

UL 1102

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Nonintegral Marine Fuel Tanks

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UL Standard for Safety for Nonintegral Marine Fuel Tanks, UL 1102

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Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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CONTENTS

FOREWORD	6
-----------------------	---

INTRODUCTION

1 Scope	7
2 General	7
2.1 Components	7
2.2 Units of Measurement	8

CONSTRUCTION

3 General	8
4 Materials	8
5 Gaskets	9
6 Baffles	9
7 Fittings	10
8 Piping	10
9 Bonding Terminal	11

PERFORMANCE

10 General	12
11 Static Pressure Test	12
12 Fire Test	12
12.1 General	12
12.2 Test method – All tests	14
12.3 General installation test	15
12.4 Specific installation	18
13 Preconditioning Test	19
14 Shock Test	19
15 Pressure Impulse Test	19
16 Slosh Test	21
17 Pressure Leakage Test	22
18 Fittings Shock Test	22
19 Marking Plate Adhesion Tests	22
19.1 General	22
19.2 Oven aging	23
19.3 Cold exposure	23
19.4 Immersion – water	23
19.5 Salt spray	23
19.6 Immersion – oil	23
19.7 Accelerated weathering	23
19.8 As-received	24
20 Gasket Tests	24

MANUFACTURING AND PRODUCTION TESTS

21 General	24
------------------	----

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MARKING

22 General	25
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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover nonintegral, vented gasoline fuel tanks designed and constructed in accordance with the United States Coast Guard Safety Standard for Gasoline Fuel Systems, Code of Federal Regulations, Title 33, Chapter 1, Part 183, Subpart J-1990 and nonintegral diesel fuel tanks.

1.2 The fuel tanks covered by these requirements are intended for fixed installation with deck fill provision and for permanent installation in accordance with the applicable installation requirements of U.S. Coast Guard; the applicable requirements of the Fire Protection Standard for Pleasure and Commercial Motor Craft (National Fire Codes, vol. 6), NFPA 302-1994; and/or the requirements of the American Boat & Yacht Council, Inc.

1.3 These requirements do not cover portable marine fuel tanks or tanks integral with any boat structure.

1.4 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.1.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

2.2 Units of Measurement

2.2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

CONSTRUCTION

3 General

3.1 All exterior edges, projections, and corners shall be smooth and rounded.

3.2 All joints and seams shall be equal to or stronger than the material being joined and shall neither provide nor create crevices in which water may collect.

3.3 The material bend radius of rectangular and specially shaped tanks and of baffle flanges and the like shall be not smaller than the minimum bend radius specified by the material manufacturer for the particular alloy and material thickness.

3.4 There shall be no openings in the bottom, sides or ends of a fuel tank other than as specified in 7.3. Any opening into the fuel tank, for example fill pipe feed pipe, vent connections, shall be at or above the topmost surface of the tank.

3.5 A fuel tank tested for compliance with this Standard shall be tested as a complete assembly, including all components necessary for its intended function and installation.

3.6 Fuel tanks shall withstand a pressure not less than 1-1/2 times the test pressure marked on the tank label. The test pressure marked on the label shall be not less than the maximum hydrostatic head to which the tank will be subjected in intended service, but not less than 3 pounds per square inch gauge (psig) (20.7 kPa). See Pressure Leakage Test, Section 17.

4 Materials

4.1 All metallic parts of the tank or combinations of metallic parts shall have corrosion resistance equivalent to the materials and minimum thicknesses listed in Table 4.1. Tanks fabricated of the materials and material thicknesses listed in Table 4.1 will be considered acceptable without corrosion testing. Metallic materials not listed in Table 4.1 may be considered acceptable if a corrosion evaluation shows the material or materials to be equivalent to or better than any of the materials listed in Table 4.1. A part in contact with the fluid intended to be handled by the fuel tank shall be resistant to the action of such fluid. Metallic combinations shall be resistant to galvanic corrosion.

Table 4.1
Acceptable metallic materials and minimum thickness for corrosion resistance

Material	Specification	Minimum nominal Inches (mm)	Thickness Gauge
Nickel-Copper	ASTM B127 Rev-1993 Class A	0.031 (0.787)	22 US STD.
Copper-Nickel	ASTM B122/B122M-1995	0.045 (1.143)	17 AWG
Copper-Silicon	ASTM B96-1993 Type A, B & G	0.050 (1.270)	26 AWG
Steel ^b	ASTM A653/A653M-1996	0.075 (1.905)	14 MFRS
Aluminum	ASTM B209-1996 Alloys 5052 or 5083 or 5086	0.090 (2.286)	18 MFRS
^a Copper tanks shall be internally tin-coated. ^b Steel tanks shall be hot-dip galvanized or equivalently protected both inside and outside with an inorganic sacrificial galvanic coating. <i>Exception: Diesel fuel tanks shall be pickled and oiled.</i>			

4.2 Nonmetallic material shall be resistant to degradation by Reference Fuel C (ASTM D471-1996) and to the effects of aging and a marine environment. Nonmetallic materials not having known and acceptable properties of aging and chemical resistance for the end use application shall be investigated to determine acceptability for the intended use. See Preconditioning Test, Section 13.

