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Fire Protection Standards for Motor Craft

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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 the public in establishing proper safeguards against loss of life and property by fire. Its membership includes more than one hundred fifty national and regional societies and associations and more than twelve thousand individuals, corporations, and organizations.

Committee on Motor Craft

of the

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These standards were prepared by the committee named above and represent a revision of "Fire Protection Regulations for Motor Craft, Edition of 1939" which are superseded hereby. These standards were adopted by the NFPA at its annual meeting in May 1948.

Fire Protection Standards for Motor Craft.*

(PLEASURE AND COMMERCIAL)

GASOLINE POWERED BOATS.

110. Engines:—Marine or Automotive Conversions.

111. It is recommended that where design permits, engines be located in a compartment separated from the rest of the hull by transverse bulkheads sufficiently tight to serve as fire breaks.

Engines should 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.

For protection against bilge wash and to remove sources of ignition as far as practicable from possible low lying explosive vapor, starting motors, generators and any spark producing devices should be mounted well above the accommodation flooring, which entails location in the upper quadrants of the crank circle.

120. Location, Material and Construction of Fuel Tanks.

121. (a) It is recommended that fuel tanks be located in water-tight compartments separate from but adjacent to the engine room, accessible for exterior examination and mounted in a pan or on a metal lined water-tight flat, above the load line, with overboard drains. Such pan or flat is not recommended where bottom of tank is below the load line. Where this arrangement is not practicable, fuel tanks may be located to suit the design of the vessel, but preferably outside of the engine compartment and so that excessive lengths of fuel piping will be avoided. All tanks shall be substantially secured in position to prevent movement and installed to afford as ready external examination and access as possible.

(b) Portable tanks below decks shall not be permitted.

122. Fuel tanks shall be constructed of copper of thickness not less than No. 18 gage (U. S. Std.), or of iron or steel of thickness not less than No. 14 gage (U. S. Std.), except that on light runabouts where cylindrical iron or steel tanks are used, those not exceeding 35 gallons capacity shall be of not less than 18 gage (U. S. Std.), and those of 35 to 70 gallons capacity of not less than 16 gage (U. S. Std.). Ferrous metal should be used only for cylindrical tanks. Non-corrodible alloys are preferable. Steel or iron tanks should be galvanized both inside and outside, preferably by the hot dipped process, after completion. Those not galvanized shall be kept well coated on the outside to prevent corrosion. Tanks should be lifted for examination annually and installation should be designed with this end in view.

123. (a) Seams of copper tanks shall be rolled, riveted and soldered or rolled and brazed. All outside rivet points and heads shall be soldered or brazed.

Seams of ferrous metal tanks shall be welded, or riveted and welded.

All outside rivet points and heads shall be welded.

*The provisions of these standards supplement and supersede those of the NFPA Regulations Governing Marine Fire Hazards in their application to motor driven vessels. Where no specific ruling is provided herein, the provisions of the Regulations Governing Marine Fire Hazards shall apply.

(b) If fuel tanks have flat heads or are not cylindrical, they shall be fitted with diaphragms, of same character of material as tanks, to break the wash of contents; and shall be properly braced on flat surfaces by diaphragms or other stays to prevent bulging and panting. Diaphragms in tanks shall be well fastened by angles or flanges. Flanges shall be bent to an inside radius of not more than twice the thickness of the flanged sheet, and the riveting, welding or brazing shall be as close to the throat of the flange as practicable.

For pressure fuel tanks, the cylindrical type is recommended.

(c) Tanks shall be designed with a factor of safety not less than 4. Gravity tanks shall be tested by static head above tank top of 10 feet of water, without showing leakage or permanent deformation. Pressure tanks shall be tested to twice the designed working pressure or that required for gravity tanks, whichever is the greater, without leakage or permanent deformation.

124. (a) Outlets on gas fuel line for drawing loose gasoline for any purpose are prohibited in the engine compartment. Drains in the bottom of fuel tanks are not recommended, but where fitted shall be closed by plugs or plugged pipes threaded into spuds, riveted and soldered, welded or brazed to the tank.

(b) It is recommended that all outlets pass through the top of the tanks. In cases where outlets pass through side or bottom, connections shall be threaded into spuds riveted and soldered, brazed or welded to the tank; and where the tank is large enough to permit inside access, an internal gate valve shut-off with extension rod packed at tank top shall be fitted.

(c) Fill pipes, fill relief vents, breathers and sounding pipes shall be so arranged that vapors or possible overflow when filling can not escape inside of hull, cabin or coamings and will flow overboard.

Fill pipe should extend nearly to the bottom of the tank and should be at least 1½-in. I.P.S. A strainer of non-corrodible wire mesh fitted in the throat of the fill pipe is recommended.

(d) Two vents shall be installed near the highest point of the tank:—

(1) a fill relief vent equal in size to the fill pipe and similarly closable at deck, to relieve tank and prevent blow-back under high speed fuel delivery:

(2) a permanently open breather of not less than standard ¼-in. O.D. tubing or equivalent for equalizing tank and atmospheric pressures.

On boats liable to heel, breathers on port side should be led to starboard and vice versa. Breather outlets should be fitted with 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.

