* R E S T R I C T E D U S E *

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H-33 *DIESEL FUEL SYSTEMS*

Based on ABYC's assessment of existing technology, and the problems associated with achieving the goals of this standard, ABYC recommends compliance with this standard for all boats, associated equipment, and systems manufactured or installed after July 31, 200X.

33.1 *PURPOSE*

These standards are guides for the design, choice of materials, construction, installation, repair, and maintenance of permanently installed diesel fuel systems.

33.2 *SCOPE*

These standards apply to all parts of permanently installed diesel fuel systems from the fuel fill opening to the point of connection to the propulsion engine and/or to any auxiliary equipment on all boats with diesel engines.

33.3 *REFERENCED ORGANIZATIONS*

ABYC - American Boat & Yacht Council, Inc., 3069 Solomons Island Road, Edgewater, MD 21037-1416. Phone: (410) 956-1050. Fax: (410) 956-2737. Web site: www.abycinc.org.

ANSI - American National Standards Institute, 25 West 43rd Street, New York, NY 10036. Phone: (212) 642-4900. Fax: (212) 398-0023. Web site: www.ansi.org

ASTM International – American Society for Testing and Materials International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Phone: (610) 832-9585. Fax: (610) 832-955. Web site: www.astm.org.

AWS – American Welding Society. 550 N.W. LeJeune Road, Miami, Florida 33126 Phone: (800) 443-9353 Web site: www.aws.org

ISO – International Organization for Standardization, ISO Central Secretariat, 1 rue de Verambe, 1211 Geneva Switzerland, tel +41 22 749 0111, fax +41 22 734 0179, Internet central@isocs.iso.ch. Contact ABYC for availability of specific documents.

Military Specification (MIL SPEC) - A specification developed by the US Armed Forces. The referenced specifications may be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120 Website: www.dodssp.daps.htm

SAE - Society of Automotive Engineers - 400 Commonwealth Drive, Warrendale, PA 15096-0001. Phone: (724) 776-4841. Fax: (724) 776-5760. Web site: www.sae.org.

UL – Underwriters Laboratories, Inc., 12 Laboratory Drive, PO Box 13995, Research Triangle Park, NC 27709-3995. Phone: (919) 549-1400. Fax: (919) 547-6000. Web site: www.ul.com.

33.4 ***DEFINITIONS*** - *For the purposes of this standard, the following definitions apply.*

Accessible - Capable of being reached for inspection, removal, or maintenance without removal of permanent boat structure.

Permanently installed - Securely fastened so that tools, such as wrenches and screwdrivers, must be used for removal.

Readily accessible - Capable of being reached quickly and safely for effective use under emergency conditions without the use of tools.

Static floating position - The attitude in which a boat floats in calm, fresh water, with fuel tanks filled to rated capacity, but with no person(s) or item(s) of portable equipment aboard. The boat should include all permanently installed factory supplied equipment and options such as, but not limited to the engine or engines, batteries, seats, engine oil, railings, fishing towers, etc., but not portable gear such as flags, searchlights, movable cushions, mattresses, portable fire extinguishers, lines, fenders, chairs, tables, anchors, chain, or PFDs. Other tanks such as water, holding, and live bait well tanks are to be empty.

33.5 ***REQUIREMENTS – IN GENERAL***

33.5.1 The installed fuel system shall be designed so that a fuel temperature rise of 60°F (33°C) shall not cause liquid fuel to spill into the boat or the environment when

33.5.1.1 the fuel tank is filled to its rated capacity according to the boat manufacturers' instructions, and

33.5.1.2 the boat is in the static floating position,

NOTE: A fuel system designed to contain 5 percent fuel expansion is one method of meeting this requirement.

33.5.2 The entire system shall be liquid and vapor tight to the hull interior spaces.

33.5.3 The system and all components shall be capable of operation within an ambient temperature range from -20°F (-29°C) to 176°F (80°C) without failure or leakage.

33.5.4 The system shall be permanently installed and all component parts shall be installed to minimize strain on fuel lines.

33.5.5 Components of the system and the fuel distribution system shall be designed and sized to provide the required fuel flow to the engine at the maximum power setting of the engine.

33.5.6 All individual components of the fuel system, as installed in the boat, shall be capable of withstanding a 2½ minute exposure to free burning fuel (N-Heptane), or No. 2 diesel fuel without leakage, when tested in accordance with Title 33 CFR, Section 183.590, *Fire Test*.

EXCEPTIONS:

1. Portions of fuel distribution systems located outside the engine compartment if a break at any point in this system will result in the discharge of no more than five ounces of fuel in 2-1/2 minutes including fuel that may drain from the engine. (See H-33.14 for requirements for fuel distribution and return lines.)

2. Self-draining fill and vent pipes located in a separate compartment from the engine compartment.

3. Fill and vent external fittings.

4. Clips and straps not essential for anti-siphon protection required by this standard.

33.5.7 Drain valves on filter(s) and fuel tank(s) shall be of the type that cannot be opened inadvertently, or shall be installed in a manner to guard against inadvertent opening. All other outlets for draining fuel from the system are prohibited.

33.5.8 A means to determine fuel level or quantity shall be provided.

33.5.8.1 If a sight gauge is used;

33.5.8.1.1 it shall be equipped with a shutoff valve at the top and at the bottom of the gauge, and

33.5.8.1.2 a warning label shall be placed adjacent to the sight gauge, and

33.5.8.1.2.1 the warning label shall comply with the requirements of H-33.16.

33.6 ***FLEXIBLE FUEL HOSE***

33.6.1 Hose shall be USCG Type A complying with the requirements of UL 1114, *Marine flexible fuel-line hose* or with the requirements of SAE J1527, *Marine Fuel Hoses*.

NOTE: SAE J1527 does not pertain to totally metallic flexible hose.

33.6.1.1 Flexible hose shall be marked on the outermost cover with the manufacturer's name or trademark, year of manufacture, and

33.6.1.1.2 All required markings must be legible and permanent on the hose itself, in block capital letters at least every 12 inches (304.8mm), and numerals at least 1/8 inch (3.16mm) high.

NOTE: Hoses less than 12 inches (305mm) in length may be tagged with the required marking.

