packless shut-off valve, controlling all burners simultaneously, is required at the manifold of all appliances.

(c) Cooking stoves, domestic hot water heaters and cabin space heaters shall comply with the applicable provisions of Sections 41–43.

1. Continuous burning pilot flames are not approved for use on any gas burning appliance when installed below the main deck.

2. Refrigerating machines operated by flame shall not be used.

(d) Gas-fired cabin space heaters shall be of the sealed combustion type, full vented to the outside atmosphere, and with combustion air taken from outside the hull and cabin.

1. Open flame gas heaters shall not be used.

427. LOCATION AND INSTALLATION.

(a) Cylinders, regulating and safety equipment shall be substantially secured, readily accessible, and so located that vapor escaping from any cause 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 semi-enclosures and equipment so placed shall be protected from climatic extremes by a housing vented to open air near the top and bottom.

2. If construction or design prevents compliance with locations specified above, the cylinder, regulating and safety equipment may be mounted in a vapor tight locker located above the waterline in an open cockpit provided the locker:

   (1) Is constructed of or lined with corrosion resistant metal.

   (2) 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 cylinder valves and testing of system for leakage.

   (3) 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 container bottom but above the water line.

3. Stowage of high pressure equipment in housings shall be such that the cylinder valves can be conveniently and quickly operated and the pressure gage dial must be fully visible.

4. Housings shall not be used for storage of any other equipment nor shall quick access to the high pressure system be obstructed in any way.

(b) Stowage provisions for unconnected reserve cylinders, filled or empty, shall be the same as the provisions above for cylinders in use. Valves of cylinders, 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 non-ferrous metal clips with no sharp edges in contact with the tubing.

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

3. Lines shall be continuous lengths of tubing from regulator to shut-off at stove manifold.

(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 cylinder valve should be checked for leakage at its outlet and at its connection to the cylinder 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 shut-off valve on the appliance open, and with one cylinder valve open, note the pressure on the gage. Close cylinder 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.

428. PRECAUTIONS.

(a) A cylinder 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 cylinder which is due for retest or inspection shall be charged with fuel until it has been retested or otherwise qualified for service in accordance with the retest and inspection requirements of the Interstate Commerce Commission.

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

(d) Safety relief valves should be inspected for proper seating each time cylinders are presented for filling.

43. Heating Equipment.

431. Service Hot Water Heating Units.

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

(b) Vent stacks should be fitted at the top of heating units 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) Continuous burning or pilot flames shall not be permitted under deck.

432. Cabin Heaters.

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

1. Bubble feed or wick type burners shall not be used for any fuel.
2. Portable heaters shall not be used.
3. Continuous burning or pilot flames shall not be used under deck.
4. Gasoline shall not be used for fuel in open flame liquid or vapor burners.

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

(c) Sealed combustion chamber heaters burning gasoline or fuel oil may be used provided they comply with Para. 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.

442. ICE MACHINES.

(a) Electric machines should have motors located on top of cabinets, or if separate from cabinets, well above bilges.

1. Wiring shall be in accordance with Chapter 5.

CHAPTER 5. ELECTRICAL SYSTEMS.

50. This chapter refers specifically to electrical installations operating at potentials under 50 volts. Those operating at potentials of 50 volts and over shall be in accordance with Electrical Engineering Regulations of the U. S. Coast Guard (CG-259).

It is to be recognized that low voltage installations do not warrant the use of substandard materials or workmanship, particularly in motorcraft where the possible presence of flammable or explosive vapors renders a spark or incandescence from a physical failure liable to serious consequences.

Class I Hazardous Locations as used in this Chapter means locations in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. This definition is in accordance with the *National Electrical Code*.

51. General. 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.

511. The system supply voltage should be determined by the maximum electrical load including consideration for the length of electrical conductors.

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

(b) Circuits added to accommodate additional electrical accessories shall comply with Sub-Paragraph 522 (b).

