INTERNATIONAL STANDARD

**ISO 10088**

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# Small craft — Permanently installed fuel systems

*Petits navires — Systèmes à carburant installés à demeure*



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# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 188, *Small craft*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 464, *Small Craft*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fifth edition cancels and replaces the fourth edition (ISO 10088:2013), which has been technically revised.

The main changes are as follows:

— pressure testing requirement updated in Annex A;

— permeation test limits and test procedures added as a new informative Annex B to serve as a reference for evaporative emissions.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Introduction

This document deals with the installed fuel system as a whole. Fire resistant hoses, non-fire resistant hoses and permanently installed petrol and diesel fuel tanks are dealt with by ISO 7840:2021, ISO 8469:2021 and ISO 21487:2022, respectively. These standards are applicable to these products supplied as components.

Some countries have environmental controls for evaporative emissions from petrol fuel systems, and this document includes an informative Annex B describing limits and test procedures for the control of evaporative emissions from permanently installed petrol fuel systems. The details in Annex B 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 B will have increased global acceptance.

# Small craft — Permanently installed fuel systems

## 1 Scope

This document specifies the requirements for the design, materials, construction, installation and testing of permanently installed fuel systems as installed for internal combustion engines.

It applies to all parts of permanently installed diesel and petrol fuel systems as installed, from the fuel fill opening to the point of connection with the propulsion or auxiliary engine(s) on inboard- and outboard-powered small craft.

Requirements for the design and testing of petrol and diesel fuel tanks for internal combustion engines that are intended to be permanently installed in small craft are given in ISO 21487:2022.

## 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 1817:2022, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 7840:2021, *Small craft — Fire-resistant fuel hoses*

ISO 8469:2021, *Small craft — Non-fire-resistant fuel hoses*

ISO 8846:1990, *Small craft — Electrical devices — Protection against ignition of surrounding flammable gases*

ISO 11105:2020, *Small craft — Ventilation of petrol engine and/or petrol tank compartments*

ISO 11192:2005, *Small craft — Graphical symbols*

ISO 13297:2020, *Small craft — Electrical systems — Alternating and direct current installations*

ISO 13297:2020/Amd 1:2022, *Small craft — Electrical systems — Alternating and direct current installations — Amendment 1*

ISO 21487:2022, *Small craft — Permanently installed petrol and diesel fuel tanks*

IEC 60068-2-52:2017, *Environmental testing — Part 2-52: Tests — Test Kb: Salt, cyclic (sodium chloride solution)*

## 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**
**accessible**
capable of being reached for inspection, removal or maintenance without removal of permanent craft structure

Note 1 to entry: Hatches are not regarded as permanent craft structures in this sense, even if tools such as wrenches or screwdrivers are needed to open them. Hatches for inspection or maintenance of fuel tanks are permitted to be covered by uncut carpet, provided that all tank fittings can be inspected and maintained through other openings.

**3.2**
**readily accessible**
capable of being reached quickly and safely for maintenance or effective use under emergency conditions without the use of tools

**3.3**
**permanently installed**
securely fastened so that tools are required for removal

**3.4**
**anti-siphon valve**
demand valve that can be opened only by fuel pump suction to withdraw fuel from a tank and that remains closed when the fuel pump is not operating, preventing siphon action created by a break or leakage at any point in the fuel distribution system

**3.5**
**static floating position**
condition in which the craft floats in calm fresh water according to light craft mass $m_{LC}$ with each fuel tank filled to rated capacity but excluding all non-permanently attached interior and exterior equipment

Note 1 to entry: The light craft mass $m_{LC}$ is specified in ISO 8666:2020, 6.3.