33.6.1.2 Hose shall be marked “USCG Type A1” or “USCG Type A2.” See H-33 Table I.

33.6.1.3 Flexible hose shall be equipped with permanently installed end fittings, such as a swaged sleeve or a sleeve and threaded insert, or may be secured with corrosion resistant metallic clamps.

33.6.1.4 The ID of a hose and the OD of a connecting spud or fitting must meet the specifications in H-33 Table II.

33.7 ***FUEL LINE SUPPORTS***

33.7.1 Hoses shall be secured and routed so that they will not chafe on boat structure or equipment.

33.7.2 Clips, straps or other means used for securing fuel lines shall be of corrosion resistant materials, and

33.7.2.1 shall be designed to eliminate cutting or abrading action where in contact with the fuel line.

33.7.3 When installed, fuel valves shall minimize strain on the fuel lines.

33.8 ***VALVES***

33.8.1 Manually operated shut-off valves shall be designed with positive stops in the open and closed positions.

33.8.2 Multiposition valves, as installed, shall clearly indicate their intended positions.

33.8.3 Tapered plug valves with an external spring shall not be used.

33.9 ***FUEL FILTERS, STRAINERS, AND WATER SEPARATORS***

NOTE: Filters, separators, and strainers meeting the requirements of ANSI/UL 1105, Marine Use Filters and Separators, comply with these requirements.

33.9.1 Dirt removal efficiency, i.e., micron rating, shall be equal to or better than that specified for the particular engine used.

33.9.2 The unit shall incorporate means for independent mounting.

33.9.3 The unit shall be designed so that routine servicing and removal for cleaning purposes will minimize, as much as practicable, any spillage of fuel into the bilge.

33.9.4 Drain openings shall be equipped with standard (tapered) pipe plugs, threaded shoulder plugs or valves in accordance with H-33.5.9.

33.9.4.1 Plugs shall not create a galvanic cell with the housing.

33.9.5 All fitting threads shall be tapered pipe threads.

EXECPTION: Threaded shouldered plugs covered in H-33.9.4

33.9.5.1 External threads shall be National Pipe Thread Fine (NPTF).

33.9.5.2 Internal threads shall be Pipe Thread Fine Short (PTFSPL).

33.9.6 Gaskets and Seals

33.9.6.1 Gaskets and seals, if used, shall form a complete ring, and shall not be split.

33.9.6.2 Cork gaskets shall not be used.

33.9.6.3 A gasket or “O” ring shall be retained by the body, or cover, when the part is removed.

33.9.7 Marking

33.9.7.1 Each unit shall be permanently and plainly marked with the following;

33.9.7.2 manufacturer’s or private labeler’s name or identifying symbol, and

33.9.7.3 date of manufacture, and

33.9.7.4 type of unit (filter, strainer, or separator), and

33.9.7.5 replacement element part designation, and

33.9.7.6 direction of fuel flow, and

33.9.7.7 test pressure, and

33.9.7.8 types of fuel for which the unit is intended, and

33.9.7.9 service instructions.

33.9.8 Installation instructions and component parts replacement list shall be provided.

33.10 ***INSTALLATION - FUEL TANK***

33.10.1 Tanks may be integral with the hull.

33.10.1.2 If cored hull construction is used where the tank is integral with the hull, the core shall not

33.10.1.2.1 deteriorate from exposure to diesel fuel, and commonly used additives, and

33.10.1.2.2 shall not permit fuel to migrate.

33.10.2 Unless specifically designed for the purpose, non-integral fuel tanks shall be installed in such a manner that they do not support decks, bulkheads, or other structure.

33.10.3 The tank labels shall be readable as positioned on installed tanks.

33.10.4 Tank connections and fittings shall be readily accessible, or accessible through an access panel, port or hatch.

33.10.4.1 The tank(s) shall be installed so that means for maintenance or replacement are provided or indicated by the boat manufacturer.

NOTES:

1. Consideration should be given to the ease of replacement of the fuel tank.

2. Replacement methods may include, but are not limited to, removal of sections of the boat (e.g. cockpit sole).

EXCEPTIONS:

1. Thermoset fiberglass reinforced plastic fuel tanks.

2. Integral fuel tanks

33.10.5 Fuel tanks shall be installed and restrained so that the fuel tank does not move at the mounting surface more than 1/4 inch (6.4mm).

EXCEPTION: Space required for expansion of new non-metallic fuel tanks.

33.10.6 For metallic fuel tanks listed in H-33 Table IV, other than stainless steel, all non-integral tank supports, chocks, or hangers shall be separated from the tank surface by a non-metallic, non-moisture-absorbent, non-abrasive material suitable for the purpose, (e.g., neoprene, Teflon, and high density plastics), permanently bonded to the tank surface with impermeable, non- hydroscopic adhesive.

NOTE: Polyurethane adhesive/sealant or equivalent will accomplish this.

33.10.6.1 For stainless steel tanks see H-33.10.10.

33.10.6.2 Self-wicking material, such as carpet pile, shall not be in contact with a metallic tank.

33.10.7 Metallic fuel tanks installed above flat surfaces shall be separated from the surfaces by at least 1/4 inch (6.4mm) air space when filled with fuel, and the flat mounting surface shall be self-draining.

33.10.8 Each metallic tank must be installed to allow drainage of accumulated water from the tank's surfaces when the boat is in its static floating position.

33.10.9 Metal tanks shall be installed where they cannot be reached by normal accumulation of bilge water in the static floating position.

33.10.10 Stainless steel tanks shall be supported to avoid crevice and pitting corrosion from entrapment of moisture by means such as welded brackets of like material, or other support material, permanently bonded to the tank surface with impermeable, non- hydroscopic adhesive.

NOTE: Brackets will move the potential for crevice and pitting corrosion from the tank surfaces to the bracket, and will assure air circulation to the tank surfaces.

33.10.11 If a metallic fuel tank is encased in plastic,

33.10.11.1 the tank material may not be a ferrous alloy, and

33.10.11.2 the plastic must be attached to the metal surface of the tank so as to prevent moisture between the metal and the plastic, and

33.10.11.3 the adhesive strength of the metal to plastic bond must exceed the cohesive strength of the plastic, and

33.10.11.4 the fuel tank must be supported in the boat by means other than plastic foam.