4.3 Terneplate steel shall not be used for the construction of diesel or gasoline fuel tanks.

4.4 An inorganic sacrificial galvanic coating shall be applied on the inside and outside of a gasoline fuel tank constructed from black iron or carbon steel.

5 Gaskets

5.1 Fitting plate and fuel gauge gaskets shall comply with the requirements of the Gasket Tests, Section 20.

5.2 Cork may be used for gaskets if used in composition with rubber compounds, and if the gasket material has been previously recognized as acceptable for the intended application.

6 Baffles

6.1 A baffle of a fuel tank shall be fabricated and assembled to provide the strength and rigidity necessary to prevent failure due to surge of the contents and/or flexing of tank surfaces. See Static Pressure Test, Section 11; Pressure Impulse Test, Section 15; and Slosh Test, Section 16.

6.2 The total open area of a baffle shall not exceed 30 percent of the cross-sectional area of the tank in the plane of the baffle. Openings in baffles shall allow liquid and vapor flow across the top and bottom of the tank.

6.3 Stiffeners may be used in lieu of baffles for purpose of adding strength to the tank.

7 Fittings

7.1 All tank fittings shall be attached to minimize the effects of local stresses encountered in the intended application and in the assembly and disassembly of connected piping and devices.

7.2 An opening threaded for pipe connection shall be threaded in accordance with the Pipe Threads, General Purpose (Inch) , Revisions and Redesignation of ASTM/ANSI B2.1-1968 (R1992)-1983.

7.3 Fill pipe connections, vent connections, and feed pipes may be connected off-center on cylindrical tanks or connected to tank ends or sides, providing all joints below the topmost surface are welded or attached by other nonremovable means. Threaded connections or bolted connections shall not be used below the topmost surface.

7.4 Fitting plates shall be secured to prevent removal and use as a clean-out plate. Compliance may be accomplished by use of one-way machine screws, epoxy coating on the screwheads, or by equivalent means.

7.5 The thread length of threaded spuds and fitting plates shall be not less than indicated in Table 7.1.

Table 7.1
Minimum thread length

Size of pipe						
Nominal inches	O.D.		Nominal length of thread			
	Inches	(mm)	Inches	(mm)		
1/4	0.540	13.7	0.3988	10.13		
3/8	0.675	17.2	0.4048	12.28		
1/2	0.840	21.3	0.5307	13.48		
3/4	1.050	26.7	0.5427	13.78		
1	1.315	33.4	0.6798	17.27		
1-1/4	1.660	42.2	0.7038	17.88		
1-1/2	1.900	48.3	0.7205	18.30		
2	2.375	60.3	0.7535	19.14		

8 Piping

8.1 Internal piping of the fuel tank shall be installed and fastened to withstand stresses due to roll and pitch of the vessel. If necessary, the piping shall be supported with internal bracing. See Pressure Impulse Test, Section 15, and Slosh Test, Section 16.

Table 8.1
Minimum nominal clamp band width

Hose O.D.		Minimum nominal clamp band width	
Inches	(mm)	Inches	(mm)
Less than 7/16	Less than 11.1		
>7/16 to 13/16	>11.1 to 20.6	5/16	7.9
Greater than 13/16	Greater than 20.6	1/2	12.7

8.2 Fuel pickup tubes and fuel fill pipes extending near the tank bottom shall have clearance to prevent contact with the bottom due to flexing of the tank. Except for diesel fuel tanks, which may be provided with a sump, pickup tubes shall have a clearance from the tank bottom no greater than:

- a) 1/2 inch (12.7 mm), plus 1/4 inch (6.4 mm), minus 1/8 inch (3.2 mm) for metallic tanks; or
- b) 3/4 inch (19.1 mm), $\pm 1/4$ inch (± 6.4 mm) for nonmetallic tanks.

8.3 Each spud, pipe, or hose fitting used with hose clamps shall have a bead or a series of annular grooves or serrations no less than 0.015 inches (0.38 mm) deep. Helical thread, grooves, and knurling shall be used.

Exception: This requirement is not applicable for tank fill lines.

8.4 Tank fittings may be constructed for use either with swaged sleeve reusable fittings or with hose clamp connections in accordance with the following:

- a) Fuel Fill Pipes – Clamped fuel fill pipe connections shall be constructed for use with two adjacent clamps in accordance with Table 8.1, with each clamp not less than 1/2 inch (12.7 mm) from the hose end and beyond any bead, or 1/2 inch beyond the end of the pipe if a bead is not provided; or
- b) Fuel Feed Line and Vent Connections – Clamped connections shall be constructed for use with at least one clamp in accordance with Table 8.1, with the clamp over serrations or beyond the bead and at least one clamp width from the hose end.