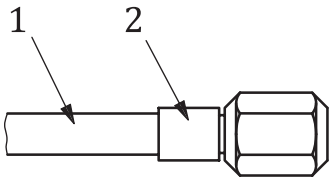
**3.6**
**petrol**
hydrocarbon fuel, or blend thereof, that is liquid at atmospheric pressure and is used in spark-ignition engines

**3.7**
**diesel**
hydrocarbon fuel, or blend thereof, that is liquid at atmospheric pressure and is used in compression-ignition engines

**3.8**
**spud**
rigid pipe or spigot used for the connection of pipes and hoses to tanks or components such as filters and pumps

**3.9**
**swaged sleeve**
permanently attached fuel hose end fitting obtained by applying even compression to a metal sleeve or ferrule, sufficient to make the inner lining of the hose take up the shape of the insert and create a pressure seal

Note 1 to entry: See Figure 1.




**Key**

1 hose

2 sleeve

**Figure 1 — Swaged sleeve**

**3.10**
**sleeve and threaded insert**
permanently attached fuel hose end fitting made by screwing an insert sleeve with threads into the hose and applying even compression to a metal sleeve or ring to secure the hose in place

Note 1 to entry: This type of connection can be made with the sleeve placed on the outside of the hose and then screwing the threaded insert into the inner lining.

**3.11**
**compartment**
cabin or enclosure able to be closed to the outside of the craft

Note 1 to entry: Multiple compartments can be joined together as long as the total volume is closed to the outside of the craft.

**3.12**
**craft's ground**
ground that is established by a conducting connection (intended or accidental) with the common ground (potential of the earth's surface), including any conductive part of the wetted surface of the hull

Note 1 to entry: "Ground" is also known as "earth".

**3.13**
**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.]

**3.14**
**entering the craft**
event in which liquids or fumes enter the interior space of the craft

**3.15**
**evaporative emissions**
fuel emissions that result from permeation of fuel through the fuel system materials or from ventilation of the fuel system

**3.16**
**diurnal emissions**
*evaporative emissions* (3.15) that occur as a result of venting fuel tank vapours during daily temperature changes while the engine is not operating

**3.17**
**emissions class 1 craft**
craft under 8 m in length or under 2,6 m beam

**3.18**
**emissions class 2 craft**
craft greater than or equal to 8 m in length or greater than or equal to 2,6 m beam

**3.19**
**SHED**
sealed housing evaporative determination enclosure

**3.20**
**carbon canister**
container with activated carbon to absorb hydrocarbon vapours from the fuel system

**3.21**
**heeled waterline**
level of the water on the hull in the fully loaded ready-for-use $m_{LDC}$ condition when the craft is inclined to

— 7° for motor boats and sailing multihulls; or

— 30° or immersion of the sheerline, whichever occurs first, for monohull sailing boats

Note 1 to entry: The fully loaded ready-for-use condition is defined in ISO 8666:2020, 7.3.

[SOURCE: ISO 9093:2020, 3.6]

# 4 General requirements

## 4.1 Materials and design

**4.1.1** Individual components of the fuel system, and the fuel system as a whole, shall be designed to withstand the combined conditions of pressure, vibration, shocks, corrosion and movement encountered under normal operating conditions and storage of the craft.

**4.1.2** Each component of the fuel system, and the fuel system as a whole, shall be capable of operation within an ambient temperature range of − 40 °C to + 80 °C, without failure or leakage.

NOTE Thermoplastic tanks and components can be affected by high return fuel temperature. It is therefore important to read the engine installation manual for information.

**4.1.3** All materials used in the fuel system shall be resistant to deterioration by its designated fuel and to other liquids or compounds with which it may come into contact under normal operating conditions, e.g. grease, lubricating oil, bilge solvents and sea water.

**4.1.4** Petrol engine compartments, petrol tank compartments and compartments with joints or fittings in fuel lines connecting spark-ignition engines with their fuel tanks shall have ventilation and ignition protection in accordance with ISO 11105:2020 and ISO 8846:1990.

**4.1.5** The only outlets for drawing fuel from the fuel system shall be

— plugs in petrol filter bowls intended solely for the purpose of servicing the filter;

— plugs or valves in diesel filter bowls intended solely for the purpose of servicing the filter.

NOTE Tank openings are covered by ISO 21487:2022.

**4.1.6** Any metal or metallic plated component of a petrol tank and its filling system that is in contact with petrol shall be grounded so that its resistance to the craft's ground is less than 1 Ω.

