भारतीय मानक

Indian Standard

IS 17471 : 2024
ISO 21487 : 2022

लघु जलयान — स्थायी रूप से संस्थापित पेट्रोल एवं डीज़ल ईंधन टैंक

(पहला पुनरीक्षण)

Small Craft — Permanently Installed Petrol and Diesel Fuel Tank

(First Revision)

ICS 47.080

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August 2024

Price Group 9

Inland Harbour Crafts and Fishing Vessels Sectional Committee, TED 18

NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical to ISO 21487 : 2022 'Small craft permanently installed petrol and diesel fuel tank' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on recommendation of the Inland Harbour Crafts and Fishing Vessels Sectional Committee and approval of the Transport Engineering Divisional Council.

This standard was first published in 2020 which was identical adoption of ISO 21487 : 2012. This revision has been undertaken to harmonize it with ISO 21487 : 2022. The major changes incorporated in this revision are as follows:

a) Introduction has been added to explain the addition of Annex A;
b) Scope has been amended to include installation of fuel tanks;
c) Some definitions have been updated;
d) Clause **4** has been updated, in particular **4.2**, **4.3.9** and **4.4.1**;
e) Sub-clause **5.2** has been updated and Table 2 has been introduced for tests;
f) Sub-clause **6.2** has been redrafted;
g) Clause **7** has been revised;
h) Annex A has been added, which provides a permeation test to determine the evaporative emissions from non-metallic tanks; and
j) Hindi title of the standard has been updated.

The text of ISO standard may be approved as suitable for publication as an Indian Standard without deviations. Certain conventions and terminologies are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practiceis to use a point (.) as the decimal marker.

In this standard, reference appears to certain International Standard for which Indian Standard also exist. The corresponding Indian Standard, which is to be substituted in its respective places, is given below along with their degree of equivalence for the edition indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 12215-6 : 2008 Small craft — Hull construction and scantlings — Part 6: Structural arrangements and details	IS 16183 (Part 6) : 2020/ ISO 12215-6 : 2008 Small craft — Hull construction and scantlings: Part 6 Structural arrangements and details	Identical

The Committee may also review the provisions of following International Standards referred in this standard and decide if these are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 10088 : 2022	Small craft — Permanently installed fuel systems
ISO 12215-5 : 2019	Small craft — Hull construction and scantlings — Part 5 : Design pressures for monohulls, design stresses, scantlings determination

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Introduction

This document provides requirements for the design, installation and testing of permanently installed fuel tanks for small craft.

Some countries have environmental controls for evaporative emissions from petrol fuel systems. Annex A describes the limits and test procedures for the control of evaporative emissions from permanently installed petrol fuel tanks. The details in Annex A allow for future standardization and application of evaporative emissions on small craft.

As the international community further restricts fuel system emissions, it is anticipated that Annex A will have increased global acceptance.

Indian Standard

SMALL CRAFT — PERMANENTLY INSTALLED PETROL AND DIESEL FUEL TANK

(First Revision)

1 Scope

This document specifies requirements for the design, installation and testing of petrol and diesel fuel tanks for internal combustion engines, that are intended to be permanently installed in small craft.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10088:2022, *Small craft — Permanently installed fuel systems*

ISO 12215-5:2019, *Small craft — Hull construction and scantlings — Part 5: Design pressures for monohulls, design stresses, scantlings determination*

ISO 12215-6:2008, *Small craft — Hull construction and scantlings — Part 6: Structural arrangements and details*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
petrol
hydrocarbon fuel, or blend of hydrocarbon fuel and denatured ethanol, that is liquid at atmospheric pressure and is used in *spark ignition engines* (3.3)

3.2
diesel
hydrocarbon fuel, biofuel, or blend of these, that is liquid at atmospheric pressure and is used in *compression ignition engines* (3.4)

3.3
spark ignition engine
engine in which an electrical spark is produced to ignite the fuel/air mixture

3.4
compression ignition engine
engine in which ignition is obtained by means of compressing the fuel/air mixture

3.5
permanently installed
securely fastened by bolts, brackets, screws, paint, adhesive, welding or other means, so that it cannot be unattached without the use of tools or chemicals

3.6
integral tank
fuel tank that forms part of the outer hull envelope, so that at least one boundary of the tank is formed by the hull

Note 1 to entry: Structural components, such as bulkheads, are not part of the hull.

3.7
non-integral tank
fuel tank that does not rely on any portion of the craft to retain fuel

3.8
tank range
set of fuel tanks characterized by the following attributes: general geometric shape, material and wall thickness

3.9
craft
small craft
recreational boat, and other watercraft using similar equipment, of up to 24 m length of hull (L_H)

Note 1 to entry: The measurement methodology for length of hull is defined in ISO 8666.

[SOURCE: ISO 8666:2020, 3.15, modified — Note 1 to entry has been added.]