(c) It is recommended that all direct current electrical systems be of the two wire type. In grounded systems, the connection between the electrical system and ground shall be used only as a means of maintaining one side of the circuit at ground potential and should not normally carry current.

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

513. Each accessory shall be provided with a name plate indicating the maker's name, the rating in volts and amperes or in volts and watts, and when intended for connection to a normally grounded supply, the grounding polarity.

52. Equipment.

521. Generators and motors shall be placed in dry, accessible and adequately ventilated locations.

(a) Generators and motors which are integral parts of propelling engines should be mounted above the crankshaft centerline. (See also Para. 213.)

(b) Independent generators and motors should be mounted on foundations as high as practicable above the bilges to avoid damage by splash or contact with low lying vapors. They shall not be located in low or pocketed positions.

(c) Generators and motors suitable for use in Class I hazardous locations are recommended.

(d) All generators shall be protected from excessive current by circuit breakers or fuses.

(e) Overcurrent protection of a third-brush type generator shall open the field circuit.

(f) An emergency switch shall be provided in the normally ungrounded main supply conductor and shall be located as closely as practicable to the supply battery.

522. Switchboards shall be placed in dry, accessible and adequately ventilated locations, preferably outside the engine compartment. Switchboards shall be metal enclosed and have provision for access to interior. All uninsulated current carrying parts shall be mounted on non-absorbent non-combustible, high dielectric insulating material.

(a) Totally enclosed switchboards of the dead front type are recommended. Wood is not considered acceptable for the enclosure.

(b) Each ungrounded conductor of circuits supplying lights, motors or appliances shall be equipped with a circuit breaker or with switch and fuse at the power distribution panel.

1. Circuit breakers, of the proper voltage rating, shall be of the manually reset type designed for inverse time delay, instantaneous short circuit protection and capable of repeatedly opening the circuit in which it is to be used without damage to the circuit breaker.

(c) Switches other than those mounted on the switchboard shall be of the enclosed type.

(d) If the storage battery is not in the same compartment and adjacent to the panel or box which distributes power to the various lighting, motor and appliance branch circuits the storage battery lead should be fused close to the battery.

523. Batteries shall be so located that gas generated in charging will be easily dissipated by natural or induced ventilation. Large banks of batteries should not be located in the same compartment with a gasoline tank or engine. All batteries shall be protected by a cage or top of non-conductive material to minimize the danger of accidental spark through dropping a metal object across terminals.

(a) Batteries shall be secured against shifting with motion of the boat and shall be accessible.

(b) Battery terminals shall be of the soldered lug type.

(c) Acid batteries should be located in a tray of lead or other suitable material resistant to deteriorating action by the electrolyte.

TABLE III.

ALLOWABLE CURRENT-CARRYING CAPACITIES OF CONDUCTORS.

BASED ON ROOM TEMP. OF 30°C., 86°F.

Size (See *National Electrical Code* for other sizes.)		Capacity of Wire in Amperes	
Gage No. A. W. G.	Area in Circular Mils	Rubber Insulated Types R, RW, RU (Sizes 12-6) Thermoplastic Insulated Types T, TW (All sizes)	Rubber Insulated Type RH
14	4107	15	15
12	6530	20	20
10	10380	30	30
8	16510	40	45
6	26250	55	65
4	41740	70	85
3	52630	80	100
2	66370	95	115
1	83690	110	130

1 Mil = 0.001 Inch Circular Mil Area = Diameter^2

NOTES: The current-carrying capacities listed above are for 1, 2, and 3 conductor cables; 80% of these capacities must be used for 4, 5, and 6 conductor cables, and 70% for 7, 8, and 9 conductor cables.

The allowable current-carrying capacities in this table are based on temperature alone and do not take voltage drop into consideration.

TABLE IV.

CONDUCTOR SIZES FOR AMPERES—LENGTHS.