9 Bonding Terminal

9.1 A bonding wire terminal shall be provided for connection of a No. 8 AWG (8.4 mm²) or larger grounding conductor. For nonmetallic tanks, the fuel fill connection, fuel feed pickup tube, and tank vent connection shall be connected to the bonding terminal with bonding wires or straps at least equivalent in cross-sectional area to a No. 8 AWG conductor.

PERFORMANCE

10 General

10.1 Representative samples of fuel tanks shall be subjected to the following applicable tests in the order given. The tank to be tested shall be a complete assembly and include the fuel pickup tube, fuel fill pipe, fuel vent connection, and the fuel gauge provided or specified for the tank. See Figure 10.1.

Exception No. 1: The Fire Test, Section 12, shall be conducted on a separate sample.

Exception No. 2: The Fittings Shock Test, Section 18, may be conducted on a section of the tank after the tank has been cut for examination.

Exception No. 3: The Marking Plate Adhesion Tests, Section 19, may be conducted on any representative material samples.

10.2 A single fuel tank design, determined to be fully representative of a series of fuel tanks of similar design, size, material thickness, and construction, may be tested as representative of that series of fuel tanks. In general, if a series of tanks is to be represented by a single tank, the test tank shall be the largest size of that series.

Exception: This requirement does not apply to the Fire Test, Section 12, or Preconditioning Test, Section 13.

11 Static Pressure Test

11.1 A fuel tank shall not leak when filled with air or inert gas at a pressure of 3 psig (20.7 kPa) or to the pressure marked on the tank label, whichever is greater.

11.2 Pressure is to be measured by a calibrated pressure gauge having a range not exceeding three times the test pressure marked on the tank label with a gauge accurate to within ± 1 percent of the maximum pressure shown on the dial.

11.3 While the tank is still under pressure, all tank seams and fittings are to be examined for leakage using a brush-applied solution of soap or detergent and water. If the tank top, sides, and bottom are fabricated by a hand lay-up process, as in the case of glass fiber reinforced plastic tanks, the soap solution shall be applied to all surfaces in addition to the fittings and seams.