4 General properties

4.1 Resistance to liquids in contact

4.1.1 All seals such as gaskets, O-rings and joint-rings shall be of non-wicking, i.e. non-fuel absorbent, material.

4.1.2 All materials used shall be resistant to deterioration by the fuel for which the system is designed and to other liquids or compounds with which the material can come in contact as installed under normal operating conditions, e.g. grease, lubricating oil, bilge solvents and sea water.

4.2 Copper-based alloys

Copper-based alloy fittings are not permitted on aluminium alloy fuel tanks unless a galvanic barrier is arranged between the fitting and the tank.

4.3 Provisions to tanks

4.3.1 There shall be provisions to determine the fuel level or quantity in the tank, considering the requirements in 5.1.2 for petrol fuel tanks and in 6.1.5 for diesel fuel tanks.

4.3.2 Metal tanks shall be designed and installed so that no exterior surface traps water.

4.3.3 All rigid tubes and pipes which extend near the tank bottom shall have sufficient clearance to prevent contact between the tube and the bottom of the tank during normal operation of the craft.

4.3.4 On metallic tanks, all metallic non-integral tank supports, chocks or hangers shall either be separated from the surface of the tank by a non-metallic, non-hygroscopic, non-abrasive material, or welded to the tank.

4.3.5 If baffles are provided, the total open area provided in the baffles shall be not greater than 30 % of the tank cross-section in the plane of the baffle.

4.3.6 Baffle openings shall be designed so that they do not trap vapour across the top of the tank and do not prevent the fuel flow across the bottom of the tank.

4.3.7 The fuel fill pipe on the tank shall have a minimum inside diameter of 28,5 mm.

4.3.8 Each ventilation pipe on the tank shall have a minimum inside diameter of 11 mm or a ventilation opening designed to prevent the tank pressure from exceeding 80 % of the maximum test pressure marked on the tank label when tested in accordance with ISO 10088:2022.

4.3.9 Tanks shall be constructed using suitable metallic materials and shall meet the minimum material thicknesses required for corrosion resistance as listed in Table 1.

Other materials are permitted if the tank manufacturer can demonstrate equivalent fuel and corrosion resistance.

Table 1 — Metallic tank materials

Material	Minimum nominal sheet thickness for corrosion resistance mm	Fuel
Copper, internally tin-coated	1,5	Petrol only
Aluminium alloys containing no more than 0,1 % copper	2,0	Diesel and petrol
Stainless steel, with all welding deposits removed	1	Diesel and petrol
Mild steel	2	Diesel only
Mild steel externally hot-dip zinc-coated after fabrication	1,5	Diesel only
Mild steel externally and internally hot-dip zinc-coated after fabrication	1,5	Petrol only
Aluminized steel	1,2	Diesel and petrol

4.4 Installation of tanks

4.4.1 Non-integral tank mechanical fixing

Non-integral tanks shall be installed so that the loads due to the mass of the tank when filled to its maximum capacity are safely distributed into the structure, with due consideration given to upward and downward acceleration due to the craft's movements at maximum speed.

NOTE Continuous flexible supports spreading loads are preferable to rigid ones. Metal or textile hold-down straps are considered as a good practice provided that chafe and corrosion are kept to a minimum.

4.4.2 Other installation requirements

All other installation requirements (e.g. filling, vent lines, fuel circuit) shall be in accordance with ISO 10088:2022.

5 Petrol fuel tanks: design and type tests

5.1 Design

5.1.1 Petrol fuel tanks shall not be integral with the hull.

5.1.2 Petrol fuel tanks shall have all fittings and openings on top, except non-metallic integrally moulded or welded metallic fill and ventilation pipes, which may be connected to the sides or ends of petrol fuel tanks, provided that they are welded to the tank and reach above the top of the tank.

5.1.3 Tank drains shall not be fitted on petrol fuel tanks.

5.2 Tests

5.2.1 Petrol fuel tanks shall be leakage-tested in accordance with Table 2.

5.2.2 Petrol fuel tanks shall be pressure-impulse-tested in accordance with Table 2.

5.2.3 Non-metallic petrol fuel tanks shall be fire-tested in accordance with Table 2.

6 Diesel fuel tanks: design and type tests

6.1 Design

6.1.1 Diesel fuel tanks may be non-integral, or integral with the structure of the craft. If an integral tank is installed in a cored hull construction, the core shall not deteriorate from exposure to diesel fuel, and to commonly used additives, and shall not permit fuel to migrate.

6.1.2 Diesel fuel integral tanks shall be built in accordance with ISO 12215-5:2019.

NOTE National standards and classification rules can be applied to prove structural integrity and welding quality.

6.1.3 If fittings in the bottom, sides or ends are installed, each connection shall have a shut-off valve directly connected to the tank. The valve shall be protected or located to prevent physical damage, or be of at least 25 mm nominal diameter.