Total Current on Circuit in Amps.	Length of Conductor in Feet from Source of Current to Most Distant Fixture										
	10	15	20	25	30	35	40	45	50	55	60
	6 Volts Two Wire—10% Drop Wire Sizes (A. W. G.)										
5	14	14	14	12	12	12	10	10	10	10	8
10	14	12	10	10	8	8	8	8	6	6	6
15	12	10	8	8	8	6	6	6	4	4	4
20	10	8	8	6	6	6	4	4	4	4	3
25	10	8	6	6	4	4	4	4	3	3	2
	12 Volts Two Wire—10% Drop Wire Sizes (A. W. G.)										
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	8	6	6	6
25	10	10	10	8	8	8	6	6	6	6	4

TABLE V.

CONDUCTOR INSULATIONS.

Type Letter *	Trade Name	Insulation	Thickness of Insulation		Outer Covering	Max. Operating Temp.	Special Provisions
R	Code	Code-Rubber	14-12 10 8-2 1	2/64 In. 3/64 In. 4/64 In. 5/64 In.	Moisture-Resistant, Flame-Retardant, Fibrous Covering	60°C. 140°F.	General Use
RW	Moisture-Resistant	Moisture-Resistant Rubber	14-10 8-2 1	3/64 In. 4/64 In. 5/64 In.	Moisture-Resistant, Flame-Retardant, Fibrous Covering	60°C. 140°F.	General Use and Wet Locations
RU	Latex	90% Unmilled Grainless Rubber	14-10 8-6	18 Mils 25 Mils	Moisture-Resistant, Flame-Retardant, Fibrous Covering	60°C. 140°F.	General Use
RH	Heat-Resistant	Heat-Resistant Rubber	14-12 10 8-2 1	2/64 In. 3/64 In. 4/64 In. 5/64 In.	Moisture-Resistant, Flame-Retardant, Fibrous Covering	75°C. 167°F.	General Use
T	Thermoplastic	Flame-Retardant Thermoplastic Compound	14-10 8 6-2 1	2/64 In. 3/64 In. 4/64 In. 5/64 In.	None	60°C. 140°F.	General Use
TW	Moisture-Resistant Thermoplastic	Flame-Retardant, Moisture-Resistant Thermoplastic	14-10 8 6-2 1	2/64 In. 3/64 In. 4/64 In. 5/64 In.	None	60°C. 140°F.	General Use and Wet Locations

**See National Electrical Code*

(d) Alkaline batteries employing metal containers shall be mounted on suitable insulating supports and shall be prevented from coming in contact with other metal which may result in a short circuit.

(e) A battery charger intended for connection to a commercial supply voltage at berthing accommodations shall employ a transformer of the isolating type.

1. It is recommended that an ammeter that is readily visible be included in the battery charger circuit.

(f) A voltage dropping resistor provided for charging a battery shall be mounted in a suitably ventilated non-combustible enclosure so installed as to prevent hazardous temperatures at adjacent combustible materials.

524. Radio telephone and other electronic equipment shall be installed only where adequate provision is made for supplying and conducting the maximum power input to the equipment under any condition of normal operation.

(a) On boats constructed hereafter, separate circuits, adequately fused, shall be provided for radio and other electronic equipment.

(b) On existing boats, where provision for spare circuits of adequate capacity has not been made, power for radio and other electronic equipment shall be drawn from the batteries via a separate enclosed safety type switch panel with no two items of equipment powered through the same set of fuses.

(c) Particular attention should be given to the type and location of radio noise suppression devices with respect to the ignition of hazardous atmospheres due to failure of the devices.

525. Accessories, such as switches, fuses, and sockets, shall be standard *National Electrical Code* types for the loads to be carried and shall be of types listed by Underwriters' Laboratories, Inc., or other recognized testing laboratory.

(a) Lighting and appliance switches, and light fixtures in the engine room, forepeak, lazarette, and galley (if LP gas is used) should be suitable for use in Class I hazardous locations. The use of switches suitable for Class I hazardous locations throughout under deck is recommended.

(b) Junction boxes (instead of junction blocks) and Edison base lamps and sockets (instead of bayonet lock type) are recommended.