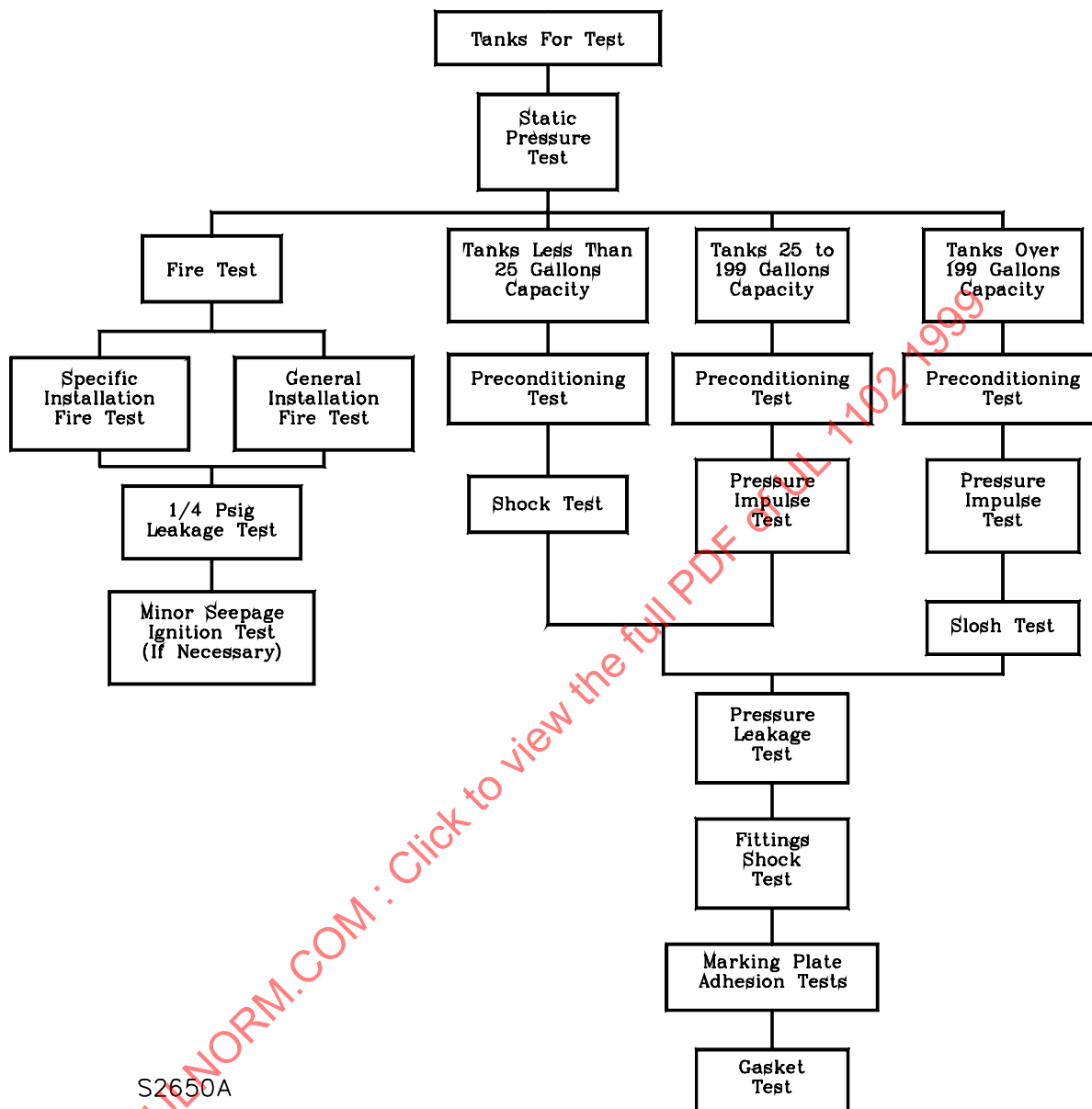
12 Fire Test

12.1 General

12.1.1 A fuel tank shall be capable of withstanding exposure to a test fire without contributing to the fire due to leakage of liquid fuel. For purposes of this test, slight vapor leakage after the fire exposure will be permitted if it can be demonstrated that the path of leakage will not permit a fire outside the tank to ignite vapors within the tank. See 12.2.9.

12.1.2 The sample tank to be tested is to be provided with all the attachments specified by the manufacturer. The tank shall be set up so that the vent line will remain fully open during the test and provision shall be made for emptying and aerostatically checking the tank after the test.

Figure 10.1
Performance test sequence chart



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12.1.3 A single fire test may be conducted to represent a series of tanks, if all of the following are met:

- a) The thinnest tank material may represent thicker material of the same alloy with the same construction but thicker material shall not represent a thinner material. A given alloy and seam construction may not represent other alloys unless it can be documented that the least fire-resistant alloy is used for the test;
- b) A smaller capacity tank may represent larger tanks provided the test tank represents the maximum exposed height of the series, thereby providing maximum exposure of the surfaces that contain no fuel when the tank is 1/4 full;
- c) Tanks with straight vertical sides may not represent tanks with exposed overhang; and
- d) Rectangular and cylindrical tanks shall not be considered representative of each other.

12.1.4 The fire test may be conducted:

- a) In accordance with 12.4.1 – 12.4.3 under conditions that simulate the installation conditions aboard a specific boat or series of boats where the installation conditions are known and controlled; or
- b) In accordance with 12.3.1 – 12.3.9 when the installation would be made in accordance with the applicable installation requirements of the standards referenced in 1.2.

12.2 Test method – All tests

12.2.1 This test shall follow the Static Pressure Test, Section 11, and the tank shall be depressurized before beginning this test.

12.2.2 The vent is to be extended, without traps, outside of the fire test area and is to be left open to simulate conditions of installation. The size of the tank vent shall be determined by the size of the vent fitting provided by the manufacturer.

12.2.3 The tank shall be filled to one-quarter rated capacity with the test fuel specified in 12.2.4. The fill pipe and fuel feed connections are to be closed during the Fire Test exposure.

12.2.4 The fuel used for filling the tank sample and for the test fire is to be representative of the fuel intended to be used. Tanks evaluated for use with both gasoline and diesel fuel shall be tested with N-heptane as the test fuel. Tanks limited to use with diesel fuel are to be tested with No. 2 diesel fuel oil.

12.2.5 The test fuel shall also be poured into all crevices and liquid traps in the liquid-tight simulated hull section in which fuel could collect as the result of a leak anywhere in the fuel system. The amount of test fuel in each liquid trap shall be sufficient to burn for a period of 2-1/2 minutes.

12.2.6 Temperatures shall be measured at points 1 inch (25.4 mm) from the tank side or end, using chrome alumel temperature probes of No. 18 AWG (0.82 mm²) thermocouple wire having a minimum temperature capability of 2000 ±15°F (1093 ±8°C). In the case of foamed-in tanks, which have little or no side exposure, the temperature probe shall be positioned 1 inch (25.4 mm) from the tank side or end and not less than 9 inches (228.6 mm) above the fuel in the area most likely to create natural draft during the test.

12.2.7 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. The test shall be conducted as follows:

- a) The fuel in the hull section or the test enclosure shall be ignited and permitted to burn for a continuous period of 2-1/2 minutes;
- b) The temperatures of the test fire shall be recorded at 15 second intervals and a time-temperature curve developed. A temperature of at least 1200°F (649°C) must be attained during the test.
- c) At the end of the 2-1/2 minute test period, any continued burning is to be extinguished.

12.2.8 Following the test, the tank shall be examined for leakage, emptied, and then pressurized with air at a pressure of 1/4 psig (1.72 kPa). The pressure shall be gradually increased by means of a regulator so as not to introduce pressure surges into the tank. The tank seams and the fittings are then to be coated with a brush-applied solution of detergent and water to check for leakage. If the tank top, sides, and bottom are fabricated by a hand lay-up process, as in the case of glass fiber reinforced plastic tanks, the soap solution shall be applied to all surfaces in addition have a visible hole, but shows evidence of a leak as indicated by the presence of bubbles from the soaped surface, the tank shall be tested in accordance with 12.2.9.

12.2.9 In the case of minor seepage, the method of test to determine compliance with 12.1.1 will vary depending on the tank material, location of the leak and the risk of injury involved. CAUTION – This testing is hazardous and must be conducted with shielding pieces should the mixture in the tank or tank section ignite. To determine the acceptability of minor seepage, the following methods are considered acceptable:

- a) The area of the leak is to be cut from the tank and the section mounted on an enclosing construction (see Figure 12.1) so as to create as small an enclosure as possible capable of separating the inside and outside surfaces. Except for the leak, and the propane/air mixture feed and discharge piping, all seams shall be vapor tight. A flammable mixture of propane and air shall be fed into the enclosed volume at a rate not to exceed 1 cubic foot per minute (0.028 m³/min). While the enclosed volume is charged with the flammable mixture, a burning wand shall be passed over the area of the leak. The internal mixture shall not ignite.
- b) The tank is to be partially filled with water to reduce the void as much as possible. The void shall then be filled with the flammable mixture in item A and an attempt made to ignite the mixture with a burning wand passed over the area of the leak.

12.3 General installation test

12.3.1 This test shall be conducted on tanks where the ultimate installation conditions are not known other than that the tank is intended for installation in accordance with the appropriate Standard.

12.3.2 The tank is to be installed and supported as shown in Figures 12.2 and 12.3.

12.3.3 The enclosures are to be fabricated of 3/4 inch (19.1 mm) thick (trade size) plywood, or of an equivalent material such as 3/4 inch pine in lieu of plywood.