33.10.12 Cellular plastic used to encase fuel tanks shall:

33.10.12.1 Not change volume by more than 5 percent or dissolve after being immersed in any of the following liquids for 24 hours at 85°F (29°C);

33.10.12.2 Reference Fuel B of ASTM D-471, or

33.10.12.3 IRM 902 Reference Oil of ASTM D-471, or

33.10.12.4 Five percent solution of trisodium phosphate in water; and

33.10.12.5 shall not absorb more than 0.12 pound (54 g) of water per square foot (0.093m^2) of cut surface measured under Military Specification MIL P-21929B. (Plastic material, cellular polyurethane, foam in place, rigid-1970)

33.10.13 Non-polyurethane cellular plastic, if used to encase fuel tanks, must have a compressive strength of at least 60 psi (414kPa) at 10 percent deflection, measured under ASTM D-1622, *Apparent Density of Rigid Cellular Plastics.*

33.10.14 Polyurethane cellular plastic, if used to encase fuel tanks, must have a density of at least two pounds per cubic foot (32.04 Kg/M^3), measured under ASTM D-1622, *Apparent Density of Rigid Cellular Plastics.*

33.11 *CONNECTIONS - FUEL HOSE*

33.11.1 Flexible hose not equipped with permanently attached end fittings, such as swaged sleeve and threaded insert, shall be attached with corrosion resistant metallic clamps.

NOTE: Some hose that meets the requirements of UL 1114, Marine (USCG Type A) Flexible Fuel-Line Hose, is not designed to be clamped.

33.11.2 The ID of a hose and the OD of a connecting spud or fitting must meet the specification in H-33 Table II.

33.11.3 Hose shall not be installed on helical threading or knurling that provides a path for fuel leakage.

33.11.4 Clamps depending solely on the spring tension of the metal shall not be used.

33.11.5 Clamps shall be installed to impinge directly on the hose and shall not overlap each other.

33.11.6 Clamps shall be beyond the flare or bead, or fully on serrations where provided, and at least 1/4 inch (6mm) from the end of the hose.

33.11.7 Hose used in the fuel tank fill system shall be secured to pipes (smooth pipes acceptable), spuds or other fittings at each connection, by at least two corrosion resistant metallic clamps with nominal band widths of at least 1/2 inch (12mm).

33.11.8 Hose used in the fuel tank vent system, or the fuel distribution and return line system, shall be secured to a fitting that is formed or machined to provide serrations, barbs or a bead with a minimum height of at least 0.015 inches (0.038 mm)

33.11.9 Hose connections used in the fuel tank vent system or the fuel distribution and return line system shall have at least one corrosion resistant metallic clamp with a minimum nominal band width as indicated in H-33 Table III.

33.11.9.1 All components of hose clamps shall have a resistance to corrosion equal to or greater than 300 series stainless steel.

33.11.9.2 Hose clamps shall be reusable.

33.12 *FUEL FILL SYSTEM*

33.12.1 All fittings and connections of the fuel fill system shall be readily accessible, or accessible through an access panel, port or hatch.

33.12.2 Separation between compartment ventilation openings and fuel fill openings shall be at least 15 inches (381mm).

33.12.3 Deck plates or permanently attached caps shall carry a permanent identification of the fuel type, e.g. FUEL OIL, DIESEL, or the ISO symbol.

NOTE: Caps or fittings connected to the fuel fill with a chain or other flexible connector are not considered to be permanently attached.

33.12.4 Fuel fill lines shall be self-draining and run as directly as practicable from the deck plate to the fuel tank connection.

33.12.5 The minimum inside diameter of the fill system shall be 1 1/8 inch (28.5mm).

33.12.5.1 To maintain the minimum diameter, using standard fittings, the minimum hose ID shall be 1½ inch (38.1mm).

33.12.6 Fuel fill lines shall be hose, fiberglass, metal pipe or minimum schedule 40 plastic.

33.12.6.1 Flexible fuel fill hose shall be USCG Type A1 or A2. See H-33 Table I.

33.12.6.2 If steel pipe is used, it shall be at least schedule 40.

33.12.7 Fuel fill(s) shall be located and oriented so that

33.12.7.1 no fuel can enter the boat when in the static floating position when tested in accordance with section H-33.17.3, and

33.12.7.2 there must be no blow back of fuel through the fuel fill fitting when tested in accordance with section H-33.17.2.

33.13 ***TANK VENT SYSTEMS***

33.13.1 The fuel vent system shall be designed to prevent spilling liquid fuel into the boat, or the environment, when tested in accordance with H-33.17.14 while fueling the boat in accordance with the boat manufacturer's instructions.

33.13.2 Minimum inside diameter of vent line shall be 7/16 inch (11.11mm).

33.13.2.1 The minimum inside diameter of vent openings in the fuel tank shall be 5/16 inch (7.93mm).

24.13.3 Each vent shall have a flame arrester that can be cleaned, unless the vent system is itself a flame arrester.

NOTE: Vent fittings that are removable are considered cleanable.

33.13.4 Fuel vent lines shall be metallic or hose.

33.13.4.1 Flexible fuel vent hose, if used, shall comply with H-33.6.

33.13.5 Separation between compartment ventilation openings and fuel tank vent line terminations shall be at least 15 inches (381mm).

33.13.6 The tank vent pipe shall have provision to minimize the intake of water without restricting the continuous release of vapor.

33.13.7 The vent system shall be self draining, and

33.13.7.1 shall connect to the highest point of the fuel tank as installed in the boat under conditions of normal operation and normal trim.

NOTES:

1. In sailing auxiliaries, it may be necessary to have dual vents, each equal in size to the specification in H-33.13.2.

2. This does not require separate lines from the tank for vent and fill systems.

24.13.7.2 All fittings and connections of the tank vent system shall be readily accessible, or accessible through an access panel, port or hatch.

33.14 ***FUEL DISTRIBUTION, RETURN AND TRANSFER SYSTEMS***

33.14.1 The diesel fuel system shall be equipped with at least one fuel filter and water separator.

33.14.2 A shut-off valve is required at the fuel tank in systems where fuel may siphon, and in gravity feed systems.

33.14.3 Electrically operated fuel pump(s) shall be connected to be energized only when the engine ignition switch is on and the engine is running. A momentary type override (five seconds) is acceptable for starting.