Approved anti-explosion combined fill, fill vent and breather fittings may be used in place of separate installations.

It is recommended that fill, fill vent, sounding pipe and breather have identification labels at deck or hull terminations.

(e) Gage glasses and try cocks shall not be used. Other methods of indicating the level of the liquid may be used, provided, however, that they are so arranged as not to expose the liquid or vapor in cabin, cockpit or under deck, or to permit vapor to drift below.

(f) It is recommended that auxiliary feeds draw from the main fuel line, but where auxiliary gasoline tanks are necessary, they shall be of a type permitting the same fill pipe and breather arrangement as required on main tanks in order to avoid handling of loose gasoline under deck. Open fills on tanks integral with auxiliaries located below decks are dangerous and shall not be used.

130. Fuel Lines.

131. (a) A shut-off valve shall be installed as close to each tank as practicable and one as close to each carburetor as practicable. The handles of all shut-offs at the tanks, whether external or internal, shall be readily accessible. Arrangements shall be provided for operating them from outside the compartments in which the tanks are located, preferably from on deck.

(b) Installation of an approved heat actuated device to shut off fuel supply near the tank in event of fire and approved mechanical or electrical devices to perform the same function when engine stops are recommended; but none of these devices obviate the requirements for manually operated shut-off valves as above.

(c) Valves for gasoline fuel lines shall be of non-ferrous metal with ground seats and installed to close against the flow. The tinning of cast bodies and bonnets and the use of a type which does not depend solely on packing to prevent leakage at the stem while in fully open position are recommended.

(d) Cocks of any type are not approved for use in gasoline fuel lines.

132. Fuel lines shall be of seamless drawn annealed copper tubing or iron pipe size copper pipe. They shall be run in sight whenever practicable, protected from mechanical injury and effectively secured against vibration by neat fitting soft metal lined or soft non-ferrous metal clips with no sharp edges in contact with tubing. Where passing through steel decks or bulkheads, lines shall be protected by close fitting ferrules of non-abrasive material. A short length of approved flexible tubing with approved fittings shall be installed for connection between fuel line and carburetor or fuel pump on all types of engine mounting.

133. (a) Tubing wall thickness shall be not less than the following:

Outside Diameter of Tubing	Thickness Stubbs Gage (B.W.G.)	Thickness Inches
1/8-in., 3/16-in., 1/4-in.	No. 21	.032
5/16-in., 3/8-in.	No. 20	.035
7/16-in., 1/2-in.	No. 19	.042

(b) Tube fittings shall be of non-ferrous drawn or forged metal and listed by Underwriters' Laboratories for use with hazardous liquids or according to Standard Practice Code for Refrigeration and Marine (published in the handbook of the Society of Automotive Engineers). If of the flared type it is important that tubing be cut square and truly flared by tools designed for those purposes. Annealing of tube ends before flaring is recommended to close any porosity.

Pipe fittings shall be of non-ferrous metal, standard pipe threaded and joints soldered after being made up. The tinning of cast fittings is recommended.

134. A strainer of approved type with bolted, dogged, bale or compression gland bonnet shall be fitted in the fuel suction line within the engine compartment and supported to take its weight off the line. A shut-off shall be fitted on each side of strainer to permit opening and cleaning. Strainers shall be of type opening on top for cleaning screens.

NOTE: Attention is drawn to paragraph 124(a) prohibiting outlets for drawing loose gasoline in the engine compartment.

135. Of various feed systems, such as mechanical, tank pressure, vacuum, gravity and electric diaphragm, the direct connected mechanical is preferred. Electric feed pumps are permissible if energized only when engine ignition is on.

140. Carburetor.

141. All carburetors, except the downdraft type, shall have integral therewith or properly connected thereto, an approved drip collector of adequate capacity. This shall be drained by a device for effectively returning drip to engine intake or discharging it overboard.

142. Air intakes shall be so directed that backfire cannot blow down into the bilge and shall be fitted with an approved backfire flame arrester.

150. Motor Exhaust.

151. The exhaust manifold should be water jacketed and cooled by raw water from a pump which operates whenever the engine is running; if not, woodwork within nine inches shall be protected by ⅛-in. asbestos board covered with sheet metal. A dead air space of ¼-in. shall be left between the protecting asbestos and the wood, and a clearance of not less than 2 inches maintained between the manifold and the surface of such protection.

152. (a) It is recommended that all of the engine cooling water be discharged through the exhaust pipe and enter at a point as near to the manifold as practicable. Where the exhaust pipe is dry or where a wet exhaust is not cooled by the entire discharge of raw water, it is recommended that a length of not less than twelve diameters of such exhaust pipe adjacent to the manifold be water jacketed and cooled in same manner as manifold, and remainder of pipe shall be kept clear of internal woodwork at least 1½-in. and properly supported by non-combustible hangers or blocks.

(b) Where the first twelve diameters of exhaust is neither jacketed nor cooled by entire discharge of raw water, woodwork within 6 inches of any part of the exhaust shall be protected by ⅛-in. asbestos board covered with sheet metal. A dead air space of ¼-in. shall be left between the protecting asbestos and the wood, and a clearance of not less than one-half its diameter shall be maintained between the pipe and the surface of such protection.