Grounding wires shall not be installed between a hose and its clamps.

**4.1.7** Fuel filling systems shall be designed to avoid spillage of fuel during refuelling to the rated capacity. Fuel systems shall be tested in accordance with 4.2.3.

**4.1.8** Provision shall be made to prevent fuel overflow from the vent opening while refuelling from entering the interior of the craft or the water.

NOTE A substance is "entering the interior of the craft", when it gets into a place being inside the surface of the watercraft. This can be the cabin or a similar place not being open to the atmosphere having one or more closing appliances used to cover an opening in the cockpit, hull or superstructures.

**4.1.9** All fuel system components in engine compartments (e.g. filters, pumps, water separators and hoses) – excluding permanently installed fuel tanks, which are tested in accordance with ISO 21487:2022 – shall individually, or as installed in the craft, be capable of withstanding a 2,5 min fire test as specified in Annex C.

Fasteners supporting metal fuel lines constitute an exception to this requirement.

**4.1.10** Copper-base alloy fittings may be used for aluminium tanks if protected by a galvanic barrier to reduce galvanic corrosion.

**4.1.11** A means to determine the level or quantity of fuel in the tank shall be provided.

## 4.2 Testing

**4.2.1** After installation, the fuel system as a whole shall pass the pressure test specified in Annex A.

**4.2.2** Small components of the fuel system (e.g. filters, pumps, water separators and hoses), required to be fire tested according to 4.1.9, shall be tested as specified in ISO 7840:2021, Annex A, with the lower part mounted 250 mm above the surface of liquid in a pan of which the sides extend beyond the component by 150 mm. The component to be tested shall be a complete assembly and shall include all accessories intended to be attached directly to the component.

**4.2.3** There shall be no spillage of fuel from the fill fitting when filling at a rate of 30 l/min from 25 % to 75 % of the capacity on the tank label. For fuel tanks of 100 l capacity or less, the fill rate may be reduced to 20 l/min. The test to determine compliance with this shall be performed on at least one craft or a representative installation.

## 4.3 Installation

**4.3.1** The fuel system shall be permanently installed. All component parts, except small connectors and fittings and short sections of flexible hoses, shall be independently supported.

**4.3.2** All valves and other components intended to be operated or observed during normal operation of the craft, or for emergency purposes, shall be readily accessible. All fittings and connections of the fuel system shall be readily accessible, or accessible through an access panel, port or hatch. Tanks need not be accessible for removal.

**4.3.3** The clearance between a petrol fuel tank and a combustion engine shall not be less than 100 mm unless a thermal barrier is provided.

**4.3.4** The clearance between a petrol tank and exhaust components having a temperature exceeding 90 °C shall not be less than 250 mm, unless a thermal barrier is provided.

**4.3.5** Fuel system electrical components shall meet the installation requirements specified in ISO 13297:2020 and ISO 13297:2020/Amd 1:2022.

**4.3.6** Fuel tanks and components of petrol fuel systems shall not be installed directly above batteries unless the batteries are protected against the effects of fuel leakage.

## 5 Fuel pipes, hoses, connections and accessories

### 5.1 Fuel filling lines

**5.1.1** The minimum inside diameter of the fill pipe system shall be 28,5 mm and the minimum inside diameter of fuel filling hoses shall be 38 mm.

**5.1.2** Fuel filling hoses located in engine compartments shall be fire resistant, of type A1, A2 or A15 in accordance with ISO 7840:2021. Fuel fill hoses outside engine compartments shall be of either type A1, A2, or A15 in accordance with ISO 7840:2021, or of type B1, B2, or B15 in accordance with ISO 8469:2021.

NOTE The 1, 2, and 15 designations describe the level of permeation:

1 = a permeation rate greater than 15 g/m$^2$/24 h but less than 100 g/m$^2$/24 h;

2 = a permeation rate of 100 g/m$^2$/24 h to 300 g/m$^2$/24 h;

15 = a permeation rate of less than 15 g/m$^2$/24 h.