6.1.4 Diesel fuel tank drains, where fitted, shall have a shut-off valve with a plug fitted in the outlet that is permanently installed, or the handle of the drain shut-off valve shall be removable with the valve in its closed position.

6.1.5 Sight gauges, if used, shall be fitted with valves at the top and bottom connections to the tank. The bottom valve shall be a manually operated self-closing valve that can only be in the open position while attended.

6.1.6 Diesel fuel tanks shall be equipped with inspection hatch(es) having a suitable diameter of at least 120 mm at suitable position(s) for cleaning and for the inspection of the lowest part(s) of the tank. The hatch shall remain accessible without the removal of permanent structures when the tank has been installed in the craft.

NOTE The hatch(es) can be located on the top or side of the tank.

6.2 Tests

6.2.1 Diesel fuel tanks shall be leakage-tested in accordance with Table 2.

6.2.2 Diesel fuel tanks shall be pressure-tested in accordance with Table 2.

6.2.3 Non-metallic non-integral diesel fuel tanks installed in an engine compartment shall pass the fire tests:

a) in accordance with 7.4, where the actual installation conditions are not known; or

b) in accordance with 7.5, in craft specific installations using a specific tank design.

7 Type tests

7.1 General

Fuel tanks shall be subjected to the tests described in Table 2. The tank to be tested shall be a complete assembly (excluding sight gauges that are protected by a self-closing valve) and shall include the fuel pick-up tube, fuel fill pipe, and fuel gauge/sender specified for the fuel tank.

Table 2 — Tank tests

Tank type	Leakage test	Pressure/ strength test	Pressure impulse test	Fire test
Petrol tanks				
Petrol, metal	7.2.1	7.2.2.2 for 5 min or 7.2.2.3 for 5 min	7.3	Not applicable
Petrol, fibre-reinforced	7.2.1	7.2.2.2 for 5 min	7.3	7.4 or 7.5
Petrol, thermoplastic low density	7.2.1	7.2.2.4 for 5 h	7.3	7.4 or 7.5
Petrol, thermoplastic high density	7.2.1	7.2.2.4 for 60 min	7.3	7.4 or 7.5
Diesel tanks				
Diesel, metal	7.2.1	7.2.2.2 for 5 min	Not applicable	Not applicable
Diesel, thermoplastic low density	7.2.1	7.2.2.4 for 5 h	Not applicable	7.4 or 7.5
Diesel, thermoplastic high density	7.2.1	7.2.2.4 for 60 min	Not applicable	7.4 or 7.5
Diesel, fibre-reinforced, non-integral	7.2.1	7.2.2.2 for 5 min	Not applicable	7.4 or 7.5
Diesel, fibre-reinforced, integral	7.2.1	7.2.2.2 for 5 min	Not applicable	Not applicable

7.2 Pressure tests

WARNING — Do not exceed the maximum static test pressure.

7.2.1 Leakage test

Each fuel tank shall be internally tested with a pressure test. The test pressure shall be the greater of:

a) 20 kPa; or

b) 1,5 times the highest hydrostatic pressure to which the tank can be subjected in service (maximum fill-up height above tank top); or

c) 1,5 times the maximum hydrostatic head at the designed tank fill level plus the system relief pressure, if the tank is to be used in a sealed fuel system.

The static test pressure shall be applied for 5 min without pressure drop or rise. After the test, the test fuel tank shall not show any leakage, when using a leak detection method other than the pressure-drop method.

Soapy water or a similar solution, both of which being non-corrosive and non-toxic, can be used as well as total immersion of the tank in water. Most small leaks do not produce an immediately detectable drop on the face of the pressure gauge, but soap solutions or immersion can reveal very small leaks by bubbling. Do not use solutions containing ammonia, which is present in some soaps and detergents. This creates a condition that attacks brass fittings like those used in fuel systems. Damage can be undetectable at first, and these fittings can develop cracks in a matter of months creating a very hazardous situation.

7.2.2 Pressure/strength type test

7.2.2.1 General

After the leakage test (see 7.2.1), the fuel tank, with all its accessories, shall be pressurized again according to Table 2 to confirm the strength requirements.

7.2.2.2 Metal and fibre-reinforced plastic (FRP) tanks

The pressure shall be gradually increased to the greater of:

a) 20 kPa; or

b) 1,5 times the highest hydrostatic pressure to which the tank can be subjected in service (maximum fill-up or overflow height above tank top); or

c) 1,5 times the maximum hydrostatic head at the designed tank fill level plus the system relief pressure, if the tank is to be used in a sealed fuel system.

This pressure shall be maintained for 5 min.

During this time, the tank shall not crack or leak; however, it may be permanently deformed.

7.2.2.3 Alternate pressure test for metal petrol fuel tanks

Metal tanks meeting the following criteria can be pressure-tested to this subclause:

a) plating thicknesses, section modules and web shear areas of stiffeners shall meet the requirements in ISO 12215-5:2019 for integral tanks;

b) the tanks shall follow ISO 12215-6:2008 regarding structural details of metal construction;

c) they shall follow welding quality meeting recognized industry accepted standards.