(c) Where exhaust lines pass through water-tight bulkheads, non-combustible packings should be installed.

153. 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 are not recommended.

154. (a) Cast or wrought iron pipe is recommended for exhausts. Where lighter weight is essential, copper tubing may be used provided that, if not jacketed as recommended in paragraph 152(a), the full discharge of raw water shall pass through the tube. For cruisers and commercial craft, gage of copper exhaust tubing should not be lighter than:

2 in. O. D.—No. 14 B. W. G.
4 in. O. D.—No. 12 B. W. G.
6 in. O. D.—No. 10 B. W. G.

(b) In runabouts, where extreme lightness is essential, exhaust tubing thickness of No. 16 B. W. G. may be used up to 3-in. O. D.

(c) When flexibility is desirable in an exhaust line, a non-metallic section may be used, provided that:

A substantial length of water-cooled metal exhaust pipe and an approved water-cooled silencer are installed between the flexible section and the exhaust manifold.

All raw water from the motor shall pass through the flexible section.

Material of the flexible section shall be specially adapted to resisting the action of oil and heat.

The flexible section shall be suitably reinforced to prevent crushing or panting by extra thickness of wall or built-in wire winding not nearer the inner surface than one-half the thickness of the wall.

As installed, it shall not be bent sufficiently to unduly stress or crimp the inner or outer linings or to permit local impingement of exhaust gases.

155. Fresh water cooling of gasoline engines is approved provided wet exhaust is cooled as per Sec. 152 by discharge of raw water from the heat exchanger or a connection from the sea fed by a pump. Radiator fresh water cooling is not approved for propulsion or auxiliary units under deck.

160. Bilges.

161. Frequent flushing and cleaning of bilges is recommended. Drain outlets should be fitted in the bottom of the hull and particular attention paid to securing complete drainage thereto and to the bilge pump suctions in order to facilitate this operation, either hauled out or afloat.

170. Ventilation.

171. Ventilation for the purpose of this Section 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 is defined as creation of a through current from outside to outside, not mere turbulence.

172. Any compartment or space in which a motor is located, particularly the lower portion and bilges, shall be provided with ventilation capable of preventing or effective to remove accumulation of flammable or explosive vapor. Tank compartments should be similarly ventilated when practicable.

173. To meet this requirement, the following is recommended:—Where motors and/or tanks are in closed compartments; permanently open and adequate inlet and outlet ventilating ducts extending to the bilges should be installed; two inlets leading to the wings at one end of the compartment and two outlets from the wings at the opposite end.

174. Where motors and/or tanks are not in closed compartments; at least one such duct should be installed in the fore part of the boat and one in the after part.

175. Ducts should be provided with unobstructed cowls or equivalent fittings. Flush or recessed inlets and transom louvre outlets are not approved.

For ventilating compartments, inlets aft higher than outlets with cowls opening forward and outlets forward with cowls opening aft are recommended.

176. Where feasible, it is also recommended that outlet ducts be fitted with wind-actuated self-trimming or rotary exhauster heads or that power operated exhausters be installed in each outlet duct. If exhausters are used, motors shall be installed outside of the ducts and as high above the accommodation flooring as practicable. They shall be run for at least five minutes before starting any engine. Size of vents should be approximately proportional to the beam of the boat with 2 sq. in. of aggregate vent area per foot of beam as a minimum.

180. Operation.

181. Attention is called to the hazard involved in the handling of gasoline. An atmospheric concentration as low as 1¼ per cent is practically odorless, but is sufficient to create a mixture which may be exploded by a slight spark. Such explosive vapor may travel a considerable distance from the point of leakage.

182. 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. A recently emptied gasoline tank is in its most dangerous condition. The following precautions are recommended therefore in order to reduce the fire and/or explosion hazard.

(a) All gasoline connections shall be tight.

(b) Gasoline or other flammable solvents, no matter how small the quantity, shall not be exposed by spilling, drawing, off or open storage or used for any kind of cleaning in closed spaces.

(c) Ventilation as adequate as possible shall be insured by attention to all arrangements therefor, both before starting and while running.

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

(e) The entire boat and especially the engine compartment shall be kept clean and free from flammable rubbish, loose oil and grease, and dirty waste or rags. Clean waste and rags shall be kept in metal lined lockers or containers. Similar receptacles shall be provided for waste and rags coated with oil, paint, remover or polish; but such accumulation shall be kept to a minimum by frequent disposal ashore.

(f) In fueling:—before tank fills are opened or gasoline brought on board, all engines, motors and fans shall be shut down, galley fires put out, and all doors, ports, windows and hatches closed. On completion, after hose or cans have been removed, any spillage shall be wiped up and the boat opened. If practicable, it shall remain open for at least five minutes before starting any engine or motor or lighting a fire. No smoking shall be permitted during a fueling operation.

(g) In order to guard against a possible spark during fueling operation, nozzle of the hose or can shall be put in contact with the fill pipe or funnel *before* starting to run in gasoline and this contact shall be kept until the flow has stopped.

NOTE: There is a serious hazard from static discharge unless this rule is observed.

(h) Lockers in which oiled clothing is carried shall be cool and well ventilated on account of the danger of spontaneous combustion.

(i) 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.

190. Hull Arrangement.

191. From standpoint of fire hazard, it is highly desirable that bilges of machinery and fuel tank spaces should be separated from bilges of accommodation spaces by bulkheads as tight as practicable, i.e., of double diagonal wood, steel plate or equivalent construction.

210. Galley Arrangement. (Applies also to sailing and steam craft.)

211. For the reason that galley stoves are liable to promiscuous, unskilled or ignorant operation more than any other piece of boats' gear involving fire risk, it is important that such equipment should be selected and installed with a view to minimizing both the personal and physical hazards. The use of approved stoves is recommended.

212. Cooking or heating stoves should not be located in the same compartment with machinery or gasoline tanks; but when such arrangement is unavoidable, stoves shall be placed as remote as possible from carburetors and tank connections.

213. Woodwork within 12 in. of bottom and sides and 24 in. over top of stoves shall be protected with ⅛-in. asbestos board covered with sheet metal and a dead air space of ¼-in. left between the protecting asbestos and the woodwork.

214. Fixed stoves shall be permanently secured in place. Portable stoves are not recommended, but if carried shall be rigidly secured in place well clear of woodwork when in use.

215. On stoves burning liquid fuel, oven should not be under the open burners on account of the danger from overflow if the burners are extinguished.

220. Galley Stoves. (Applies also to sailing and steam craft.)

221. Coal, Charcoal or Wood:—Such stove installations are covered in Regulations on Marine Fire Hazards, but a clearance of at least 3 in. between bottom of stove and deck is recommended unless installed on a hollow tile base.

222. Alcohol, Solid and Fluid:—Containers of solidified alcohol shall be properly secured on a fixed base to prevent sliding or overturning in a sudden roll of the vessel.

(a) For fluid burners where wet priming is used, a catch pan not less than ¾-in. deep shall be secured inside the frame of the stove or metal protection thereunder flanged up ¾-in. to form a pan.

(b) Gasoline shall not be used for priming.

(c) Large fuel tanks for fixed stoves shall be separate therefrom and mounted either outside or inside with outside fill and vent. Small units of approved type with integral tanks properly baffled from the burners may be used.

(d) Either pressure or gravity feed is permissible, but where gravity or siphon is used an easily accessible shut-off valve shall be fitted in fuel line at tank, and if tank is outside, also at the stove.

(e) It is important that burner assembly be easily demountable for cleaning and the unit so located as to facilitate that operation.

223. Fuel Oil or Kerosene:—Where wet priming is used, a catch pan not less than ¾-in. deep shall be secured inside the frame of the stove, or metal protection thereunder flanged up ¾-in. to form a pan.

(a) Gasoline shall not be used for priming.

(b) Fuel tanks for fixed stoves shall be separate therefrom, mounted either outside, or inside with outside fill and vent.

(c) Either pressure or gravity jet feed is permissible. Bubble feed or any system which may be affected by list or roll of the vessel shall not be

used. On gravity or siphon tanks, an easily accessible shut-off valve shall be fitted in fuel line at tank, and if tank is outside, also at the stove.

(d) Burners shall not be primed when hot and burner tips shall be kept clean to avoid choke, extinguishment and consequent flooding.

(e) It is important that burner assembly be easily demountable for cleaning and the unit so located as to facilitate that operation.

224. GASOLINE:—Gasoline stoves shall not be used on boats.

225. LIQUEFIED OR COMPRESSED GAS SYSTEMS:—Systems, including regulating and safety equipment, shall be listed by Underwriters' Laboratories, Inc., for marine use.

226. 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 and are not readily dispelled by overhead venting. Acetylene and methane are lighter than air. All of these vapors when mixed with air in certain proportions are explosive. Safety requires absolute prevention of vapor escape.

227. Cylinders and drums and their pressure relief devices shall be I.C.C. standard for the contained product and shall be filled according to I.C.C. regulations.

228. Systems introducing fuel below decks in gaseous form are regarded as the less hazardous of the liquefied or compressed gas systems. Each cylinder in such systems shall have a stop valve directly on the cylinder outlet and the systems shall be provided with a regulating device limiting the pressure at the burners to not over one pound per square inch (28 in. water column).

229. Systems introducing fuel below decks in liquid form are regarded as the more hazardous of the liquefied or compressed gas systems. Each drum in such systems shall have a stop valve, or a check valve in combination with a stop valve, directly on the drum outlet; and where gas may attain a vapor pressure of over 20 lbs. per square inch gauge at 100°F., the system shall be provided with a regulating device limiting the pressure at the burners to not over 20 lbs. per square inch.

230. (a) In both systems the low pressure side of the regular or the L.P. line shall be provided with a pressure relief device and the chamber above the diaphragm with a vent, both of which may discharge outboard through a common outlet. (See par. 112-119, incl.)

(b) In multi-cylinder or multi-drum systems, a stop valve shall be provided in each line from the container to the regulator or manifold in addition to the valves required at the containers.

(c) Continuous burning or pilot lights are not permitted.

(d) Only dry primed burners shall be used.

(e) An automatic device to shut off gas supply in case flame is extinguished shall be fitted to oven burners and is recommended for other burners on the stove when practicable. A packless type master valve for shutting off all burners simultaneously is required at the stove manifold.