EXCEPTION: Electrical fuel pumps used to transfer fuel between tanks.

33.14.4 Fuel distribution, return and transfer lines shall be flexible hose or metallic.

33.14.5 Flexible hose shall comply with H-33.6.

33.14.6 Metallic fuel lines shall be aluminum or copper alloy pipe of no less than schedule 40, or

33.14.6.1 copper alloy tubing with a nominal wall thickness of at least .032 inches (.81mm).

33.14.7 Rigid fuel distribution lines secured to hull members shall be connected to the engine by a flexible section.

33.14.8 The rigid line shall be supported within four inches (101.6mm) of this connection.

33.14.9 In systems with multiple engines and/or multiple tanks, valves at junctions shall be labeled as to function and position.

NOTE: When fuel is not being returned to supply tank there may be a potential for overflow.

33.15 ***FUEL SYSTEM GROUNDING***

33.15.1 Each metal or metallic plated component of the fuel fill system that is in contact with the fuel and the fuel tank shall be grounded so that its resistance to the boat's ground is less than one ohm.

NOTES:

1. The deck fill is considered to be in contact with the fuel.

2. For the grounding of liquid level transmitters see ABYC E-11, AC and DC Electrical Systems on Boats

EXCEPTION: Removable fuel fill caps.

33.15.1.1 Grounding wires shall not be clamped between the fill pipes and the flexible hose. See ABYC E-11, *AC & DC Electrical Systems on Boats.*

33.16 ***FUEL SYSTEM LABELING***

33.16.1 A warning label shall be placed in a readily visible location on the boat, or at a point of frequent servicing of the boat, and

33.16.1.1 the label shall be comply with ABYC T-5, *Safety Signs and Labels*, and shall contain at least the following informational elements:

33.16.1.1.1 the hazard intensity signal word;

33.16.1.1.2 the nature of the hazard;

33.16.1.1.3 consequences that can result if the instructions to avoid the hazard are not followed;

33.16.1.1.4 instructions on how to avoid the hazard.

NOTE: An example of such a label follows:

⚠ WARNING
AVOID SERIOUS INJURY OR DEATH **FROM FIRE** **RESULTING FROM LEAKING FUEL.** **INSPECT SYSTEM FOR LEAKS** **AT LEAST ONCE A YEAR.**

33.16.2. Sight gauge operation.

33.16.2.1 A label shall be placed adjacent to the sight gauge;

NOTE: An example of such a label follows:

⚠ **WARNING**
LEAKING FUEL IS A FIRE HAZARD **AVOID SERIOUS INJURY OR DEATH FROM FIRE.** **KEEP BOTH SIGHT GAUGE VALVES CLOSED,** **EXCEPT WHEN CHECKING FUEL LEVEL.**

33.16.3 TANK LABELS

33.16.3.1 All fuel tanks shall bear a label with at least the following information:

33.16.3.1.1 manufacturer's name or trademark and address-

33.16.3.1.2 month, or lot number, and year of manufacture-

33.16.3.1.3 capacity in US gallons/liters;

33.16.3.1.4 material specification and thickness;

33.16.3.1.5 fuel for which the tank is suitable;

33.16.3.1.6 maximum test pressure;

33.16.3.1.7 model designation.

33.16.3.2 Each letter and number on this label shall

33.16.3.2.1 be at least 1/16 inch (1.6mm) high, and

33.16.3.2.2 contrast with the basic color of the label, or embossed on the label.

33.16.3.3 Each label shall:

33.16.3.3.1 withstand the combined effects of exposure to water, oil, salt spray, direct sunlight, heat, cold, and wear expected in normal operation of the boat, without loss of legibility, and

33.16.3.3.2 resist efforts to remove or alter the information on the label without leaving some obvious sign of such efforts.

33.16.3.4 The tank label shall be readable as positioned on the installed tank.

33.17 ***INSTALLATION TESTS***

33.17.1 Prior to installation each tank shall be tested to the maximum pressure indicated on the tank label. The fuel tank shall evidence no leakage under such testing.

33.17.2 There must be no blow back of fuel through the fill fitting when filling at a rate of nine gpm (34 lpm) from 1/4 to 3/4 of the capacity on the tank label. For fuel tanks of 25 gallons (95 liters) capacity or less, the fill rate may be reduced to six gpm (23 lpm).

NOTE: A test to determine compliance with this requirement may be performed on a representative installation.

33.17.3 Fuel fills shall be located and oriented so that no fuel can enter the boat when it is in its static floating position and fuel overflows at a rate of five gpm (19 lpm) for five seconds.

33.17.4 Overflow from the fuel tank vent at the rate of two gpm (7.5 lpm) or less shall not enter the boat.

33.17.5 After installation, the fuel system of every boat shall be pressure checked to at least three psi (21kPa), or at 1½ times the maximum hydrostatic head to which it may be subjected in service, whichever is greater.

33.17.5.1 The fuel system shall evidence no leakage under such testing, checked at a minimum of five minutes after application of the test pressure, for systems of 50 gallons (190 liters) or less capacity, with one additional minute for each increment of 10 gallons (38 liters), or fraction thereof, above 50 gallons (190 liters).

33.17.5.1.1 Test tanks over 500 gallons (1900 liters) for 50 minutes plus 1/2 minute for each increment of ten gallons (38 liters) over 500 gallons (1900 liters).

33.17.5.2 A leak detection method other than the pressure drop method must be used at every joint except at the deck fill and exterior vent fittings.

NOTE: Soapy test solutions should be non-corrosive and non-toxic. Ammonia, present in some soaps and detergents, creates a condition that attacks brass fittings like those used in fuel systems. Undetectable at first, these fittings may develop cracks creating a very hazardous situation.

33.18 *DIESEL FUEL TANKS*

33.18.1 All materials used shall be resistant to deterioration as a result of contact with diesel fuel and other liquids or compounds with which the material may normally come in contact under normal operating conditions, e.g., grease, lubrication oil, common bilge solvents, and salt or fresh water.

33.18.2 Metallic Tanks

33.18.2.1 Copper tanks shall be internally tin coated.

33.18.2.2 If galvanized, sheet steel tanks shall be galvanized on the outside only.

33.18.2.3 Tank fitting plates shall be made of 5052, 5083, 5086, 6061, or 6063 aluminum or 300 series stainless steel.

33.18.2.4 Aluminized steel tanks shall have a corrosion inhibiting baked paint or equivalent coating not less than .0015 inch (.0381mm) thickness applied to the total tank exterior.

33.18.2.5 Fuel tanks shall not be constructed of terneplate steel.

33.18.3 Corrosion Resistance

33.18.3.1 For corrosion resistance, fuel tank material shall be at least the minimum thickness listed in H-33 Table IV. Metallic materials not listed in H-33 Table IV shall be tested in accordance with ASTM B117, Salt Spray (Fog) Testing for a minimum of 400 hours and demonstrate corrosion resistance equivalent to a similar material listed.

NOTE: Material thickness specified in H-33 Table IV may not be sufficient to meet the structural requirements of the standard.

33.18.3.2 Non-metallic materials, such as fiberglass, are acceptable for corrosion resistance; however, all other requirements of this standard must be met.

33.18.3.3 Metals and metal alloys used in a fuel system shall be selected to minimize galvanic action.

NOTE: The copper based alloys normally used for fuel fittings and lines are acceptable for direct coupling with all fuel tank materials listed in H-33 Table IV, except aluminum.

33.18.3.3.1 Copper-base alloy components shall be separated from contact with aluminum tanks or fitting plates by means of a galvanic barrier, such as 300 series stainless steel.

33.18.3.4 After machining, all steel pipe fittings shall be zinc plated, and treated with yellow dichromate dip per ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

33.18.3.5 Fasteners used to couple fittings, such as fuel senders to aluminum tanks, shall be of 300 series stainless steel.

33.18.4 Design, Construction, and Testing

33.18.4.1 Non-integral fuel tanks shall be capable of withstanding mechanical strength tests as described in H-33.21.

33.18.4.2 The test pressure shall not be less than three psi (21kPa). See H-33.21.1.

33.18.4.3 The tank design shall be such that no exterior metallic part of the tank will trap water when the tank is installed as intended with the boat in the static floating position.

33.18.4.4 If baffles are provided, the total open area provided in the baffles shall be a maximum of 30 percent of the tank cross section in the plane of the baffle. Baffle openings shall be designed so that they do not prevent the fuel flow across the bottom, or trap vapor across the top of the tank.

33.18.4.5 Threaded connections into fuel tanks shall be in accordance with American Standard Taper Pipe Thread (NPTF) and shall provide for thread engagement in accordance with H-33 Table V.

33.18.4.6 Rigid tubes and fill pipes that extend near the tank bottom shall have clearance to prevent contact with the bottom due to flexing of the tank.

33.18.4.7 If the fuel pick-up tube and/or return tube is not furnished as part of the tank, the tank manufacturer shall provide a detailed construction print of the installation.

33.18.5 Labeling

33.18.5.1 Each tank shall be provided with an information label complying with the requirements of H-33.16.3.

33.18.6 Each tank shall be tested prior to installation to the maximum pressure indicated on the tank label. The fuel tank shall evidence no leakage under such testing. The test pressure shall not be less than three psi (21kPa). See H-33.21.1.

33.19 *DIESEL OUTBOARD POWERED BOATS*

33.19.1 Outboard boats intended for use with only diesel as the propulsion fuel shall be so identified.

33.19.2 No pressurized tanks shall be built into, or permanently attached to, hulls.

33.19.3 A quick disconnect connection may be used between the motor and fuel distribution lines, but must automatically shut off fuel flow when it is disconnected.

33.19.4 Fuel distribution lines shall be installed by the manufacturer in outboard powered boats equipped with permanent tanks. See H-33.14.

EXCEPTION: Fuel tanks with withdrawal fittings near the stern that, as installed, provide anti-siphon protection.

33.19.5 Fuel distribution lines shall terminate at a fitting at the stern, where provision is made for drainage or leakage. The stern fitting is not required if anti-siphon protection is provided by an anti-siphon or electrically operated valve.

33.20 *NON-INTEGRAL DIESEL FUEL TANK TESTING FOR FIRE RESISTANCE*

33.20.1 Representative samples of the fuel tanks shall be subjected to the test described herein. The tank to be tested shall be a complete assembly, and include the fuel pick-up tube, fuel return tube, fuel fill pipe, and fuel gauge specified for the fuel tank.

33.20.2 A single fuel tank design, shown to be fully representative of a series of fuel tanks of similar design, size, and construction, may be tested as representative of that series of fuel tanks.

33.20.3 A fuel tank shall be capable of withstanding exposure to a test fire without contributing to the fire due to leakage of the fuel contained therein. For the purpose of this test, slight vapor leakage will be permitted, except in the tank shell, if it can be shown that the path of leakage will not permit a fire outside the tank to ignite vapors within the tank.

33.20.4 The fuel tank sample to be tested is to be provided with all the attachments specified by the manufacturer.

33.20.5 As Installed Fire Test

33.20.5.1 This test shall be conducted to qualify fuel tanks intended to be installed in a particular model boat, or series of boats, where the construction of the tank is known, and the installation of the tank is specified or otherwise controlled.

33.20.5.2 The fuel tank sample shall be installed in an actual or simulated hull section of sufficient size to simulate fire conditions aboard the boat. All bulkheads, supports, floors, and other surfaces in the

simulated fuel tank compartment shall be of the same material, or of equivalent flammability to that used on the boat.

33.20.5.3 To qualify a fuel tank intended for use in a series of boats, the fuel tank sample shall be installed in a simulated hull section providing the maximum fire exposure representative of that series of boats.

33.20.5.4 The fuel tank sample, and all connecting piping and fittings, shall be checked for leakage at an aerostatic pressure of three psi (21kPa) applied to the tank vent. Following the pressure test, the pressure shall be released and the tank vent left open to simulate a normal condition. The size of the fuel tank sample vent shall be determined by the size of the vent fittings provided by the manufacturer.

33.20.5.5 The fuel tank sample shall be filled to one-quarter rated capacity with diesel fuel, and all openings capped or plugged, except for the fuel tank vent, which is to be extended without traps outside the fire test area.

33.20.5.6 If a fuel tank sample is to be evaluated for use with both gasoline and diesel fuel, gasoline shall be used inside the fuel test sample.

33.20.5.7 N-Heptane shall be poured into all crevices and liquid traps in which fuel could collect in the boat, assuming a leak anywhere in the fuel system. If possible, the amount of fuel in each liquid trap shall be sufficient to burn for a period of 2½ minutes.

33.20.5.8 The test method described in H-33.20.7 shall be used.

33.20.6 General Installation Fire Test

33.20.6.1 This test shall be conducted to qualify fuel tanks where the actual installation conditions are not known.

33 20.6.2 The fuel tank sample is to be supported in a test enclosure, as shown by Figure 1, if the fuel tank is intended for below deck installation, or in a test enclosure, as shown by Figure 2, if the tank is intended for above deck installation.

33.20.6.3 The side supports of the fuel tank sample are to be spaced to support the fuel tank ends, and at each fuel tank baffle, and are to be formed to maintain the fuel tank sample two inches (50.8mm) away from the inside surface of the simulated hull side panel.

33.20.6.4 The supports for the bottom of the fuel tank sample are to be located in the same manner as the side supports, and are to be formed to maintain the fuel tank sample three inches (76.2mm) above the side surface of the enclosure.

33.20.6.5 The fuel tank sample is to be secured to the test enclosure by steel straps. The top of the test enclosure shall be formed so that the maximum fuel tank sample setback does not exceed two inches (50.8mm), and the clearance between the top of the test enclosure and the top of the fuel tank sample is not less than seven inches (177.8mm), nor more than 34 inches (863.6mm).

33.20.6.6 The area of the enclosure beneath the fuel tank sample is to serve as the fuel reservoir, and shall be formed so that the surface of the test fuel extends six inches (152.4mm) beyond the fuel tank sample ends, and two inches (50.8mm) beyond the exposed front surface of the fuel tank sample. The

reservoir shall be made leak proof, and shall be capable of containing sufficient fuel to burn for a period of 2½ minutes.

33.20.6.7 The fuel tank sample and all connecting piping and fittings shall be checked for leakage, and three psi (21kPa) aerostatic pressure applied to the tank vent. Following this pressure test, the pressure shall be released and the tank vent left open to simulate a normal condition. The size of the fuel tank sample vent shall be determined by the size of the vent fitting provided by the manufacturer.

33.20.6.8 The fuel tank sample is to be filled to one-quarter rated capacity with diesel fuel, and all openings capped or plugged, except for the fuel tank vent, which is to be extended without traps outside the fire test areas.

33.20.6.9 If a tank is to be evaluated for use with both gasoline and diesel fuel, gasoline shall be used inside the fuel tank sample.

33.20.6.10 N-Heptane shall be poured into the reservoir in accordance with H-33.20.5.7.

33.20.6.11 The test method described in H-33.20.7 shall be used.

33.20.7 Test method for Fuel Tank Fire Test

33.20.7.1 The area in which the test is to be conducted is to be free from drafts, but shall have provision for a free inflow of air during the test.

33.20.7.2 The N-Heptane in the hull section or the test enclosure shall be ignited and permitted to burn for a continuous period of 2½ minutes.

33.20.7.3 All burning is to be extinguished at the end of the 2½ minute test period.

33.20.7.4 Following the test, the fuel tank sample shall be examined for leakage and then pressure checked with 1/4 psi (1.75kPa) of aerostatic pressure. This pressure shall be applied gradually by means of a suitable regulator so as not to strain the tank due to pressure surge. The tank fails the test if leakage is detected in the tank shell while using a means other than the pressure drop method.

33.21 *NON-INTEGRAL DIESEL FUEL TANK TESTING FOR MECHANICAL STRENGTH*

33.21.1 Representative samples of the fuel tanks shall be tested by the tank manufacturer at 1½ times the maximum test pressure indicated on the tank label, with gauge or sending unit installed. See H-33.17. The fuel tank shall not exhibit any leakage.

33.21.2 Representative samples of fuel tanks shall be subjected to mechanical strength tests as applicable according to H-33.21.4, 5, and 6.

33.21.3 Mechanical strength tests for non-metallic diesel fuel tanks, and non-metallic components in metallic tanks, shall be conducted on the fuel tank samples that have contained diesel fuel for 30 days at room temperature 70°F - 80°F (21.1°C - 26.7°C). Fuel tank samples intended to be qualified for use with gasoline as well as diesel fuel shall have contained ASTM Reference Fuel C, and maintained at a temperature between 70°F - 80°F (21.1°C and 26.7°C) for a period of at least 30 days.

33.21.4 Shock Test - Fuel tanks of less than 25 gallons (95 liters) capacity shall not leak, or show signs of permanent deformation, or other signs of failure following; 1000 cycles of vertical shocks, with an acceleration of 25 g's, with a duration measured at the base of the shock envelope of 6-14 milliseconds.

33.21.4.1 The fuel tank sample filled to capacity with water shall be mounted to a platform using the supports, chocks, or hangers either furnished with the tank, or intended to be used in a boat installation.

33.21.4.2 The platform shall be connected to a device that will repeatedly raise and drop the platform, at a rate not to exceed 80 impacts per minute. By varying the height of the drop and/or cushioning under the platform, the top surface of the platform shall be calibrated as close to the tank center of gravity as is practicable to provide the specified shock impacts.

33.21.4.3 The tank shall be tested to meet the requirements of H-33.21.1.

33.21.5 Pressure Impulse Test - Fuel tanks of 25 gallons (95 liters) capacity and more shall not leak, or show signs of permanent deformation, or other signs of failure following 25,000 cycles of pressure-impulse.

33.21.5.1 The fuel tank sample, filled to capacity with water, shall be mounted using support, chocks, or hangers, either furnished with the tank, or intended to be used in a boat installation.

33.21.5.2 The fuel tank sample is to be attached to a regulated source of pressure of either air, nitrogen, or water. The control mechanism of the pressure source is then to be set to cause the pressure in the sample, measured at its top-most surface, to vary from zero to three to zero psig (0-21kPa) at a rate of not more than 15 cycles per minute

33.21.5.3 The tank shall be tested to meet the requirements of H-33.20.7.4.

33.21.6 Slosh Test - Fuel tanks of 200 gallon capacity (757 liters) and more shall not leak, or show signs of permanent deformation, or other signs of failure following 500,000 cycles of rocking motion. This test shall be performed following the Pressure Impulse Test on the same fuel tank sample. If testing equipment of sufficient capacity is not available for the slosh testing of large tanks, an analytical method may be used to demonstrate compliance. The results of this analysis shall be certified by an independent third party.

33.21.6.1 The fuel tank sample used for this test is to be provided with all attachments specified by the manufacturer.

33.21.6.2 The fuel tank sample is to be centered on a rocker assembly to simulate the recommended tank installation using supports, chocks, or hangers either furnished with the tank, or intended to be used in a boat installation.

33.21.6.3 The fuel tank sample is to be filled with dye colored water to one-half its rated capacity, and all fuel tank fittings, except the tank vent, are to be capped.

33.21.6.4 The rocker assembly shall be adjusted to produce a rocking motion of approximately 15º to either side of a vertical reference line, at a rate of three to four seconds per cycle.

33.21.6.5 The axis of rotation of the rocker, and fuel tank sample, shall be parallel to the tank baffles, and perpendicular to the centerline of the tank length, at a level not more than six inches (152.4mm) above or below the tank bottom.

33.21.6.6 The tank shall be tested to meet the requirements of H-33.20.7.4.

FIGURE 1 - ENCLOSURE - BELOW DECK INSTALLATION

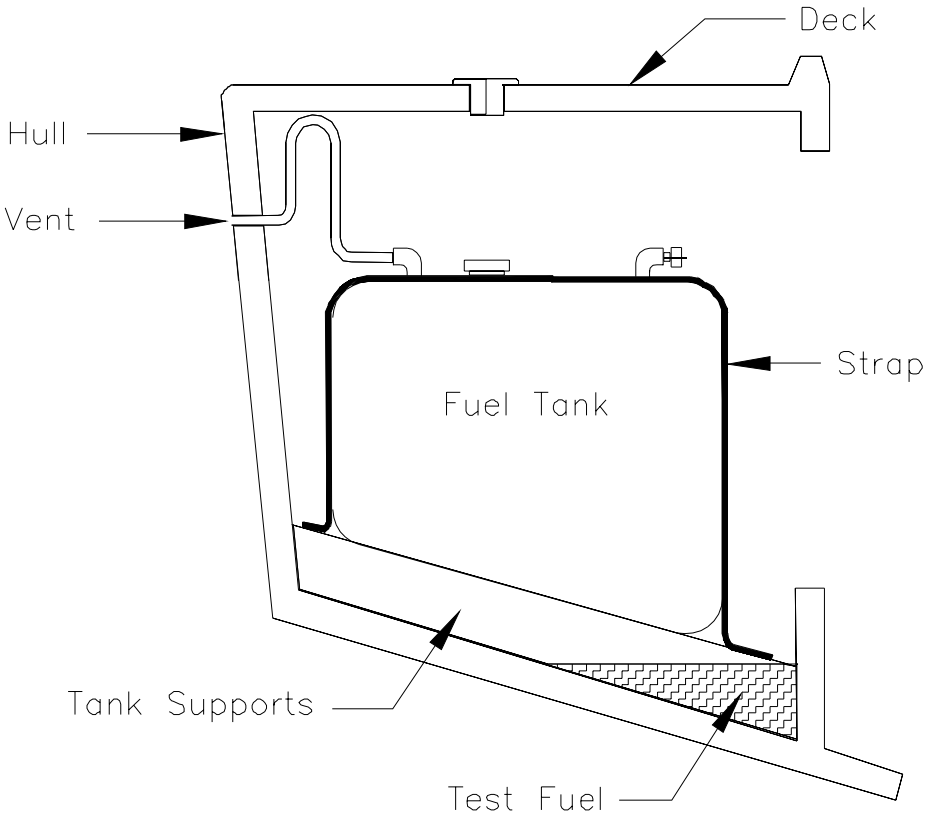

FIGURE 2 - ENCLOSURE - ABOVE DECK INSTALLATION

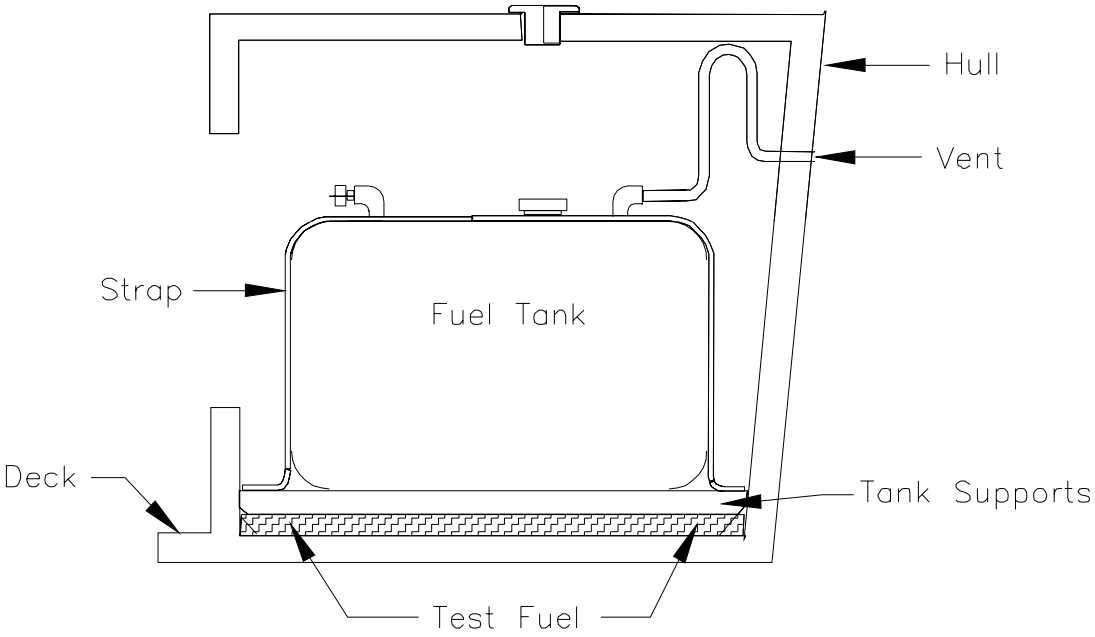

TABLE I - TYPES OF HOSE

HOSE MARKING	PERMEATION RATING	2 1/2 MINUTE FIRE TEST
USCG TYPE A1	100 g/m2/24 hrs.	required
USCG TYPE A2	300 g/m2/24 hrs.	required
USCG TYPE B1	100 g/m2/24 hrs.	not required
USCG TYPE B2	300 g/m2/24 hrs.	not required

TABLE II - MATING OF HOSE WITH SPUDS

Column 1 IF Minor OD of the connecting spud, pipe or fitting is: Inches (Millimeters)	Column 2 The inside diameter of the hose must not exceed the minor outside diameter of the connecting spud, pipe, or hose fitting by more than the following distance: Inches (Millimeters)
Less than 3/8 (9.53)	0.020 (0.508)
3/8 (9.53) thru 1 (25.4)	0.035 (0.889)
Greater than 1 (25.4)	0.065 (1.651)

Note: Spud measurements in column 1 are nominal dimensions

TABLE III - MINIMUM NOMINAL HOSE CLAMP BAND WIDTH

OUTSIDE HOSE DIAMETER	MINIMUM CLAMP BAND WIDTH
Inches (Millimeters)	Inches (Millimeters)
Less than 7/16 (11.11)	1/4 (6)
7/16 (11.11) thru 13/16 (20.64)	5/16 (8)
Over 13/16 (20.64)	3/8 (10)

TABLE IV - METALLIC FUEL TANK MATERIAL AND FABRICATION REQUIREMENTS

MATERIAL (NOTE 1)	SPECIFICATION	MINIMUM NOMINAL SHEET THICKNESS
Nickel-Copper	ASTM-B127-98 Class A	.031 in. (.79mm)
Copper-Nickel	ASTM-B122/B 122M-00	.045 in. (1.14mm)
Copper	ASTM-B152/B 152M-00 Type E.T.P.	.057 in. (1.45mm)
Copper-Silicon	ASTM-B96/B96M-01 Types A, B & G	.050 in. (1.27mm)
Steel Sheet	ASTM A653/A 653M-02A	.0747 in. (1.90mm)
Aluminized Steel	ASTM A-463/A 463M-02a	.0478 in. (1.21mm)
Aluminum	Alloy 5052 or 5083 or 5086	.090 in. (2.29mm)
Stainless Steel	316L or 317L	.0747 in. (1.9mm) .031 in (.79mm) (NOTE 2)

NOTES:

1. See American Welding Society recommendations for welding processes.

2. Cylindrical stainless steel tanks with domed heads and a capacity of less than 20 gallons are permitted to use this lighter gauge steel.

TABLE V - MINIMUM THREAD ENGAGEMENT

NOMINAL PIPE SIZE Inches	MINIMUM THREAD ENGAGEMENT (See NOTE) Inches
1/8	.162
1/4	.228
3/8	.240
1/2	.320
3/4	.339
1	.400
1-1/4	.420
1-1/2	.420
2	.436

NOTE: The minimum lengths of thread engagement are those that can normally be achieved by hand, when assembling internal thread to external thread fittings. Additional tightening is necessary to make a joint that will not leak.

H-33 APPENDIX A - STAINLESS STEEL WELDING (INERT GAS)

H-33.Ap.1 The welding process must be tungsten inert gas (TIG) welding. TIG welding is a non-consumable electrode process in which the arc is shielded in a pure argon inert gas atmosphere. The ceramic nozzle should be an AWC #13N08 (#4) or equivalent. The tungsten electrode tip must be two percent thoriated tungsten which promotes much faster arc starting and 0.062 (1.6mm) diameter to 0.093 (2.4mm) diameter maximum. The tip should be ground to a point, with the point no longer than 1 1/2 times the electrode diameter. The point must be ground with grinding wheel marks parallel to the electrode. The electrode pointed tip, when inserted into the torch nozzle, must extend 0.094 (2.4mm) to a maximum 0.156 (4.0mm) beyond the nozzle. The filler wire (rod) must be stainless steel of 308L grade .040 (1.02mm) to .060 (1.5mm) diameter maximum. Filler wire must be kept clean and handled with gloves only. Argon shielding gas cylinder pressure should never be allowed to fall below 50 psi (345 kP). Argon pressure setting for welding should be 10 - 18 CFH (4.7 to 8.1 cf/min.) With the work to be welded, the work must be made as fast as possible to prevent extreme heat migration. At the end of a segment of weld, the filler rod should be pulled away and the arc maintained from three to five seconds before ending the weld. It is important to weld as fast as possible without degrading any critical material physical properties. A sign of a good weld is a gold to copper color with some blue. Darker gray or black indicates surfacing carbons from extreme temperature, which could be from welding too slowly, or with too high an amperage setting.

CAUTION: Care must be taken that the tungsten tip does not touch the work piece. That would cause burning away of the point of the electrode causing an uncontrolled arc and greater heat migration, which may also burn away an amount of the base material of one of the work pieces creating an undesirable grooved surface.

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Origin and Development of ABYC H-33, Diesel Fuel Systems

This standard for diesel fuel systems was initially a part of P-2, Safe Installation of Fuel Systems for Propulsion and Auxiliary Machinery. First printed in 1967 as a proposed standard, the project included both gasoline and diesel fuel systems on boats. In 1970, P-2 was published as an adopted standard. Subsequently, the standard was renamed H-24, Fuel Systems (all permanently installed), and was published in 1975. In 1984, the standard split fuel systems into gasoline and diesel, and H-33, now titled Diesel Fuel Systems was published in 1984. Subsequent editions were published in 1989 and 1998. The 200X Edition is the work of the Fuel and Vent PTC.

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