NOTE Requirements for the welding quality are found in ISO 5817.

The pressure shall be gradually increased to the greater of:

— 30 kPa; or

— 1,5 times the highest hydrostatic pressure to which the tank can be subjected in service (maximum fill-up height above tank top) plus 10 kPa.

This pressure shall be maintained for 5 min.

During this time, the tank shall not crack or leak; however, it may be permanently deformed.

7.2.2.4 Thermoplastic tanks

Prior to the pressure test, thermoplastic tanks shall be filled and stored for at least 28 days at an ambient temperature of not less than 21 °C with one of the following fuels:

a) the fuel for which the tank is fabricated; or

b) liquid C test fuel blended to 10,0 % ± 1,0 % ethanol by volume; or

NOTE Liquid C specifications can be found in ISO 1817.

c) CE10 fuel, which is a mixture of 90 % by volume of liquid C and 10 % by volume of fuel ethanol.

The pressure test shall be performed immediately after emptying the test liquid out of the tank.

The pressure shall be gradually increased to the greater of:

— 20 kPa; or

— 1,5 times the highest hydrostatic pressure to which the tank can be subjected in service (maximum fill-up height above tank top); or

— 1,5 times the maximum hydrostatic head at the designed tank fill level plus the system relief pressure, if the tank is to be used in a sealed fuel system.

This pressure shall be maintained according to Table 2.

During this time, the tank shall not crack or leak; however, it may be permanently deformed.

7.3 Pressure-impulse type test for petrol fuel tanks

7.3.1 A test fuel tank, representative of the tank range, shall not exhibit any leakage or other signs of failure after 25 000 cycles of pressure impulses.

7.3.2 The pressure-impulse test of thermoplastic tanks shall be conducted on a tank prepared in accordance with 7.2.2.4.

7.3.3 The tank to be tested, fully filled with water, shall be mounted using the support, chocks or brackets, either furnished with the tank or as intended to be used in a craft installation.

7.3.4 The tank to be tested shall be attached to a regulated source of pressure of either air, nitrogen or water. The control mechanism of the pressure source shall then be set to cause pressure in the tank under test, measured at its top-most surface, to vary from 0 kPa to 20 kPa to 0 kPa at a rate of not more than 15 cycles per minute.

7.3.5 Before and after the pressure-impulse test, the tank shall meet the leakage test specified in 7.2.1.

7.4 General fire-resistance test for non-metallic fuel tanks

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

7.4.2 A representative sample from the tank range can be selected for the fire test.

The following criteria shall be met for a tank to be considered to be of the same range:

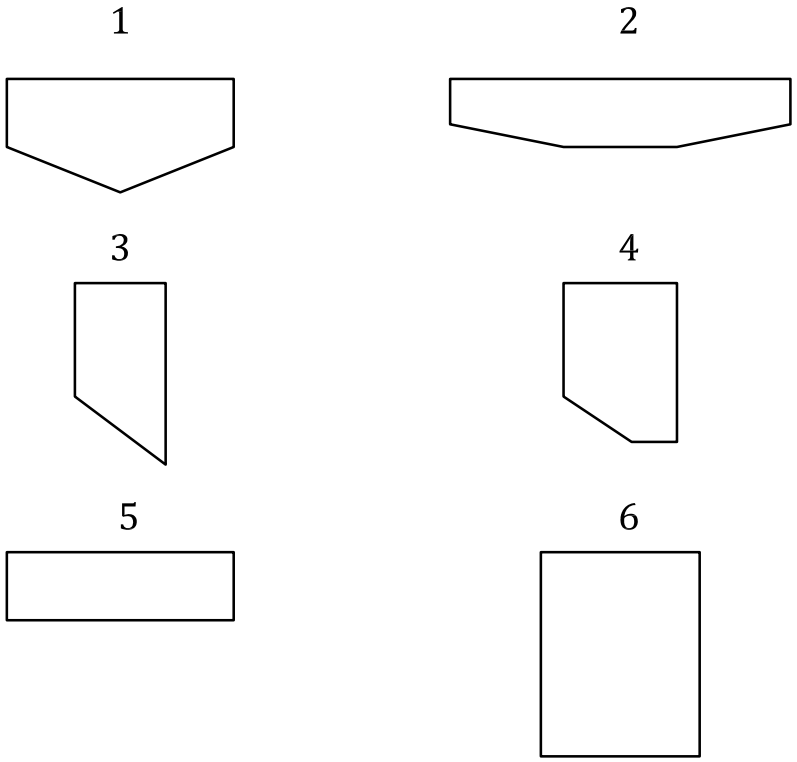
a) fabricated from the same material, using the same methods;

b) with the same wall thickness;

c) with a similar shape and with the same number of surfaces, see Figure 1;

d) with a similar configuration, i.e. the arrangement and geometric form of stiffeners, cones, recesses and fittings are very similar;

e) if baffles are fitted, a maximal volume to baffle spacing ratio shall be defined for the range.