Figure 12.1
Typical tank section setup for leak testing

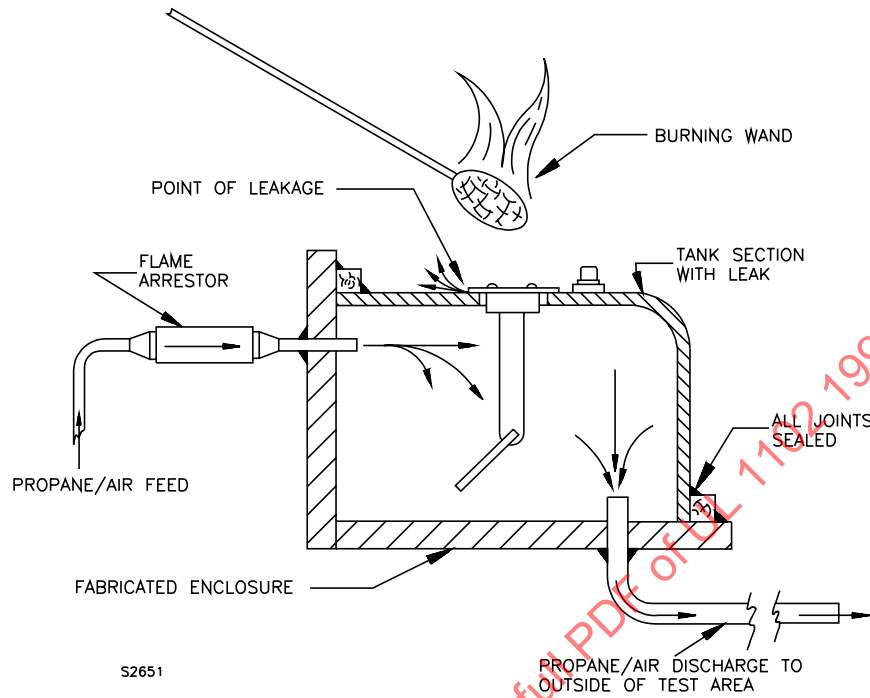


Figure 12.2
Typical general fire test setup

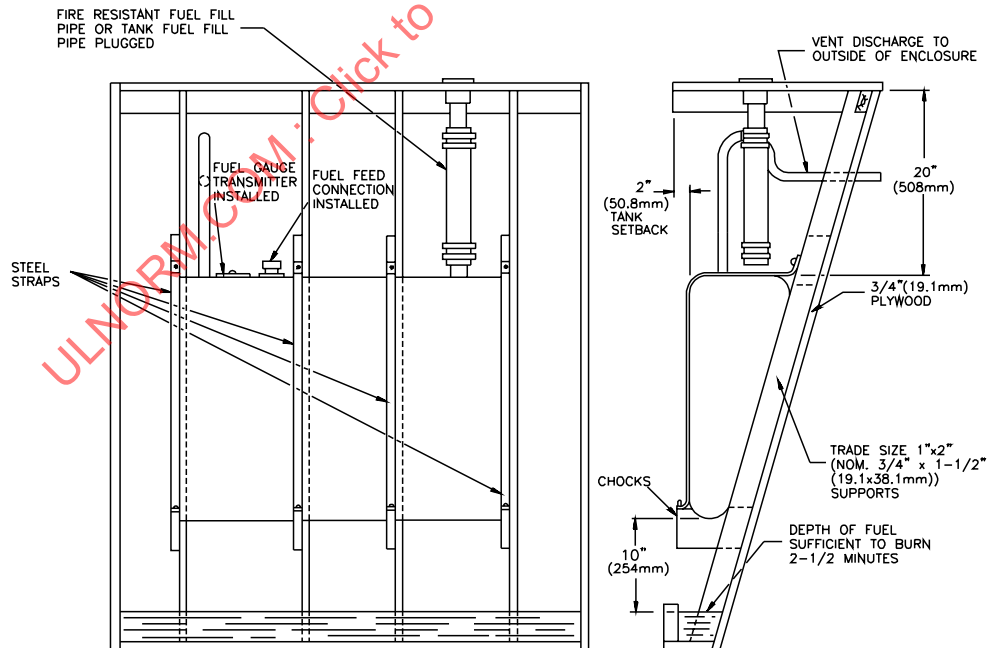
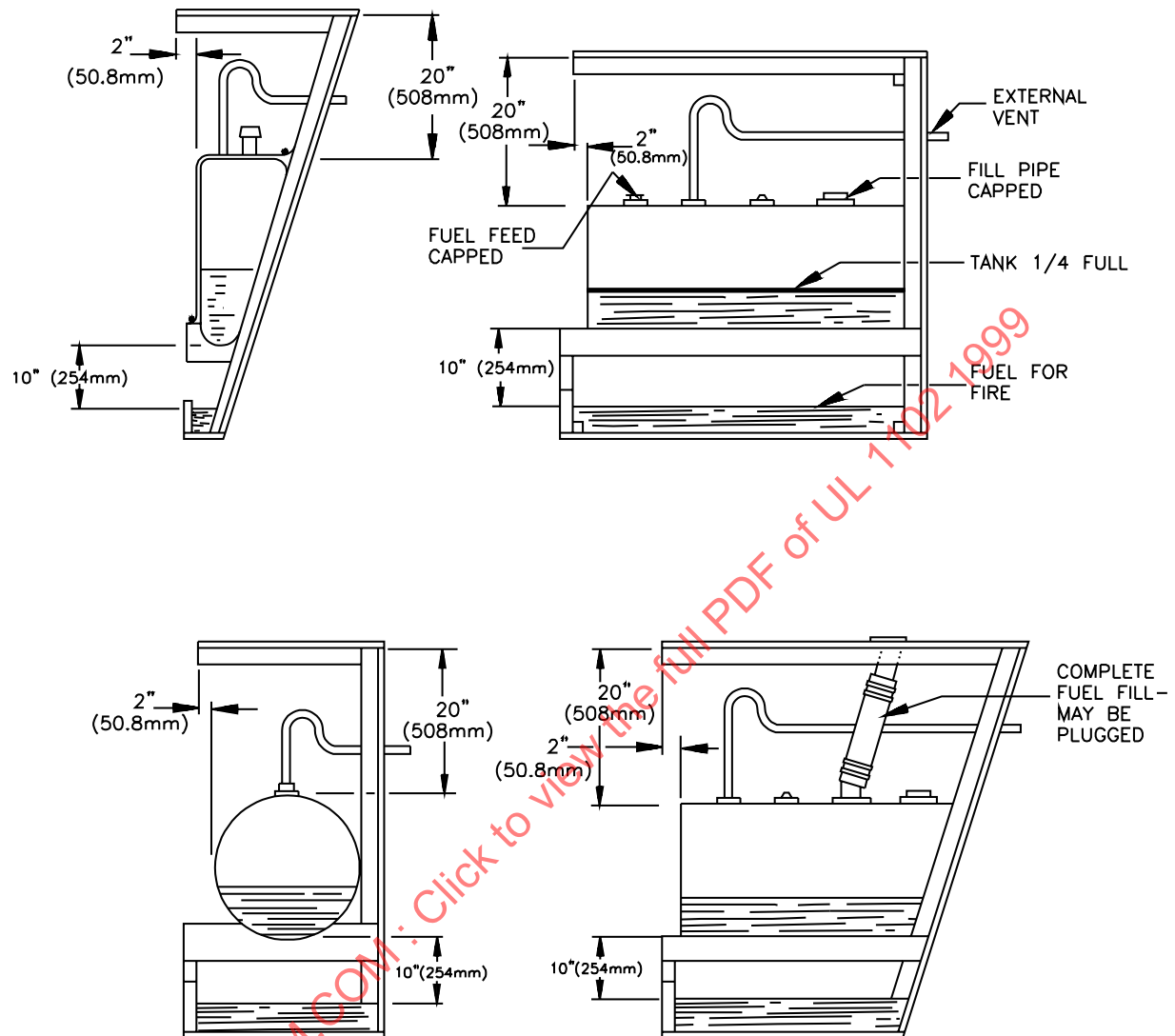


Figure 12.3
Typical general fire test setups



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12.3.4 The back supports for the fuel tank set-up in the enclosure specified in 12.3.3 are to be constructed of pine, or the equivalent, with a trade size thickness of 1-inch by 2-inch (25 by 52 mm). The supports are to be positioned with the smaller dimension against the tank's back surface and located at each end and in-line with each tank baffle. Except for cylindrical or custom-shaped tanks, the supports are to maintain a clearance of 1-1/2 inches (38.1 mm) between the tank and test enclosure side. For cylindrical and custom-shaped tanks a clearance of 1-1/2 inches is to be maintained at the narrowest point between the tank and the test enclosure.

12.3.5 For a metallic or a fiberglass tank, the tank bottom supports for the fuel tank test set-up in the enclosure specified in 12.3.3 are to be constructed of pine, or the equivalent, with a trade size of 1 inch by 3 inches (25 by 76 mm). The supports are to be positioned with the smaller dimension against the tank bottom and located at each baffle and at each end of the tank.

12.3.6 For a plastic tank, the tank bottom supports for the fuel tank set-up in the enclosure specified in 12.3.3 are to be constructed of pine, or the equivalent, with a trade size of 1 inch by 3 inches (25 by 76 mm). The supports are to be:

- a) Positioned with the smaller dimension against the tank bottom; and
- b) Located at each baffle and at both ends of the tank.

Additional tank bottom supports are to be added and equally spaced at intervals not to exceed 12 inches (305 mm).

12.3.7 The entire tank test enclosure for these test set-ups described in 12.3.4 – 12.3.6 is to maintain a 10-inch (254 mm) clearance between the bottom of the tank and test fuel.

12.3.8 The fuel tanks are 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 setback is $2 \pm 1/2$ inches (50.8 ± 12.7 mm) and the clearance between the top of the test enclosure and the top of the fuel tank is 20 ± 2 inches (508 ± 50.8 mm).

12.3.9 The area of the enclosure beneath a metallic or fiberglass fuel tank is to serve as the test fuel reservoir and is to be formed so that the surface of the test fuel extends 6 inches (152.4 mm) beyond the fuel tank ends and $2 \pm 1/2$ inches (50.8 ± 12.7 mm) beyond the exposed front surface of the fuel tank. The reservoir is to be made leakproof and is to be capable of containing sufficient fuel to burn for a period of 2-1/2 minutes.

12.4 Specific installation

12.4.1 This test shall be conducted on tanks intended to be installed in a specific model of boat or series of boats where the construction of the tank is known and the installation of the tank is specified or otherwise controlled.

12.4.2 The tank shall be installed in an actual or simulated hull section of sufficient size to simulate fire conditions aboard the boat. All bulkheads, supports, decks, and other surfaces in the tank compartment shall be of material equivalent to that used on the boat. A tank for use in a series of boats shall be installed in a simulated hull section that provides the maximum exposure condition of that series of boats.

12.4.3 In order to create the maximum draft condition, all hatches and doors shall be removed or fully open during the tests.

13 Preconditioning Test

13.1 There shall be no evidence of softening or other deterioration after a tank filled to capacity with ASTM Reference Fuel C has been maintained at a temperature of 70°F (21°C) or higher for a period of 30 days.

13.2 This test shall be conducted on nonmetallic tanks immediately preceding the Shock Test, Section 14, for fuel tanks of less than 25 gallons (94.6 liters) capacity, and immediately preceding the Pressure Impulse Test, Section 15, for fuel tanks of 25 gallons or more capacity.

14 Shock Test

14.1 Fuel tanks of less than 25 gallons (94.6 liters) capacity shall not leak when subjected to the shock tests described in 14.2 – 14.5.

14.2 The fuel tank sample used for this test shall be provided with all attachments specified by the manufacturer.

14.3 The tank is to be filled to capacity with water and secured to the platform of the impact test machine to simulate an intended installation. If the tank does not have integral mounting provisions, a chock shall be placed under each baffle and under the tank ends.

14.4 The tank shall be subjected to 1000 shock impacts at a rate of 15 impacts per minute or less. The duration of each shock pulse is to be between 6 and 14 milliseconds measured at the base of the shock wave envelope, and the acceleration is to be adjusted in accordance with the following:

- a) If the tank is not labeled in accordance with 22.1(j) for installation aft of the half length of the boat, the vertical acceleration shall be set at 25 g [800 ft/s² (245 m/s²)].
- b) If the tank is labeled for installation with its center of gravity aft of the half length of the boat, the vertical acceleration shall be 15 g [480 ft/s² (147 m/s²)].