**5.1.3** Fuel filling lines shall be self-draining to the tank(s) when the craft is in its static floating position.

**5.1.4** The fuel filling system shall be designed so that accidental fuel spillage does not enter the interior of the craft during fuelling, when it is in its static floating position.

NOTE A substance is "entering the interior of the craft", when it gets into a place being inside the surface of the watercraft. This can be the cabin or a similar place not being open to the atmosphere having one or more closing appliances used to cover an opening in the cockpit, hull or superstructures.

**5.1.5** The distance between compartment ventilation openings and fuel fill openings shall be at least 400 mm, except where the craft's coaming, superstructure or hull creates a barrier to prevent fuel vapour entering the craft through the ventilation opening.

**5.1.6** The fuel filling point shall be marked "petrol" or "diesel" and/or with a symbol specified in ISO 11192:2005 to identify the type of fuel to be used.

### 5.2 Vent lines and components

**5.2.1** Each fuel tank shall have a separate vent line.

**5.2.2** Vent hoses located in engine compartments shall be fire resistant, of type A1, A2, or A15 in accordance with ISO 7840:2021. Vent hoses outside engine compartments shall be of either type A1, A2, or A15 in accordance with ISO 7840:2021, or type B1, B2, or B15 in accordance with ISO 8469:2021.

**5.2.3** Each ventilation pipe shall have a minimum inside diameter of 11 mm (95 $mm^2$) 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 21487:2022.

**5.2.4** Vent lines shall not have valves other than those that permit free flow of air and prevent flow of liquid (fluid) both in and out of the tank(s).

**5.2.5** Vent lines shall be self-draining when the craft is in its static floating position.

**5.2.6** The distance between compartment ventilation openings and fuel vent openings shall be at least 400 mm, except where the craft's coaming, superstructure or hull creates a barrier to prevent fuel vapour entering the craft through the ventilation opening.

**5.2.7** The vent line shall be arranged to minimize intake of water without restricting the release of vapour or intake of air and shall not allow fuel or vapour overflow to enter the craft.

**5.2.8** The vent-line termination or a gooseneck in the vent-line routing shall be located above the heeled waterline of the craft.

**5.2.9** The vent lines on all petrol installations shall incorporate a flame arrester device that fulfils the requirements in 4.1.7 and 5.2.3, unless the vent is included as part of a combined vent and fill fitting.

**5.2.10** For vent-line components in engine compartments, with the ability to capture fuel, the fire test requirements in 4.1.9 apply.

## 5.3 Fuel distribution, return and balancing lines

**5.3.1** Metal fuel lines shall be made of seamless annealed copper or copper–nickel or equivalent metal with a nominal wall thickness of at least 0,8 mm. Aluminium lines may be used for diesel.

**5.3.2** Rigid fuel lines shall be connected to the engine by a flexible hose section. Support shall be provided within 100 mm of the connection to the metal supply line on the rigid side of the connection.

**5.3.3** Connections in rigid fuel lines shall be made with screwed, compression, cone, brazed or flanged joints.

**5.3.4** Flexible fuel hoses shall be used where relative movement of the craft structures supporting the fuel lines would be anticipated during normal operating conditions.

**5.3.5** Flexible fuel hoses shall be accessible for inspection and maintenance.

**5.3.6** Petrol hoses shall be fire-resistant, type A1, A2 or A15 hoses in accordance with ISO 7840:2021, except hoses entirely within the splash well at the stern of the craft connected directly to an outboard engine, which shall be type B1, B2, or B15 hoses in accordance with ISO 8469:2021 or A1, A2 orA15 hoses in accordance with ISO 7840:2021.

**5.3.7** Diesel hoses shall be fire-resistant, type A1, A2, or A15 hoses in accordance with ISO 7840:2021.

**5.3.8** Fuel lines shall be properly supported and secured to the craft structure above bilge water level, unless specifically designed for immersion or protected from the effects of immersion.

**5.3.9** There shall be no joints in fuel pipes or hoses other than those required to connect required fuel- line components, e.g. filters and bulkhead connections.