Key

1 type 1: horizontal central V bottom
2 type 2: horizontal central flat bottom tank
3 type 3: lateral vertical tank with slant bottom
4 type 4: lateral vertical tank with flat bottom
5 type 5: rectangular horizontal
6 type 6: rectangular vertical

Figure 1 — Primary fuel tank shapes

7.4.3 The following tanks from each range shall be fire-tested:

a) the tank with the smallest capacity;

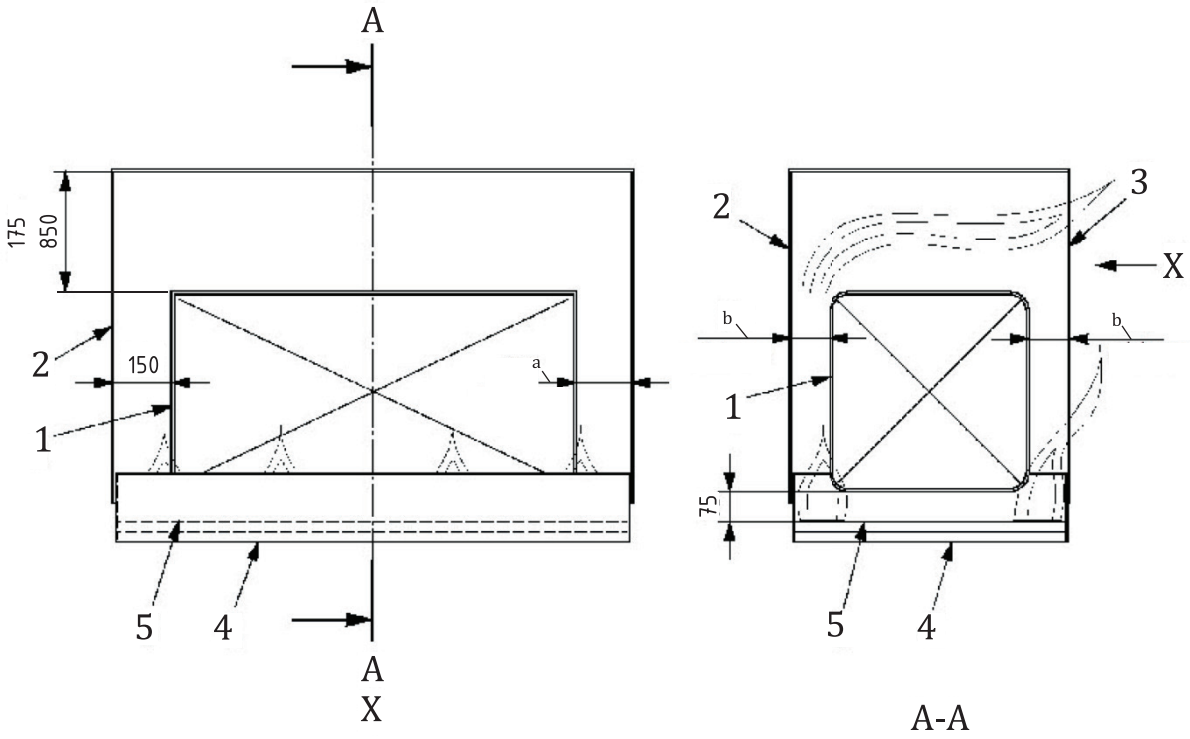
b) the tank with the largest capacity;

c) tanks between the smallest and the largest capacities, selected at intervals of no more than a 33 % by volume calculated in comparison to the smallest tank.

7.4.4 Prior to the fire test, the tank shall be tested in accordance with 7.2 and shall meet the requirements of 7.2.

7.4.5 The tank to be tested shall be supported at its ends and at each baffle in a test enclosure. The enclosure shall be a fire-resistant box closed on its top, bottom and ends, and only open on one of its sides (see Figure 2). The clearance between the tank to be tested and the test enclosure shall be at least 50 mm on the sides, 150 mm on the ends and between 175 mm and 850 mm on the top.

Dimensions in millimetres



Key

1 tank to be tested
2 test enclosure
3 open part of the enclosure
4 bottom of heptane pan
5 top of heptane level
a 150 minimum.
b 50 minimum.

Figure 2 — Sketch of the tank to be tested and the test enclosure

7.4.6 The lowest point of the tank to be tested shall be vertically 75 mm above the liquid surface of the reservoir containing heptane. The sides of the reservoir shall extend 50 mm beyond the vertical sides and 150 mm beyond the ends of the tank to be tested. The reservoir shall be made leakproof and shall accommodate enough heptane to burn continuously for 2,5 min. See Figure 1.

