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NATIONAL FIRE PROTECTION ASSOCIATION
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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 over a hundred and eighty national and regional societies and associations (list on outside back cover) and more than fifteen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This pamphlet is one of a large number of publications on fire safety issued by the Association; a complete list is available without charge on request. The standards, prepared by the technical committees of the National Fire Protection Association 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 National Fire Protection Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

NFPA standards are purely advisory as far as the Association is concerned, but are widely used by law enforcing authorities in addition to their general use as guides to fire-safety.

Definitions

The official NFPA definitions of "shall", "should" and "approved" are:

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.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The standards are prepared, as far as practicable, in terms of required performance, avoiding specifications of materials, devices or methods so phrased as to preclude obtaining the desired results by other means. 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 and the Factory Mutual Laboratories 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. 302–1954

Foreword.

This 1954 edition of "Fire Protection Standards for Motor Craft" adopted by the National Fire Protection Association May 17–21, 1954, represents the cumulative result of twenty-nine 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 in 1951, 1952, 1953 and 1954. The 1950 edition and subsequent amendments thereto were prepared by the Committee on Motor Craft and Marinas, endorsed by the General 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 inboard powered 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 inboard powered 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. The following table is included for reference purposes.

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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 with both provided with exterior fittings as per Section 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) A recommended means for grounding is the use of No. 4 copper wire properly secured to spars and led directly as practicable to a ground plate attached to the wetted surface of the hull.

(b) Metallic standing rigging should be effectively connected from lower ends to the common ground.

142. Radio antennas shall be provided with means for grounding during electrical storms in accordance with Paragraph 141(a) or by exterior lead to suitable grounding underwater.

(a) Grounding of radio antennas constitutes sufficient protection for wooden boats without masts and spars.

*For further guidance especially for larger craft reference to Section 26, NFPA *Code for Protection Against Lightning* is recommended.

143. A steel hull is an adequate ground and in a steel hull with steel masts if there is good metallic connection between hull and masts no further protection from lightning is necessary.

144. Lightning protection provisions are quite likely to receive scant attention and therefore its composition and assembly should be strong and materials used should be highly resistant to corrosion. Bends in the grounding conductor should be kept to a minimum.

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.

(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 and shall not be installed under deck.

(a) Carburetors and electrical components should be in general compliance with Paragraphs 212 and 213.

(b) The fuel system shall be in general compliance with Chapter 3.
(c) The fuel tank shall not be integral or attached to the engine.
(d) The exhaust pipe shall be effectively cooled or lagged.

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 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 operated.

222. Unsecured portable engines shall not be used.

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.

NOTE: Types of non-metallic exhaust piping recommended consist of a high quality, steam, oil and acid resisting compound, covered with (a) several plies of a heat resistant woven material, (b) a spiral round wire winding suitably spaced and firmly anchored at such distance from the ends as to provide soft connection cuffs, (c) several more plies of heat resistant woven material and (d) an outer covering of heat and oil resistant synthetic material.

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) 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.

(d) 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.

(e) 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.

(f) 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. Finished welds should be of same 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. This may be accomplished prior to the attachment of the final closure.

(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.

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.

(k) All 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. Baffle plates and flanges or angles shall be of the same material and at least equal in thickness to the tank walls.
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 lbs. per sq. in., without deformation or leakage. Each shall be subjected to such a test over a minimum period of 6 hours by the tank manufacturer and should again be similarly tested by the boatbuilder before 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 221.

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 annealed tubing of copper, nickel-copper or copper-nickel with minimum nominal thickness of .049 inches, except:

1. Wall thickness of filling pipes shall be in accordance with the Iron Pipe Size (I.P.S.) scale.
2. Where maximum flexibility is necessary a short length of approved flexible tubing especially designed for high resistance to salt water, petroleum oils, heat and vibration may be used.

(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, and should be marked to indicate direction of flow.

1. Cocks of any type shall not be used on 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)2. 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)2 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 stoves and all other woodwork within 18 in. surrounding stoves shall be effectively protected with a non-combustible 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 lbs. p.s.i.
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 outside of 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) Vapors from petroleum gases are heavier than air regardless of their varying rates of evaporation. Such vapors will tend to sink to the bottom of an enclosed compartment into which they are released, will ultimately diffuse throughout, and are not readily dispelled by overhead venting. All of these vapors when mixed with air in certain proportions are explosive. Safety requires absolute prevention of vapor escape. For the purpose of this section, "system" shall mean all component parts including gas-consuming appliances.

(b) 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.

(c) 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.

(d) 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.

(e) 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.

(f) 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.

(g) All component parts of systems, except cylinders appliances and low pressure tubing, shall be designed to withstand a pressure of 500 pounds per square inch gage without rupture.

(h) 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.

(i) 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 retested in accordance with the regulations of the Interstate Commerce Commission.

(b) Cylinder markings shall include the following: ICC specification symbol, under which the cylinder was fabricated, followed by the designed service pressure in pounds, — the serial number and identifying symbol (letters), — the minimum water capacity in pounds, — the tare weight in pounds (including all attached fittings but not including the protective cap), — and the dates (month and year) when the cylinder was tested.

(c) Prescribed cylinder markings shall be maintained in a legible condition. Cylinders shall be maintained free from corrosion and properly painted for such protection.

(d) If on account of painting or any other reason, the prescribed cylinder markings cannot be kept plain and legible, a metal plate brazed, soldered or otherwise securely fastened to the cylinder, with a reproduction of the said markings plainly stamped thereon, may be permitted.

(e) Each cylinder shall bear a test date marking, indicating that it has been tested within the past five years.

(f) 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.

423. VALVES AND SAFETY RELIEF DEVICES.

(a) Each cylinder shall have a manually operated shut-off valve installed directly at the cylinder outlet, 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, the latter designed to yield when the cylinder has been emptied of *liquid* gas by the relief valve under over-heat condition.

(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 multi-cylinder system shall be provided with a two-way positive shut-off manifold valve of manually operated type.

(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 .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 .032 inches. All high pressure tubing between cylinders and regulators shall have a minimum wall thickness of .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, 42 and 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 the locations specified above, the cylinder, regulating and safety equipment may be mounted in a vapor tight container located above the waterline in an open cockpit provided the container:

(1) Is constructed of 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. After this test the distribution tubing shall be connected to the regulator and appliance and the whole system subjected to the following test:

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 a gas whose vapor pressure at 130° F. exceeds the registered service pressure of the cylinder by more than 20 percent.

(b) 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 minimum water content and tare weight in pounds.

(c) If a cylinder is due to be retested, it shall not be charged with fuel until it has been retested and otherwise maintained in accordance with regulations of the Interstate Commerce Commission.

(d) Retests shall be of the hydrostatic type, in a water-jacket, at two times the service pressure, with testing equipment and method approved by the Bureau of Explosives. This is the responsibility of the owner of the cylinder at time of testing.

(e) 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.

(f) Charging of cylinders shall be such that the liquid gas will not completely fill the cylinder at a temperature of 130° F.

(g) The vapor pressure in the cylinder at 70° F. must not exceed the service pressure for which the cylinder was designed.

(h) Safety relief valves should be tested for proper operation at five year intervals.

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 regulations of the U. S. Coast Guard for merchant vessels and its designated reference "Recommended Practice for Electrical Installations on Shipboard" of the A.I.E.E. (Publication No. 45, December 1948).

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 main or 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).

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 supply conductor of an engine starting motor. This switch 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 of the engine compartment. The backs shall be metal encased and have provision for access thereto. All un-

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

insulated 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 conductor of circuit supplying lights, motors or appliances shall be equipped with a circuit breaker or switch and fuses at the point of attachment to the power source.

(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. Preferably, batteries should not be located in the same compartment with a gasoline tank or engine; but where location elsewhere is impracticable, they shall be effectively screened by a cage or similar structure 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.

(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-phone 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) A separate circuit, fused at the main distribution panel, shall be provided for all radio equipment.

(b) 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.

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

(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:

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

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.

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*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

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 IC 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.

(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) Unless a splice is made by an insulated pressure wire connector, listed by Underwriters' Laboratories, Inc., it shall be thoroughly soldered, taped first with rubber and then with friction tape to afford insulation equivalent to that of the conductors joined.

(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. Where metal enclosures of electrical equipment are conductively connected to one side of the supply circuit, the conductor employed shall be identified throughout the wiring system. The identified conductor shall be connected to the terminal of the same polarity at each source of supply.

(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 ground is necessary to guard against the effects of electrolysis.

(a) The negative terminal is recommended for the grounding polarity.

(b) Where a ground plate is provided for radio equipment, it shall 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 may be defined as fires in ordinary combustibles such as wood, paper, textiles, rubbish, etc., where the quenching and cooling effect of quantities of water, or water solutions is of first importance.

Class B fires may be defined as fires in flammable liquids, greases, etc., where a blanketing or smothering effect is essential.

Class C fires may be defined as fires in electrical equipment, where the use of a non-conducting extinguishing agent is of first importance.

602. CLASSIFICATION OF FIRE EXTINGUISHERS: Underwriters' Laboratories inspection label attached to fire extinguishers indicates the classification that has been assigned to the device. The letter A, B or C indicates the class of fire while the suffix numerals, 1, 2, 3, etc., indicate the number of extinguishers required to form a unit of protection. Thus the classification "A-1" signifies that the appliance is suitable for use on A fires and that one such appliance is required to make one unit of first aid fire protection. The classification "B-2," "C-2" signifies that the device is suitable for class B and C fires and that two such appliances are required to make one unit of first aid fire protection.

The classification of various types and sizes of hand fire extinguishers may also be found in the *Standards for the Installation, Maintenance and Use of First Aid Fire Appliances* (*NFPA No.* 10) prepared and published by the National Fire Protection Association and published also by the National Board of Fire Underwriters.

TABLE VIII.

FIRE EXTINGUISHERS.

Type of Extinguisher	Fire Suitability "A"	Fire Suitability "B"	Fire Suitability "C"	Extinguishing Agent	Subject to Freezing	Annual Maintenance Required*	Operating Precautions
SODA-ACID	Yes	No	No	Water and products of sodium bicarbonate and sulfuric acid reaction.	Yes	Discharge, refill and tag.	Do not use on live electrical equipment.
ANTI-FREEZE	Yes	No	No	Water solution of calcium chloride and corrosion inhibitor.	No	Weigh cartridge, replenish solution and tag.	Do not use on live electrical equipment.
LOADED STREAM	Yes	Yes	No	Water solution of alkali-metal salt.	No	Weigh cartridge and tag.	Do not use on live electrical equipment.
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.
VAPORIZING LIQUID**	No	Yes	Yes	Specially treated carbon tetrachloride or chlorobromomethane.	No	Partly discharge, refill, and tag.	Avoid exposure to toxic fumes. Maintain ventilation where used.
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.

* 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.

61. General.

611. All first aid 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 power boats shall carry not less than two first aid fire extinguishers.

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

(b) Minimum recommended hand fire extinguisher equipment and location of it is as follows:

Type of Boat	*Extinguishers*	*Typical Assignments*
Runabouts	2-B2	Driver's and/or passenger pits
Cruisers under 35 ft.	2-B2	Bridge and cabin
Cruisers 36 ft. - 45 ft.	3-B2*	Motor compt., bridge and galley
Cruisers 46 ft. - 55 ft.	4-B2*	Motor compt., bridge and galley
Cruisers 56 ft - 75 ft.	5-B2*	Motor compt., bridge, C.Q. and galley
Cruisers 76 ft. - 100 ft.	6-B2*	Motor compt., bridge, C.Q. and galley
Sail Auxiliary	2-B2	Motor compt. and galley
Sail only	1-B2	Cabin
Commercial under 30 ft.	2-B2	Motor compt. and pilot house
Commercial 30 ft. and over	4-B2*	Motor compt., pilot house and galley

*Where more than two B-2 units are recommended, the specified extinguishing capacity may be made up of a smaller number of larger units; e.g. three B-1 units may be used instead of six B-2 units.

622. A fixed carbon dioxide fire 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.