**5.3.10** Petrol line systems shall be designed or installed to prevent fuel siphoning out of the tank(s) following a failure in the system. The following examples illustrate how this can be achieved:

— routing all parts of fuel lines, from which an assumed leakage can enter the craft, above the level of the tank top when the craft is in its static floating position, including fuel-containing parts on the engine; if straps are used, they shall be fire resistant; or

— fitting an anti-siphon valve (see 3.4) as close as practical to the tank fittings with a rated siphon-protection head greater than that required to avoid the siphon effect; or

— fitting a manual shut-off valve as close as practical to the tank – which shall be capable of being closed from an indicated readily accessible location outside the engine compartment – in a position that is self-draining from the valve to the tank; or

— fitting an electrically operated valve as close as practical to the tank withdrawal fitting which is activated to open only when the engine is running, or the starting device is operated; a momentary override type is acceptable for starting.

**5.3.11** Diesel line systems shall be designed or installed to prevent fuel siphoning out of the tank(s) following a failure in the system. The following examples illustrate how this can be achieved:

— meeting the requirements of 5.3.10; or

— fitting a manual shut-off valve as close as practical to the tank. This valve shall be capable of being closed from an indicated accessible location outside the engine compartment. If electrically operated valves are used, they shall be equipped with a manual emergency operating or by-passing device.

**5.3.12** Diverting valves in diesel return lines shall ensure that the return line flow is not restricted.

## 5.4 Hose fittings and hose clamping

**5.4.1** Fuel hoses shall be secured to the pipe, spud or fitting by metal hose clamps or be equipped with permanently attached end fittings such as a swaged sleeve or a sleeve and threaded insert.

**5.4.2** Pipes, spuds or other fittings for hose connection with hose clamps shall have a bead, flare, series of annular grooves or serrations. The fuel-tank spud constitutes an exception to this requirement. Continuous helical threading knurls or grooves, which can provide a path for fuel leakage, shall not be used.

**5.4.3** Spuds or other fittings for hose connection with hose clamps shall have a nominal outer diameter which is the same as the nominal inner diameter of the hose.

**5.4.4** Hose connections designed for a clamp connection shall have a spud at least 25 mm long.

**5.4.5** Hose connections having a nominal diameter of more than 25 mm shall have two hose clamps. The spud shall be at least 35 mm long, to provide space for the clamps.

**5.4.6** Spuds intended for hose connection shall be free from sharp edges that could cut or abrade the hose.

**5.4.7** Hose clamps shall be made of CrNi 18-8 stainless steel, or equivalent, and be reusable. Clamps depending solely on spring tension shall not be used. The nominal clamp band width shall be at least 8 mm for nominal outside hose diameters up to and including 25 mm and at least 10 mm for bigger hoses. Clamps shall be of the correct size and shall be fitted according to the clamp manufacturer's requirements.

**5.4.8** Clamps shall be installed to fit directly on the hose and shall not overlap each other. Clamps shall be installed behind the bead, if any, or fully on the serrations on spuds at least one clamp width from the end of the hose.

## 5.5 Valves and fittings

**5.5.1** Manually operated valves shall be designed with positive stops in the open and closed positions or shall clearly indicate their open and closed positions.

**5.5.2** The integrity and tightness of a valve shall not depend solely on spring tension.

**5.5.3** Threaded valve housing covers that can be exposed to an opening torque when the valve is operated shall be secured against unintentional opening by a device that can be reused.

**5.5.4** If a transparent tubular or flat glass column-type sight gauge is installed (only allowed in diesel tanks), it shall be as close as practical to the tank, protected to minimize the risk of physical damage, and shall be fitted with a self-closing valve at the bottom that can only be manually operated to open while attended. The top valve is not required to be self-closing.

## 5.6 Fuel filters

**5.6.1** Petrol fuel systems shall be equipped with a fuel filter, which may be fitted on the engine(s).

**5.6.2** Diesel fuel systems shall be equipped with at least one fuel filter and one water separator. The two functions may be combined in one unit.

**5.6.3** Each filter shall be supported by mechanical means other than the fuel lines either on the engine or craft structure.

## 5.7 Labelling

All components (e.g. filters, pumps and water separators) that fulfil the requirements of this document shall be labelled or marked with the following:

— manufacturer's name or trademark;

— ISO 10088, fire resistant;

— type of fuel or fuels for which the component is suitable.

NOTE For labelling or marking of hoses, see ISO 7840:2021 or ISO 8469:2021.

# Annex A
(normative)

# Pressure testing

**WARNING — Do not exceed the test pressure. Do not use solutions containing ammonia.**

## A.1 General

**A.1.1** When testing a separate component of a fuel system, the test pressure shall be equal to the greater of the following two values: 20 kPa or 1,5 times the highest hydrostatic pressure to which the component can be subjected in service.

**A.1.2** When testing a separate component containing non-metallic parts in contact with fuel or fuel vapour, the component shall be filled with test liquid in accordance with ISO 1817:2022 and stored for at least 28 days at a temperature of not less than + 21 °C.

**A.1.3** Pressure testing shall be performed immediately after emptying the component. Individual or assembled components, and individual tanks shall be pressure-tested and any leakage detected either by submerging in water or by using a leak-detecting solution.

**A.1.4** A component shall not show any leakage during pressure testing for 5 min.

## A.2 Systems test

**A.2.1** The complete fuel system on every craft shall be pressure-tested to the greater of 20 kPa, or 1,5 times the maximum hydrostatic head to which it may be subjected in service, or 1,5 times the maximum hydrostatic head at the designed tank fill level plus the system relief pressure. For complete systems as a whole, the pressure-drop method shall be used. Tanks with a capacity of less than 200 l shall be tested for at least 5 min. Systems with larger tanks shall be exposed to pressure for 1,5 s per litre of tank capacity up to a maximum of 30 min.

During this test, fuel-fill deck plates and vent-line through-hull fittings may be replaced by plugs. The fuel connection at the fuel feed pump of the engine shall be disconnected and sealed. Anti-siphon valves and other fuel valves shall be open.

**A.2.2** Fuel systems shall not show any leakage during pressure testing.

# Annex B
(informative)

# Methods and tests for controlling emissions of petrol fuel systems

NOTE This annex provides an example of usual evaporative and diurnal emissions limits, as well as related test methods of a petrol fuel systems. This can be subject to international or national regulations.

## B.1 General requirements

**B.1.1** Marine petrol fuel tanks, including engine-mounted fuel tanks and portable marine fuel tanks, shall meet the requirements related to diurnal emissions specified in this clause. Diurnal emission controls shall continue to function during engine operation.

**B.1.2** Diurnal emissions from petrol fuel tanks shall not exceed 0,11 g/l/day when measured using the test procedures specified in Clause B.4. An alternative standard of 0,043 g/l/day applies for fuel tanks installed in emissions class 2 crafts when measured using the corresponding fuel temperature profile in Clause B.4. Portable marine fuel tanks are not subject to the requirements of this paragraph but shall instead comply with the requirements of B.1.3.

**B.1.3** Portable marine fuel tanks and associated fuel-system components shall meet the following requirements.

**B.1.3.1** They shall be self-sealing when detached from the engines. The tanks shall not vent to the atmosphere when attached to an engine. An integrated or external manually activated device shall be included in the fuel tank design to temporarily relieve pressure before refuelling or connecting the fuel tank to the engine. However, the default setting for such a vent shall be consistent with B.1.3.2.

**B.1.3.2** They shall remain sealed up to a positive pressure of 24,5 kPa; however, they may contain air inlets that open when there is a vacuum pressure inside the tank. Such fuel tanks shall not contain air outlets that vent to the atmosphere at pressures below 34,5 kPa.

**B.1.3.3** Detachable fuel lines that are intended for use with portable marine fuel tanks shall have connection points that are self-sealing when not attached to the engine or fuel tank.

## B.2 Methods of compliance

**B.2.1** Compliance with the diurnal emission standards specified in Clause B.1 shall be verified using any of the control technologies specified in B.2.2 and B.2.3.

**B.2.2** A marine petrol fuel tank sealed to a positive pressure of 7,0 kPa — The fuel tank may contain air inlets that open when there is a vacuum pressure inside the tank.

**B.2.3** A marine petrol fuel tank equipped with a passively purged carbon canister — The carbon shall adsorb no more than 0,5 grams of water per gram of carbon at 90 % relative humidity and a temperature of 25 ± 5 °C. The carbon granules shall have a minimum mean diameter of 3,1 mm. The canister shall have a volume compensator or some other device to prevent the carbon pellets from moving within the canister as a result of vibration or changing temperature. The canister shall meet the requirements and pass the tests of Clause B.3.

## B.3 Carbon canister — Requirements and tests

**B.3.1** A single production representative sample shall be used for all tests

**B.3.2** The working capacity of the canister for emissions class 1 craft shall be a minimum of 0,95 grams of vapour storage capacity per litre of nominal fuel tank capacity when tested using the measurement procedures specified in B.3.14.

**B.3.3** The working capacity of the canister for emissions class 2 craft shall be 0,37 grams of vapour storage capacity per litre of nominal fuel tank capacity.

**B.3.4** Carbon canisters shall have a minimum carbon volume of 11 millilitres per litre of nominal fuel tank capacity (or 4,2 millilitres per litre for fuel tanks used in emissions class 2 nontrailerable crafts). The carbon canister shall have a minimum effective length-to-diameter ratio of 3,5, and the vapour flow shall be directed with the intent of using the whole carbon bed. The carbon shall have a minimum carbon working capacity of 90 g/l.

NOTE The carbon canister volume is based on existing evaporative emissions requirements in effect at the time this annex was added.

**B.3.5** The system and all components shall be capable of operation within an ambient temperature range from -40 °C to 80 °C without failure or leakage.

**B.3.6** The canister manufacturer shall provide installation instructions.

### B.3.7 Leakage test

**B.3.7.1** The carbon canister shall have a maximum allowable leak rate of 25 $cm^3$/min at 34 kPa gauge pressure.

**B.3.7.2** As installed, the canister shall evidence no leakage when subjected to the systems pressure of 21 kPa.

### B.3.8 Flow restriction

The allowable air tube pressure drop across the carbon canister shall be less than 01,0 kPa at 60 SLPM (standard litres per minute) air flow for canisters that vent refuelling vapours, or 3,5 kPa at 60 SLPM air flow for canisters that do not vent refuelling vapours.

### B.3.9 Canister connection strength test

**B.3.9.1** The canister ports shall have sufficient strength to withstand a minimum load of 23 kg. Pull the connection in all directions at a 90° angle to the connection opening at a rate of 25 mm/min until the port breaks. The load shall be greater than 23 kg.

**B.3.9.2** Female threaded ports shall have a barb or intended fitting installed to perform this test.

### B.3.10 Fire resistance test

**B.3.10.1** Canisters intended to be mounted inside an engine compartment shall be capable of withstanding a 2,5 min exposure to free burning fuel (N-Heptane) as required by ISO 7840:2021, Annex A. Canisters shall be tested void of liquid and/or fuel vapour.

**B.3.10.2** After the canister returns to ambient temperature, the canister sample shall be examined, and pressure checked with 1,7 kPa of aerostatic pressure. Pressure shall be applied gradually by means of a suitable regulator so as not to strain the canister due to pressure surge, and maintained at test pressure for a minimum of 5 min. The canister fails the test if leakage is detected in the canister using a means other than the pressure drop method.

### B.3.11 Thermal cycle test

Canisters shall meet leakage and flow restriction requirements of B.3.7 and B.3.8 after being exposed to 40 temperature cycles as follows:

a) 1 h at -40 °C;

b) heat to 80 °C over a 1 h period;

c) 1 h at 80 °C;

d) cool to 40 °C over a 1 h period.