WARNING — Fire tests can be dangerous, particularly using heptane. Heptane is a petrol type of product that produces a repeatable fire test. Petrol varies, due to additives, in its heat content and therefore will not uniformly reach a repeatable temperature from test to test – heptane will. Precautions shall be taken when conducting fire tests.

7.4.7 The area in which the test is conducted shall be free from draughts, but shall allow a free inflow of air during the test.

7.4.8 Fill the tank to be tested to 25 % of its maximum capacity with the intended fuel.

All openings in the tank to be tested shall be capped or plugged, except fuel-tank vent lines that shall be extended outside the fire-test area. Components fitted on the tank or in the test rig that are not intended to be tested shall be sufficiently heat protected.

7.4.9 The heptane in the reservoir shall be ignited and permitted to burn for a continuous period of 2,5 min. The temperature shall reach a minimum of 650 °C within 25 mm of the surface of the tank at some time during the test.

7.4.10 At the end of the 2,5 min test period, any remaining flames shall be extinguished.

NOTE It is important that the fire be extinguished quickly at the end of the 2,5 min so the test sample can be judged at the required time and not subjected to a prolonged fire.

7.4.11 After cooling down, the tested tank shall be examined for leakage. It shall be drained and pressure-tested with a slowly increased air or inert gas pressure up to 1,8 kPa. After the test, the tank shall show no evidence of leakage as defined in 7.2.1.

7.5 Fire-resistance test for non-metallic fuel tanks as installed

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

7.5.2 Install the tank to be tested in an actual or simulated hull section of sufficient size to simulate fire conditions aboard the craft. All structural elements shall be made of the same material as that used on the craft, or of a material of equivalent flammability.

7.5.3 To assess a tank intended for use in a series of craft, the tank to be tested shall be installed in a simulated hull section providing the maximum fire exposure representative of that series.

7.5.4 Prior to the fire test, the tank to be tested shall have been tested in accordance with 7.2 and shall meet the requirements of 7.2. Then, the test pressure shall be released.

7.5.5 The area in which the test is conducted shall be free from draughts, but shall allow a free inflow of air during the test.

7.5.6 Fill the tank to be tested to 25 % of its maximum capacity with the intended fuel.

All openings shall be capped or plugged, except fuel-tank vent lines which shall be extended outside the fire-test areas. Components fixed on the tank or in the test rig that are not intended to be tested shall be sufficiently heat protected.

7.5.7 Pour heptane into all crevices and liquid traps in which fuel could collect in the craft, assuming a leak anywhere in the fuel system. The amount of heptane shall be sufficient so that, when ignited, it shall burn for 2,5 min.

7.5.8 The heptane in the simulated hull section shall be ignited and burn for a continuous period of 2,5 min. The temperature shall reach a minimum of 650 °C within 25 mm of the surface of the tank at some time during the test.

7.5.9 At the end of the 2,5 min test period, any continued burning shall be extinguished.

NOTE It is important that the fire be extinguished quickly at the end of the 2,5 min so the test sample can be judged at the required time and not subjected to a prolonged fire.

7.5.10 After cooling down, the tested tank shall be examined for leakage. It shall be drained and pressure-tested with a slowly increased air or inert gas pressure up to 1,8 kPa.

After the test, the tank shall show no evidence of leakage as defined in 7.2.1.

8 Marking

All fuel tanks shall display the following information in contrasting or embossed letters and numerals at least 5 mm high:

a) manufacturer's name or trademark, and full address or website link;

b) year of manufacture (last two digits);

c) maximum capacity, expressed in litres;

d) maximum temperature to which the tank may be exposed (for non-metallic tanks only);

e) fuel or fuels for which the tank is suitable, using symbols or in words;

NOTE Requirements for symbols are found in ISO 11192.

f) maximum fill-up height above tank top, expressed in metres, and maximum test pressure, expressed in kilopascals;

g) "ISO 21487" marking or label, if the tank is a non-metallic petrol fuel tank fire-tested in accordance with 7.4.

The entire marking and its type of labelling shall be visible during inspections after the tank is installed. A supplementary label can be required for this purpose.

Annex A
(informative)

Permeation testing of non-metallic fuel tanks

A.1 Fuel tank testing

A.1.1 Fuel specification. Use petrol blended with ethanol such that the blended fuel has 10,0 % ± 1,0 % of ethanol by volume. As an alternative, fuel CE10 may be used. This is a mixture of 90 % by volume of liquid C, and 10 % by volume of fuel ethanol.

NOTE Liquid C specifications can be found in ISO 1817. It is blend of 50 % 2,2,4-trimethylpentane and 50 % toluene.

A.1.2 Permeation emissions shall be calculated as defined in A.1.7 i) with the results from weighing a sealed fuel tank before and after a temperature-controlled soak (as described in A.1.4).