14.5 At the conclusion of this test, the tank shall be subjected to the Pressure Leakage Test, Section 17.

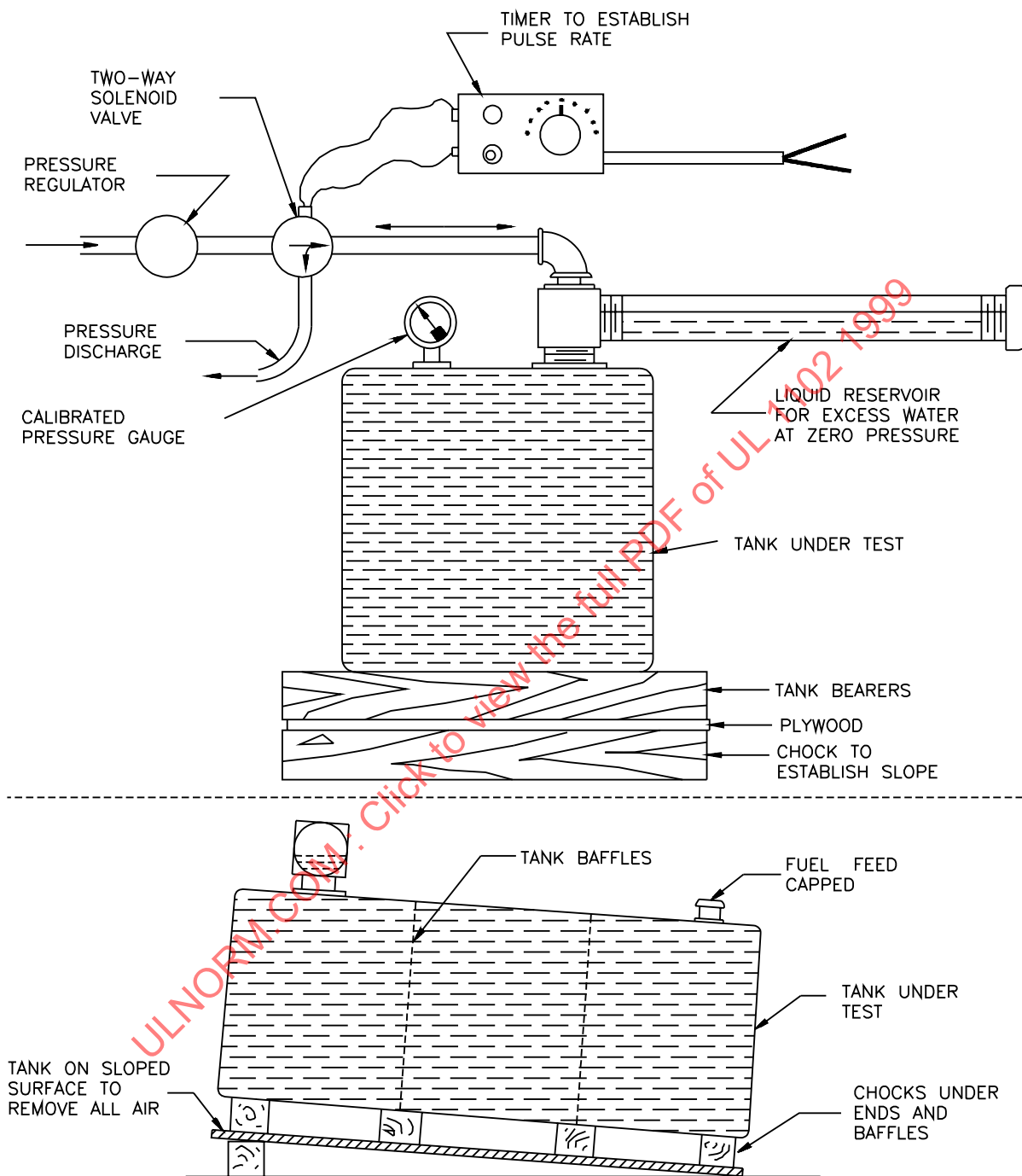
15 Pressure Impulse Test

15.1 All fuel tanks having a capacity of 25 gallons (94.6 liters) or more shall not leak when subjected to the tests described in 15.2 – 15.6.

15.2 The fuel tank and fuel feed line connections shall be plugged or capped and the pressure impulse connection made to the fuel fill pipe opening in accordance with 15.4.

15.3 Chocks shall be located under each baffle and at the tank ends, and the tank set up on an inclined plane at an angle sufficient to cause any entrapped air in the tank to rise toward the fuel fill pipe opening when the tank is filled to capacity with water. See Figure 15.1.

Figure 15.1
Pressure impulse test setup



TANK MOUNTING DETAILS