### B.3.12 Corrosion resistance — Salt fog

External metallic parts of the canister shall be tested during 168 h in accordance with IEC 60068-2-52. Method of salt spray (fog) testing. These parts shall not exhibit any functional material degradation or deterioration. Components required for installation and hose connection shall be installed for testing.

NOTE The use of ASTM B117-19 is considered as equivalent to this test.

### B.3.13 Humidity and vibration

#### B.3.13.1 Humidity preconditioning

Canisters shall be soaked at 35 °C and 80 % relative humidity for a period of 72 h. Canisters shall have no vacuum applied during this test and all of the ports shall be capped.

EXCEPTION Humidity preconditioning is not required for non-hygroscopic materials.

#### B.3.13.2 Vibration

Following the humidity preconditioning, canisters shall meet the performance requirements of Clause B.4 when exposed to random vibration, rough water shock, and towing shock. The canisters shall be mounted to the shaker table using the canister mounting provisions for all vibration tests.

#### B.3.13.3 Random vibration

Table B.1 contains the acceleration levels of random vibration profiles ($G_{rms}$). Each profile shall be run for a duration of 20 h for a total of 60 h to completely test the durability of the component.

**B.3.13.3.1** Testing shall occur with a temperature profile transposed over the test time per axis test. The temperature profile shall be a dwell of 0,5 h at -40 °C, transition consistently from -40 °C to 80 °C in 4,5 h, dwell at 80 °C for 0,5 h, transition to -40 °C in 4,5 h and dwell at -40 °C for 0,5 h. This profile can be run in either direction.

**B.3.13.3.2** A vacuum shall be drawn on the vapour inlet port, sufficient to maintain 5 SLPM flow throughout the entire vibration test. The flow out of the vapour inlet shall be filtered to capture any carbon that leaves the canister. The maximum carbon particle size lost shall not exceed 500 µm.

#### B.3.13.4 Rough water shock

Apply 2 250 half-sine shock pulses with a 15*g* amplitude and a duration of 12 ms in the vertical direction. In addition, apply 250 half-sine shock pulses with a 22*g* amplitude and a duration of 14 ms in the vertical direction.

#### B.3.13.5 Towing shock

Apply 1 125 half-sine shock pulses with a 15*g* amplitude and a duration of 6 ms in the vertical direction.

**B.3.13.6** Canisters shall not permit particles greater than 500 µm to migrate out of any canister port, under any condition. Pressure drop across canister after completion of vibration and shock tests shall not increase by more than 0,5 kPa in comparison from new and untested samples at 60 SLPM.

**B.3.13.7** The carbon canister mounting and bracketry shall be validated using the application specific vibration profile. If the profile is unavailable, use the profile in Table B.1. Hoses shall be installed and supported per canister manufacturer's specification. Fill the canister with water equivalent to the carbon heel to simulate worst case mounting load. Run the vibration test above without flow to the canister and all ports uncapped.

**B.3.13.8** Upon completion of the test, the canister mounting and bracketry shall show no evidence of permanent deformation or other signs of failure.

### B.3.14 Carbon canister working capacity determination

#### B.3.14.1 Number of test cycles

The working capacity is determined through cyclic loading and purging of a carbon canister. Ten or more cycles are required to stabilize new carbon. A minimum of three cycles is adequate if the carbon has a previous history of stabilization with butane or gasoline vapours. The "working capacity" value is the average lower value of the butane mass supplied to the canister for the last two repeatable cycles.

#### B.3.14.2 Canister purge

Start the sequence by first purging the canister with 400 bed volumes of dry air or nitrogen in 30 min at laboratory conditions. Bed volume is the design volume of the carbon contained in the canister. Purge for all the canister models is defined as a 400 bed volume purge in approximately 30 min. The purge rate therefore varies with canister size. Purge shall be accomplished by drawing a vacuum at the tank or purge port, or by pushing air or $N_2$ into the atmospheric vent.

#### B.3.14.3 Pause

Pause testing for approximately 5 min between purge and load and also load and purge sequences.

#### B.3.14.4 Measurement

Weigh the test canister before and after each canister load sequence.