A.1.3 Cap testing. Perform durability cycles on fuel caps intended for use with hand-held equipment by putting the fuel cap on and taking it off 300 times. Tighten the fuel cap each time in a way that represents the typical in-use experience.

A.1.4 Preconditioning fuel soak shall be performed prior to emissions testing, as follows:

a) Fill the tank to the maximum capacity with the fuel specified in A.1.1. Seal it and allow it to soak at 28 °C ± 5 °C for at least 20 weeks. Alternatively, the tank may be soaked for at least 10 weeks at 43 °C ± 5 °C. Time spent during the preconditioning steps in d) below may be counted as part of the preconditioning fuel soak as long as the ambient temperature remains within the specified temperature range and the fuel tank is at least 40 % full. Fuel may be added or replaced as needed to conduct the specified durability procedures.

b) Empty the fuel tank and immediately refill it with the specified test fuel to its maximum capacity. Care should be taken not to spill any fuel.

c) Allow the tank and its contents to equilibrate at a temperature of 28 °C ± 2 °C. Seal the fuel tank as described in A.1.5 once the fuel temperatures are stabilized at the test temperature. The tank shall be sealed no more than 8 h after refuelling. Until the fuel tank is sealed, take steps to minimize the vapour losses from the fuel tank, such as keeping the fuel cap loose on the fuel inlet or routing vapours through a vent hose.

d) If the control of emissions of the tank involves a surface treatment, or other post processing treatments such as a coating, preconditioning durability testing shall be performed prior to the emissions tests. The following tests may be performed in any order:

    1) Pressure/vacuum cycling. Perform a pressure test by sealing the tank and cycling it between + 13,8 kPa and −3,4 kPa for 10 000 cycles at a frequency of 1 cycle/minute. The purpose of this test is to represent environmental wall stresses caused by pressure changes and other factors such as vibration or thermal expansion.

    2) UV exposure. Perform a sunlight-exposure test by exposing the tank to an ultraviolet light of at least 24 W/m^2 (0,40 $W\text{-}h/m^2/min$) on the tank surface for at least 450 h. Alternatively, the fuel tank may be exposed to direct natural sunlight for an equivalent period of time as long as the tank is exposed to at least 450 h of daylight.

3) Slosh testing. Perform a slosh test by filling the tank to 40 % to 50 % of its capacity with the fuel specified in A.1.1 and rocking it at a rate of 15 cycles per minute until one million total cycles are reached. Use an angle deviation of +15° to −15° from level.

A.1.5 Seal the fuel tank as follows:

a) If fuel tanks are designed for use with a filler neck such that the fuel cap is not directly mounted on the fuel tank, it is permissible to seal the fuel inlet with a nonpermeable covering.

b) If fuel tanks are designed with fuel caps directly mounted on the fuel tank, one of the following approaches shall be used.

1) Use a production fuel cap expected to have permeation emissions at least as high as the highest-emitting fuel cap that is expected to be used with fuel tanks from the emission family.

NOTE Fuel caps with a nitrile rubber seal are considered to be the worst case.

2) The fuel inlet may be sealed with a nonpermeable covering if emissions from the fuel cap are accounted for separately. This may involve a separate measurement of permeation emissions from a worst-case fuel cap.

3) If a low-permeability material is specified for a fuel gasket, the fuel inlet may be sealed with a nonpermeable covering. Calculate an emission rate for the complete fuel tank using a default value of 30 g/m^2 per 24 h or the fuel cap (or 50 g/m^2 per 24 h for testing at 40 °C). Use the smallest inside cross-sectional area of the opening on which the cap is mounted as the fuel cap's surface area.

4) Openings that are not normally sealed on the fuel tank (such as hose-connection fittings and vents in fuel caps) may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

5) Openings for petcocks that are designed for draining fuel may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

6) Openings for grommets may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

7) A fuel tank may be produced for testing without machining or stamping those holes.

A.1.6 Reference tank. A reference tank is required to correct for buoyancy effects that can occur during testing. Prepare the reference tank as follows:

a) Obtain a second tank whose maximum capacity is within 5 % of the test tank's maximum capacity. A tank that has previously contained fuel or any other contents that can affect its mass stability shall not be used.

b) Fill the reference tank with inert material (e.g. glass beads) such that the mass of the reference tank differs from the fuel filled test tank by no more than 20 g or 0,5 %, whichever is the least.

c) Ensure that the inert material is dry.

d) Seal the tank.