(c) Magnetic starting switches suitable for use in Class I hazardous locations are recommended where installed close to starting motors.

53. Wiring—Size, Insulation, etc.

531. Ignition wiring as supplied or recommended by engine manufacturers is generally acceptable.

532. Wiring sizes for lighting and power (for appliances) shall be in accordance with Table III.

(a) As a precaution against rupture by vibration all conductors shall be of the stranded type and no conductor smaller than No. 14 A. W. G. shall be used except for short fixture leads or intercommunication wiring as per Para. 532(f).

(b) Table IV indicates the gauge of conductor required for corresponding lengths and steady state (stable) values to obtain a recommended voltage drop of not more than ten per cent at the load terminals of a two conductor circuit. Other values can be computed by means of the following formula:

$$\text{cm.} = \frac{K \times I \times L \text{ (x 2 for two wire circuit)}}{E}$$

Where: cm. = circular-mil area of conductor
K = 10.75 (a constant representing the mil-foot resistance of copper)*
I = Load current in amperes
L = Length of conductor from center of distribution in feet
E = Voltage drop at load in volts

(c) After computing the circular-mil area required, reference should be made to TABLE III for selection of the required conductor gauge size. When the computed circular-mil area is found to be less than any value given in the table, the next larger size conductor is to be used.

(d) Light and power (appliance) conductors for interior wiring shall be insulated in accordance with TABLE V.

1. Where desired, non-metallic sheathed multiple conductor cable may be employed instead of individual conductors.
2. Lead sheathed unarmored conductors and conductors armored with spiral wound flat metal stripping are not approved.
3. Conductors armored with metallic basket weave or helical wire, with or without inside lead sheathing, in accordance with the A.I.E.E. Recommended Practice for Electrical Installations on Shipboard, may be used.
4. Where desired, metallic sheathed cable Type M I, as defined in the *National Electrical Code,* may be used.

(e) Conductors, from exterior water tight receptacles to exterior fixtures, shall be flexible cord in accordance with TABLES VI and VII.

(f) For inter-communication wiring, rubber or thermoplastic covered single braid 1C cable, type RF-32 (rubber covered fixture wire—1/32 in. insulation) stranded and not smaller than No. 16 A.W.G. or equivalent shall be used. Commercial bell wire shall not be used.

54. Wiring—Installation.

541. All wiring shall be run as high as practicable above bilges.

(a) Surface wiring shall be protected in accordance with the *National Electrical Code:* Article 352 for metal raceways, Article 346 for conduit, and Article 348 for metallic tubing. The extended use, however, of conduit is not recommended because of the liability of moisture accumulating therein.

*The value of this constant published by the International Association of Electrical Inspectors is 10.8; the difference in results is so small as to be negligible.

TABLE VI.

FLEXIBLE CORDS.

Type Letter *	Trade Name	Size A. W. G.	No. of Conductors	Conductor Insulation	Outer Covering	Use
S	Hard Service Cord	18 to 10 incl.	2 or More	Rubber Thermo-plastic	Rubber	Pendant or Portable—Damp Places—Extra Hard Usage
SO					Oil-Resistant Compound	
ST					Thermo-plastic	

**See National Electrical Code*

TABLE VII.

ALLOWABLE CURRENT-CARRYING CAPACITY OF FLEXIBLE CORD.

Size A. W. G.	Amperes
18	7
16	10
14	15
12	20
10	25

(b) Concealed wiring may be unprotected, but shall be secured by neat fitting non-ferrous cleats with rounded edges spaced not over 14 inches apart

(c) Where it is necessary for wiring to pass through structural members, it shall be adequately protected.

542. Wiring joints and splices shall be mechanically secure.

(a) Splices may be made by insulated pressure wire connectors of a type listed by Underwriters' Laboratories, Inc., or soldered and adequately taped, or by means of a locking type plug connector with sealed ends that is suitable for use in marine atmospheres.

(b) Where ends of stranded conductors are to be clamped under terminal screws, they shall be formed and soldered unless fitted with pressure terminal connectors listed by Underwriters' Laboratories.

543. Conductors shall be protected in accordance with their current-carrying capacities as given in TABLE III.

NOTE: Overcurrent protection for conductors is provided for the purpose of opening the electric circuit if the current reaches a value which will cause an excessive or dangerous temperature in the conductor or conductor insulation.

(a) The conductors supplying motors and motor-operated appliances shall be protected by a separate overcurrent device which is responsive to motor current. This device shall be rated or set at not more than 125 per cent of the motor full-load current rating for an open type motor marked to have a temperature rise not over 40°C and not more than 115 per cent for all other types of motors.

544. The metal enclosures of electrical equipment should be bonded to the metal structure of the vessel or to the common bonding conductor in the case of wooden vessels. In grounded systems, the negative polarity of the supply source should be connected to the bonding system for protective purposes, but shall not normally carry current.

(a) Appliances shall be connected to supply circuits so as to maintain polarity throughout the system to insure against short circuiting.

545. On wooden boats, bonding together of all metal enclosures, frames and supports of electrical equipment including battery trays to a common bond is necessary to guard against the effects of electrolysis.

(a) Where a ground plate is provided for radio equipment it shall have at least 12 square feet of exposed surface and be connected to the common bonding conductor.

CHAPTER 6.

FIRE EXTINGUISHING EQUIPMENT.*

60. Introductory Information.

601. CLASSIFICATION OF FIRES: For all practical purposes there are three general classes of fires:

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

Class "B" fires, defined as fires in flammable petroleum products or other flammable liquids, greases, etc. where the "blanketing-smothering" effect of oxygen-excluding media is most effective.

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

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

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

TABLE VIII.

FIRE EXTINGUISHERS.

Type of Extinguisher	Fire Suitability "A"	Fire Suitability "B"	Fire Suitability "C"	Agent Extinguishing	Subject to Freezing	Annual Maintenance Required*	Operating Precautions
CARBON DIOXIDE**	No	Yes	Yes	Carbon dioxide.	No	Weigh and tag.	Smothering in high concentrations. Avoid contact with discharge horn.
DRY CHEMICAL**	No	Yes	Yes	Specially treated sodium bicarbonate.	No	Weigh cartridge and tag.	None.
FOAM	Yes	Yes	No	Foam from reaction of aluminum sulfate and sodium bicarbonate with added foam stabilizer.	Yes	Discharge, refill and tag.	Do not use on live electrical equipment.

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

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

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

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

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

61. General.

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

62. Equipment.

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

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

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

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

Volume of Space (cu. ft. net)	Carbon Dioxide in lbs.
140	10
220	15
300	20
375	25
500	35
800	50
1,200	75
1,600	100

and up to 4,500 cu. ft. at the rate of 1 lb. of gas per 18 cu. ft. of space and above 4,500 at 1 lb. per 20 cu. ft.

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

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

63. Installation.

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

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

632. Fixed carbon dioxide extinguishing systems shall be installed in accordance with the *Standards 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 in National Fire Codes, Vol. IV and in separate pamphlet form by the National Fire Protection Association.

(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.

TABLE IX.

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; 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 nearby an entrance to the compartment unless someone is normally present in the compartment.

CHAPTER 7.

OPERATION AND MAINTENANCE.

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

71. Hull.

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

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

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

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

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

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

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

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

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

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

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

72. Engines.

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

(a) Before starting engines:
  (1) Ventilate engine compartment.
  (2) See that lubricating oil reservoir is full.
  (3) See that engine cooling water intakes are open.

(b) When engine starts:
  (1) Check oil pressure.
  (2) Make certain of cooling water circulation—e.g. check exhaust discharge.

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

73. Fuel Systems.

730. 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.

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

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

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

732. Utmost care shall be exercised during fueling operations.

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

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

(c) Before opening tanks the following precautions shall be observed.
- (1) All engines, motors, fans shall be shut down.
- (2) Galley stoves shall be extinguished. (Coal fires shall be banked.)
- (3) All ports, windows, doors and hatches shall be closed.
- (4) Quantity of fuel to be taken aboard shall be determined in advance of fueling operations.

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

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

(f) After fuel flow has stopped:
- (1) Fill cap shall be tightly secured.
- (2) Any spillage whatsoever shall be wiped up completely.
- (3) Entire boat shall be opened and allowed to ventilate for at least five minutes before starting any engines or lighting galley fires.

74. Cooking, Heating and Auxiliary Appliances.

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

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

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

(c) Burners shall not be primed while hot.

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

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

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

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

(c) Changing of cylinders shall be in accordance with the instructions which follow and under the supervision of licensed 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.
2. Burn out gas content in low pressure lines and proceed with cylinder change as in single cylinder system.

For both types of systems:

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

(d) Frequent (bi-weekly recommended) tests of the entire system at service pressure shall be made by closing cylinder valves and observing the gage. If tight there should be no noticeable drop in ten minutes. Trial for location of leaks shall be made with soap suds and *never with flame.*

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

75. Electrical System.

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

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

76. Fire Extinguishers

Maintenance

761. All fire extinguishers should be examined at regular intervals several times a year to make certain that they have not been tampered with and have not suffered corrosion or damage. Seals should be inspected to determine that the extinguishers have not been operated since last being charged.

762. Foam type extinguishers shall be discharged, cleaned, inspected for mechanical defects or serious corrosion, and recharged annually.

763. Dry chemical fire extinguishers shall be kept full with specified weight of chemical at all times. Cartridges shall be reweighed annually and if found to weigh less than the minimum weight stamped thereon shall be replaced with a full one or recharged. "Those provided with gauges shall be recharged when pressure is below prescribed operating limits."

(a) Extinguishers of this type shall be refilled after use even though only partly discharged.

(b) Before recharging, hose shall be cleared of all chemical.

764. Carbon dioxide type fire extinguishers shall be reweighed semi-annually and cylinders in fixed carbon dioxide systems shall be reweighed at least annually, but preferably every six months and if found lighter than the weight indicated on the name plate shall be made tight and recharged.

(a) Extinguishers of this type must always be recharged after use even though only partly discharged.

(b) Extinguishers of this type and cylinders in fixed systems shall be provided with tags showing date weighed, weight found and weigher's signature.

Operation

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

766. For Class "B" fires in flammable liquids such as gasoline, diesel fuel, or kerosene, devices of carbon dioxide, dry chemical, or foam types are the most effective means of extinguishment.

(a) Foam type fire extinguishers are carried to the fire in the vertical position, inverted and set in operation at the fire. If the fire is in a flammable liquid, the operator should stand back to allow the foam to fall on the fire without much force since flames otherwise may be spread unnecessarily. While primarily intended for use on Class "B" fires, they are also effective on fires in ordinary combustibles or Class "A" fires in which case the full force of the stream may be used. They must be protected from freezing.

(b) Dry Chemical type fire extinguishers are provided with a nozzle or horn for spraying the dry chemical in a dense cloud from five to about fifteen feet from the extinguisher for small sizes, and farther for larger sizes. For open fires in flammable liquids, the discharge should be applied in a rapid sweeping motion to the near edge of the flames at their base, working toward the far edge. For running dripping fires from leaks in fuel tanks or lines, extinguishment should be started at the lower part of the fire working upwards. Leakage should be stopped as soon as possible.

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

(d) Fixed Carbon Dioxide type fire extinguishing systems are provided for either manual operation or for both manual and automatic operation. The manual release should be used without waiting for the automatic feature to come into play if a fire occurs aboard an attended vessel. Persons should not remain below during or after discharge of the system as the effects can be dangerous to life. All hatches, ports, doors or other openings to areas covered by a fixed system should be closed prior to release if possible.

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

77. Emergency Equipment.

771. Pyrotechnics carried as emergency equipment shall be stored in a dry place in a waterproof metal box or locker.