(f) To facilitate detection of possible leaks, an odorant shall be added to fuel gases which do not emit a natural distinctive odor.

INSTALLATION OF LIQUEFIED OR COMPRESSED GAS SYSTEMS.

231. Comprehensive printed instructions and a labeled diagram shall be furnished with each system, covering details of proper installation.

232. Only the kind and specification of gas for which the system is designed and listed shall be used.

233. Cylinders or drums, and regulating and safety equipment shall be substantially secured and located so that vapor escaping from any cause cannot reach the bilges, machinery space, accommodations or other enclosed spaces.

(a) Such locations are confined to open deck or cabin top or in a dummy stack, provided the deck in way is vapor tight to the compartment below. Locations under deck, in a cockpit and on portions of the deck enclosed at the sides by bridge or cabin structures, are not approved.

(b) Cylinders or drums and their regulating and relief equipment shall be protected from climatic extremes by a box or housing (as dummy stack) vented to the open air by holes near the bottom for heavy gases and near the top for light gases.

234. The discharge from the low pressure reliefs shall be led preferably to the stern or, if not feasible, to a point at least two feet distant (and if possible farther) from any part of an opening to the interior of the boat or from a motor exhaust which is below the level of such discharge. Outlet ends shall be turned down to prevent choking the line with water.

235. For low pressure (gaseous phase) systems, line and branches from the regulator to the burners shall be seamless soft copper of the same gage thickness as required for gasoline feed lines (see Section 23); except that for acetylene, soft brass or composition tubing shall be used. (Unalloyed copper is not suitable for use with acetylene.)

236. For high pressure systems (liquid phase) and lines from cylinders to regulator in low pressure systems, the tubing shall be seamless soft copper $\frac{3}{16}$-in. O. D. with wall thickness 3/64-in. or No. 18 Stubs gage (B. W. G.).

237. Fittings for standard and heavy gage tubing shall be of approved type (see Sections 133(a), 133(b)); but if of heavy gage flared type, annealing of tube ends before flaring is essential. S.A.E. soldered type with drawn or forged non-ferrous metal fittings using only high temperature solder or brazing is also approved.

238. Lines shall be exposed to sight but protected from mechanical injury as far as possible and substantially secured against vibration by neat fitting soft metal lined or soft non-ferrous metal clips with no sharp edges in contact with tubing. Where passing through steel decks or bulkheads, lines shall be protected by close fitting ferrules of non-abrasive material.

OPERATION OF LIQUEFIED OR COMPRESSED GAS SYSTEMS.

239. Brief printed instructions and labeled diagram for operation and maintenance shall be posted where visible for ready reference.

240. Changing of cylinders or drums shall be supervised by one of the licensed personnel when such officers are carried, or by other responsible person when no such officers are carried.

241. In single container systems:—when container is to be changed, close the stop valve on the container and burn out the gas content of the line by lighting all burners, then *shut off the burners.* Disconnect the empty container, leaving the *stop* valve on the container and keep closed, then connect the fresh container.

(a) In types necessitating transfer of an attached fitting containing the stop valve, make this transfer on deck in the open, remote from openings leading below and from sources of ignition.

242. In multi-container systems:—when the container in use becomes exhausted, shut off all burners before turning on the reserve container. When container is to be changed, shut both container stop valve and stop valve in the line to the regulator. It is then unnecessary to burn out the gas content of the low pressure lines, and change of containers may be executed as in a single container system.

243. In either a single or multi-container system:—after turning on a fresh container, 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 container stop valve, and test for leaks and faulty or improperly adjusted regulator.

244. Unconnected reserve container shall be subject to the same stowage restrictions as those in service. Empty containers 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.

245. Particular care shall be taken against snuffing a flame from boil-over, gust of air or any other cause, and frequent attention shall be given to joints and glands to insure constant tightness.

246. Systems shall be provided with a pressure gauge. At installation they shall be tested with air or water and proven tight at not less than twice the service pressure.

Thereafter, frequent tests at service pressure shall be made (bi-weekly recommended) by closing the cylinder valves and observing the gauge. If tight, there should be no noticeable drop in ten minutes. Trial for location of leaks shall be done with soapsuds or other non-combustible substance and *not with flame.*

250. Cabin Heaters and Hot Water Boilers.

251. Gasoline shall not be used for fuel in open flame liquid or vapor burners. Approved sealed combustion chamber heaters burning either gasoline or fuel oil are permitted. Bubble feed burners are not permitted for any kind of fuel. Portable heaters are not approved.

252. The requirements for installation and operation of galley stoves (pars. 210-247) shall be observed where applicable.

253. All gas burning heaters shall be equipped with an automatic device to shut off gas supply to the heater in case the flame is extinguished.

254. Continuous burning or pilot lights are not permitted under deck. Units so equipped may be used if installed above the main deck and equipped in compliance with Sec. 253 whether gas or oil burner.

260. Ice Machines.

261. Machines operated by flame are not permitted. Electric machines should have motors preferably located on top of the cabinets, or if separate from cabinets, well above the bilges. For wiring, see Sec. 280.

270. Air-Cooled Engines.

271. Air-cooled internal combustion engines operating auxiliaries or for propulsion are not approved when installed under deck or in a cabin.

272. When such a unit is used for operating an auxiliary, its location shall be confined to open deck outside of coamings or to cabin top, and any housing over such unit shall be open when engine is running. Unsecured portable units are not approved.

273. When such a unit is used for propulsion of an open boat, fuel tank shall be separate from the unit, properly secured and fitted with a flexible connection in the feed line as per Para. 132. There shall be a shut-off valve in the feed line at the tank, and filling connection and breather shall be so installed that spillage or vapor forced out during filling cannot flow inside the coaming. The exhaust pipe shall be effectively lagged.

280. Electrical Equipment.

281. Electrical installations operating at potentials of 32 volts and over shall be in accordance with regulations of the Bureau of Marine Inspection, U. S. Coast Guard, and its designated reference "Recommended Practice for Electrical Installations on Shipboard" of the A.I.E.E. (Publication No. 45, 1945.) Those operating at potentials under 32 volts shall conform to the following:

NOTE: Low voltage installations do not warrant admission of sub-standard material and workmanship in motor craft where the possible presence of flammable or explosive vapors renders a spark or incandescence from a physical failure liable to entail serious consequences.

Where explosion-proof apparatus is specified, it shall conform to requirements for such apparatus contained in the National Electrical Code with respect to Class I hazardous locations.

282. Generators and motors shall be placed in dry, accessible and adequately ventilated locations. Independent generators and motors should be mounted on foundations as high as practicable above the floor to avoid damage by splash from the bilges or by coming in contact with low-lying vapors, and shall not be located in low or pocketed positions unless they are of explosion-proof type. Generators and motors which are an integral part of the propelling unit shall be installed above the center line of the crank shaft. Generators, up to and including 1500 watts capacity, driven by the propelling unit, shall be fused at the generators.

283. (a) Switchboards shall be placed in dry, accessible and adequately ventilated locations, preferably outside of the engine compartment. The backs shall be metal encased and provision shall be made for access thereto. All uninsulated current carrying parts shall be mounted on non-absorbent, non-combustible, high dielectric composition. Totally enclosed switchboards of the dead front type are recommended.

A master switch shall be installed on the main panel, and where the starting motor is on an independent circuit, an additional switch shall be installed.

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

(b) 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.

Conductors shall be protected in accordance with their current-carrying capacities as given in the table included in Section 285.

The conductors supplying motors and motor-operated appliances shall be protected by a separate over-current 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 at not more than 115 per cent for all other types of motors.

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

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

284. (a) Batteries should be so located that gas generated in charging can be easily dissipated by natural or induced ventilation. Acid batteries should be set in lead pans. 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 condition.

(b) Batteries should be secured against shifting with the roll of the boat and should be easily accessible for observation of terminals, testing and replenishment. 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 off by a cage or similar structure in order to minimize the danger of accidental spark through dropping a metal object across terminals.

Battery terminals shall be of the soldered lug type.

(c) An emergency switch shall be provided in the normally ungrounded supply conductor of an engine starting motor. The switch shall be located as closely as practicable to the supply battery.

285. (a) Ignition wiring as supplied or recommended by engine makers is generally acceptable.

Light and power wiring sizes shall be according to the following table for current to be carried. As a precaution against rupture by vibration all conductors shall be of the stranded type and no conductor smaller than No. 12 A. W. G. shall be used. The allowable current-carrying capacities in the table are based on temperature alone and do not take voltage drop into consideration.

TABLE I.

ALLOWABLE CURRENT-CARRYING CAPACITIES OF CONDUCTORS.

BASED ON ROOM TEMP. OF 30°C., 86°F.

(See National Electrical Code for other sizes.)

Size Gage No. A. W. G.	Area in Circular Mils	Capacity of Wire	
		Rubber Insulated Types R, RW, RU (Sizes 12-6) Thermoplastic Insulated Types T, TW (All sizes) Amp.	Rubber Insulated Type RH Amp.
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

NOTE: 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.

(b) The supply source employed shall be of a voltage value which will insure a minimum voltage drop with the maximum load demand likely to be obtained for the size of boat involved.

The following values are suggested as a guide:—

Boat Length—Feet	Minimum Supply—Volts
Less than 35	6
35 - 45	12
45 - 75	32
More than 75	110

The same supply voltage should be used throughout.

Starting source independent of the light and power source is recommended.

(c) The size of conductor required when an allowable voltage drop and current are given can be readily determined by 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

*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 III.

CONDUCTOR INSULATIONS.

Type Letter	Trade Name	Insulation	Thickness of Insulation		Outer Covering	Max. Operating Temp.	Special Provisions
R	Code	Code-Rubber	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	12-10 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	12-10 8-6	18 Mils 25 Mils	Moisture-Resistant, Flame-Retardant, Fibrous Covering	60°C. 140°F.	General Use
RH	Heat-Resistant*	Heat-Resistant Rubber	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	12-10 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	12-10 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

After computing the circular-mil area required, reference may be made to Table I 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.

Table II, derived from the preceding formula, indicates the required conductor sizes for general current values and lengths of conductor at recommended maximum voltage drops of 1.5 volts for a 6-volt supply and 2 volts for a 12-volt supply. Other values may be computed by the formula.

TABLE II.

CONDUCTOR SIZES FOR AMPERES—LENGTHS.

Total Current, on Circuit, 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—1.5-Volt Drop. Wire Sizes (A. W. G.)										
5	12	12	12	12	12	12	12	12	12	12	12
10	12	12	12	12	12	12	12	10	10	10	10
15	12	12	12	12	12	10	10	10	8	8	8
20	12	12	12	10	10	10	8	8	8	8	6
25	12	12	10	10	8	8	8	8	6	6	6
	12 Volts Two Wire—2-Volt Drop. Wire Sizes (A. W. G.)										
5	12	12	12	12	12	12	12	12	12	12	12
10	12	12	12	12	12	12	12	12	12	12	12
15	12	12	12	12	12	12	12	10	10	10	10
20	12	12	12	12	12	12	10	10	8	8	8
25	12	12	12	10	10	10	8	8	8	8	8

286. Light and power conductors for interior wiring shall be insulated in accordance with Table III.

Where desired, non-metallic sheathed cable may be employed instead of individual conductors.

Conductors passing to the exterior shall be run in metal kick-pipes or stuffing tubes to water-tight receptacles. From such receptacles to exterior fixtures, conductors shall be flexible cord as indicated in Tables IV and V.

TABLE IV.

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	

TABLE V.

ALLOWABLE CURRENT-CARRYING CAPACITY OF FLEXIBLE CORD.

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

For intercommunication wiring, rubber or thermoplastic covered single braid IC cable, type RF-32 (rubber covered fixture wire—$\frac{3}{32}$-in. insulation) stranded and not smaller than No. 16 A. W. G. or equivalent, shall be used. Commercial bell wire shall not be used.

287. (a) All wiring shall be run as high as practicable above the accommodation flooring. 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. However, the extended use of conduit and metallic tubing 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 in. apart.

(c) Lead sheathed unarmored conductors and conductors armored with spiral wound flat metal stripping are not approved. 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.

288. (a) Wiring joints and splices shall be mechanically secure. Unless a splice is made by a pressure wire connector, listed by Underwriters' Laboratories, Inc., it shall be thoroughly soldered. 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, Inc.

(b) Splices, unless provided with insulated wire connectors listed by Underwriters' Laboratories, Inc., shall be first taped with rubber and then with friction tape to afford insulation equivalent to that of the conductors joined.

289. (a) 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.

(b) Lighting and power switches and light fixtures in the engine room, forepeak, lazarette and galley (if gas is used for the range) shall be of the explosion proof type. The use of explosion proof switches throughout under deck is recommended.

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

(d) Magnetic starting switches, approved for use in hazardous locations, mounted close to the starting motors and explosion-proof starting motors and generators are also recommended.

(e) Each electric appliance shall be provided with a name plate giving the maker's name and the normal rating in volts and amperes or in volts and watts and the grounding polarity.

(f) On wooden boats, bonding together of all metal enclosures, frames and supports of electrical equipment including battery trays to a common point is necessary to guard against the effects of electrolysis. The negative terminal is recommended for the common point.

(g) 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 same polarity at each source of supply. Appliances shall be connected to supply circuits so as to maintain polarity throughout the system to insure against short circuiting.

(h) A separately fused circuit from the main distribution panel shall be provided for all radio equipment.

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

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

290. Lightning Protection.

291. On wooden boats it is recommended that attention be given to protection against lightning damage by grounding vertical projections in general compliance with land practice as recommended by the NFPA Code for the Protection of Life and Property Against Lightning, pending specific recommendations for marine installations to be promulgated.

310. Lamps and Lanterns.

311. Gasoline burning lamps and lanterns are not permitted. Oil lamps shall have metal bodies and, except hand lanterns, shall be kept in brackets well secured or suspended and stayed. They shall be secured in the brackets by an efficient device for holding them in place and shall have metal shields over the chimneys. Hand lanterns when suspended shall be secured by clips or lashings. Kerosene should be carried in an approved receptacle with a tight cover, and this receptacle, and oil burning lamps and lanterns not in service brackets, should be kept in a metal lined locker which is vented to the outside air.

320. Fire Extinguishing Equipment.

321. All hand extinguishers and extinguishing systems shall be on the "List of Inspected Fire Protection Equipment and Materials" issued by Underwriters' Laboratories, Inc., and on the approved list of the Bureau of Marine Inspection, U. S. Coast Guard.

322. (a) 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.

(b) CLASSIFICATION OF FIRE EXTINGUISHERS:—The 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" would signify 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 NFPA Standards for the Installation, Maintenance and Use of First Aid Fire Appliances.*

323. PROPERTIES:—A description of properties of various extinguishing elements is given below for reference purposes.

FIRE EXTINGUISHERS.

Soda-Acid *(Class A)*

Effect: Primarily quenching and cooling.
Freezing: Requires protection below 32°F.
Dielectric: Low. Not to be used on live electrical equipment.
Uses: For wood, paper, and fabric fires.
Limitations: Least effective on flammable liquid fires. Dangerous in electrical apparatus.
By-effects: Harmless. Little danger of acid stream if properly charged.

Anti-freeze *(Class A)*

Chemicals treated to resist freezing.
Otherwise generally same as soda-acid.
Under this classification are calcium chloride and loaded stream** types.

Vaporizing Liquid (Carbon tetrachloride base) *(Class B and C)*

Effect: Becomes fire-smothering gas at 140°F.
Freezing: Non-freezing above —50°F.
Dielectric: High.
Uses: For fires in electrical apparatus and in confined fires in flammable liquids where burning surface is accessible to stream.
Limitations: Ineffective unless vaporized by heat, and smothering gas quickly dissipates in atmosphere.
By-effects: Harmless to fabrics, etc. Users should avoid inhaling undue amount of vapors and gases particularly in confined spaces.

Foam *(Class A and B)*

Effect: Smothering by inert gas in foam blanket.
Freezing: Solutions require protection below 32°F. Dry powders unaffected by atmospheric temperatures.
Dielectric: Low. Not to be used on live electrical equipment.
Uses: For fires in combustible materials and flammable liquids where burning surface is accessible to stream or flow.
Limitations: Dangerous on fires in electrical apparatus.
By-effects: Harmless.

*Published by the National Fire Protection Association in National Fire Codes, Vol. IV; by the National Board of Fire Underwriters in Pamphlet No. 10.

**Loaded stream fire extinguishers are suitable for use on Class A and B fires.

Carbon dioxide *(Class B and C)*

Effect: Smothering and cooling by inert gas applied direct on flames or into burning compartment.
Freezing: Unaffected by atmospheric temperatures.
Dielectric: High. Equal to air.
Uses: For fires in flammable liquids, and electrical apparatus.
Limitations: Except in confined spaces, smothering gas quickly dissipates in atmosphere.
By-effects: Smothering, but not toxic.

Dry chemical (Expelled by Pressure) *(Class B and C)*

Effect: Smothering.
Freezing: Non-freezing.
Dielectric: High.
Uses: For fires in flammable liquids and electric apparatus.
Limitations: Easily dissipated by drafts.
By-effects: Harmless.

324. (a) INSTALLATION AND UPKEEP:—Portable hand fire extinguishing equipment shall be provided, and fixed extinguishing systems for protection of machinery spaces, separate compartments for fuel tanks, bilges and galley are recommended.

Hand extinguishers and manual controls for systems shall be placed so that they may be readily reached from outside the compartment which they are intended to serve.

Dual manual controls, well separated, are recommended for systems.

Neither carbon dioxide nor carbon tetrachloride should be discharged into closed compartments while occupied by persons, particularly sleeping quarters, as their effects may prove dangerous to life.

(b) Soda-acid, foam, and anti-freeze type extinguishers shall be discharged, cleaned, inspected for mechanical defects or serious corrosion, and recharged annually.

(c) Vaporizing liquid (carbon tetrachloride base) extinguishers of the hand pump type shall be examined at regular intervals—several times a year—to make sure they have not been tampered with, to detect any injuries and to see that they are full. A small amount of liquid should be discharged to check operation of the unit and the extinguisher again refilled. If the discharged liquid is to be reused it should be directed into a clean dry receptacle. Only refill liquids furnished by the extinguisher manufacturer should be used.

(d) Stored pressure and cartridge type vaporizing liquid (carbon tetrachloride base) fire extinguishers shall be inspected at regular intervals in strict accordance with maintenance instruction found on the name plate of the device. Only liquid furnished by the extinguisher manufacturer should be used.

(e) Carbon dioxide type fire extinguishers shall be reweighted 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. They must always be recharged after use even though only partly discharged.

(f) 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. These extinguishers shall be refilled after use even though only partly discharged. Before recharging hose shall be cleared of all chemical.

325. RECOMMENDED HAND EXTINGUISHER EQUIPMENT:—All power boats shall carry not less than two hand extinguishers mounted in accessible but separate locations. On boats having a galley stove, one extinguisher shall be mounted convenient thereto. A table of minimum recommended hand fire equipment and typical locations is given below:

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.**

326. SMOTHERING SYSTEMS:—A fixed carbon dioxide fire smothering system, listed for motor craft by Underwriters' Laboratories, Inc., and installed in accordance with the NFPA Standards for Carbon Dioxide Fire Extinguishing Systems* insofar as they apply, is recommended for machinery spaces, separate compartments for fuel tanks, bilges, and galleys. The quantity of gas required for such smothering 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.
1200	75.
1600	100.

and up to 4500 cu. ft. at the rate of 1 lb. of gas per 18 cu. ft. of space and above 4500 at 1 lb. per 20 cu. ft.

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.

Systems may be manually or automatically operated.

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

Plan of application of smothering systems may be (a) independent systems installed to cover the various spaces required; (b) single system of sufficient capacity for all required spaces simultaneously; (c) single system of sufficient capacity for the largest required space, distributed by direction valves at the controls to other required spaces. (a) and (b) are preferred. A device arranged to stop the engine simultaneously with the operation of the smothering system is recommended.

*Published by the National Fire Protection Association in National Fire Codes, Vol. IV; by the National Board of Fire Underwriters in Pamphlet No. 12.