A.1.7 Permeation test run. Terms used in the calculation of permeation are listed in Table A.1. Perform the permeation test applying the following steps:

a) Determine the area, in square metres, of the inside of the fuel tank's containing surfaces (i.e. excluding the surface of baffles), accurate to at least three significant figures. Less accurate estimates of the surface area may be used if the surface area is not overestimated.

b) Weigh the sealed test tank and record its mass. Place the reference tank on the balance and tare it so it reads zero. Place the sealed test tank on the balance again and record the mass difference, m_0, between the test tank and the reference tank. Take this measurement directly after sealing the test tank as specified in A.1.5.

c) Carefully place the sealed test tank within a temperature-controlled room or enclosure.

d) Close the room or enclosure as needed to control temperatures and record the time. Adequate ventilation shall be provided to prevent an accumulation of hydrocarbon vapours in the room or enclosure that can affect the degree to which fuel permeates through the fuel tank. This can simply involve passive ventilation to allow fresh air exchanges.

e) Ensure that the measured temperature in the room or enclosure stays within the temperatures specified in g) below.

f) Leave the sealed test tank in the room or enclosure for the duration of the test run.

g) Hold the temperature of the room or enclosure at 28 °C ± 2 °C. Measure and record the temperature at least daily.

h) Measure the mass loss daily by weighing the sealed test tank compared to the reference tank. Calculate the cumulative mass loss, in grams, for each measurement. Calculate the coefficient of determination, r^2, based on a linear plot of cumulative mass loss versus test days. The daily measurements shall be made at approximately the same time each day. Up to two daily measurements may be omitted in any seven-day period. Test for 10 full days, then determine when to stop testing as follows:

   1) Testing may be stopped after the measurement on the tenth day if r^2 is at or above 0,95 or if the measured value is less than 50 % of the limit of the applicable standard. If testing is stopped with an r^2 below 0,95, data may not be used to show compliance with an emission limit less than twice the measured value.

   2) If after 10 days of testing the r^2 value is below 0,95 and the measured value is more than 50 % of the applicable standard, continue testing for a total of 20 days or until r^2 is at or above 0,95. If r^2 is not at or above 0,95 within 20 days of testing, discontinue the test and precondition the fuel tank further until it has stabilized emission levels, then repeat the testing.

i) Record the mass difference, m_i, between the reference tank and the test tank for each measurement. Subtract m_i from m_0 and divide the difference by the internal surface area of the fuel tank. Express this value in g/m^2, and divide it by the number of test days (using at least two decimal places) to calculate the emission rate in g/m^2 per 24 h.

   EXAMPLE A tank with an internal surface area of 0,720 m^2 weights 1,31 g less than the reference tank at the beginning of the test, and weights 9,86 g less than the reference tank after soaking for 10,03 days. The emission rate is calculated as follows:

   [(–1,31 g) – (–9,86 g)]/0,720 m^2/10 days = 1,187 5 g/m^2 per 24 h.

j) Determine the final emission result based on the cumulative mass loss measured on the final day of testing. Round this result to the same number of decimal places as the emission limit.

Table A.1 — Definition of terms used in calculating permeation rate

Symbol	Description	Unit
r^2	Coefficient that determines the end of the test	Not applicable
m_i	Difference in mass between reference tank and test tank on day "i" after the test starts	g
m_0	Initial difference in mass of reference tank and test tank	g

A.2 Fuel caps

If a fuel tank's permeation emissions are measured with a nonpermeable covering in place of the fuel cap under A.1.4 d) 2), the permeation emissions shall be measured separately from a fuel cap. The fuel cap and the fuel tank may be certified separately or by combining the separate measurements into a single emission rate based on the relative surface areas of the fuel tank and fuel cap. If combining separate measurements, they shall both be tested at the same temperature as specified in A.1.4 a). Measure the fuel cap's permeation emissions as follows:

a) Select a fuel cap expected to have permeation emissions at least as high as the highest-emitting fuel cap that is expected to be used with fuel tanks from the tank range. Include a gasket that represents production models. If the fuel cap includes vent paths, seal these vents as follows:

   1) if the vent path is through grooves in the gasket, use of another gasket with no vent grooves is permitted if it is otherwise the same as a production gasket;

   2) if the vent path is through the cap, seal any vents for testing.

b) Attach the fuel cap to a fuel tank with a capacity of at least 1 l. The tank shall be made of metal or some other impermeable material.

c) Use the procedures specified in Clause A.1 to measure permeation emissions. Calculate emission rates using the smallest inside cross-sectional area of the opening on which the cap is mounted as the fuel cap's surface area.

Bibliography

[1] ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

[2] ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

[3] ISO 8666:2020, *Small craft — Principal data*

[4] ISO 11192, *Small craft — Graphical symbols*

NATIONAL ANNEX B

(*National Foreword*)

B-1 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act,* 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

(*Continued from second cover*)

Attention is drawn to the possibility that some of the elements of this draft standard may be the subject of patent rights. The Bureau of Indian Standards shall not be held responsible foridentifying any or all such patent rights.

Annex A is for information only.

This standard also makes a reference to BIS certification marking of the product. Details of which are given in National Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2: 2022 ‘Rules for rounding of numerical values (*Second Revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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This Indian Standard has been developed from Doc No.: TED 18 (23959).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi