
Small craft — Fire-resistant fuel hoses

Petits navires — Tuyaux souples pour carburant résistants au feu

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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. www.iso.org/directives

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The committee responsible for this document is ISO/TC 188, *Small craft*.

This fourth edition cancels and replaces the third edition (ISO 7840:2004), which has been technically revised, mainly concerning test liquids in [5.2](#) to cover hoses' long-term resistance to petrol fuel mixed with ethanol as well as diesel fuel mixed with Fatty Acid Methyl Esters (FAME).

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Small craft — Fire-resistant fuel hoses

1 Scope

This International Standard specifies general requirements and physical tests for fire-resistant hoses for conveying petrol or petrol blended with ethanol and diesel fuel or diesel fuel blended with FAME, designed for a working pressure not exceeding 0,34 MPa for hoses with nominal bore up to and including 10 mm and 0,25 MPa for hoses up to 63 mm inner diameter in craft of hull length up to 24 m.

It applies to hoses for small craft with permanently installed fuel systems. It does not apply to hoses entirely within the splash well at the stern of the craft connected directly to an outboard engine.

Specifications for non-fire-resistant fuel hoses are given in ISO 8469¹⁾. Specifications for permanently installed fuel systems are given in ISO 10088.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3:1973, *Preferred numbers — Series of preferred numbers*

ISO 1307, *Rubber and plastics hoses — Hose sizes, minimum and maximum inside diameters, and tolerances on cut-to-length hoses*

ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

ISO 1817:2011, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 7233:2006, *Rubber and plastics hoses and hose assemblies — Determination of resistance to vacuum*

ISO 7326:2006, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

ISO 10088:—¹⁾, *Small craft — Permanently installed fuel systems*

EN 14214:2008+Amd.1:2009, *Automotive fuels — Fatty acid methyl esters (FAME) for diesel engines — Requirements and test methods*

3 General requirements

Hoses complying with this International Standard shall present a non-porous, smooth inner surface, free from defects and chemical contaminants.

Hoses shall demonstrate suitability for marine use by complying with the requirements of the tests in [Clause 5](#). They shall be marked according to [Clause 6](#).

4 Nominal bore

[Table 1](#) gives some of the inner diameters based on series R 10 of ISO 3:1973. Tolerances shall conform to ISO 1307 or the values given in [Table 1](#).

1) To be published.

Table 1 — Inner diameters and tolerances

Dimensions in millimetres

Inner diameter, <i>d</i>	Tolerance
3,2	± 0,5
4	
5	
6,3	± 0,75
7	
8	
9,5	
10	
12,5	
16	
19	
20	± 1,25
25	
31,5	
38	± 1,5
40	
50	
63	

5 Physical tests on finished hose

5.1 General

New samples shall be used for each of the tests below.

5.2 Test liquids

a) Petrol:

- 1) by volume 100 % liquid 2 specified in ISO 1817:2011, Table A.2;

AND

- 2) a mixture of by volume 90 % of liquid 2 specified in ISO 1817:2011, Table A.2, and 10 % by volume of ethanol.

b) Diesel:

- 1) a mixture of by volume 90 % liquid F specified in ISO 1817:2011 and 10 % by volume of Fatty Acid Methyl Esters (FAME), specified in EN 14214:2008+Amd.1:2009.

5.3 Bursting pressure

For each test liquid as specified in 5.2, fill three hoses or sample lengths from the hoses and store them for 40 days in air at a temperature of $40\text{ °C} \pm 2\text{ °C}$.

Empty the liquid out and fill the hoses or sample lengths with cold water; subject them to hydrostatic pressure as specified in ISO 1402.

The bursting pressure shall be at least 1,4 MPa for hoses with an inner diameter of 10 mm or less and 1,00 MPa for hoses with an inner diameter of more than 10 mm.

5.4 Vacuum-collapse test

Carry out the test in accordance with ISO 7233:2006, method A, using the test conditions specified in [Table 2](#).

Table 2 — Pressure conditions for the vacuum collapse test

Inner diameter, d mm	Vacuum kPa
$d \leq 10$	80
$10 < d \leq 25$	35
$d > 25$	No test required

The test duration shall be 60 s and the diameter of the sphere 0,8 d (inner diameter of the hose). The sphere shall pass freely through the hose while under vacuum.

5.5 Volume change in test liquids

Determine the change in volume of the hose (tube and cover) by the procedure described in ISO 1817.

Place the test pieces in test liquids as specified in [5.2](#) at a temperature of $40 \text{ °C} \pm 2 \text{ °C}$ for 40 days.

If the hose is made of a homogeneous compound (with or without reinforcement), the swelling shall not exceed 35 % by volume, as measured by displacement in water. For hose with an inner layer of fuel-resistant material and a cover of another material, mainly intended for weather and ozone resistance, the increase in volume shall not exceed 35 % for the tube and 120 % for the cover.

5.6 Mass reduction of test hose

Determine the reduction in mass of the inner layer by the procedure described in ISO 1817. Fill three hoses or submerge test pieces from the hoses with test liquids, as specified in [5.2](#), and store them for 40 days in air at a temperature of $40 \text{ °C} \pm 2 \text{ °C}$.

The reduction in mass of the inner layer shall not exceed 8 % of the initial mass of the test pieces.

NOTE A reduction in mass of 8 % corresponds to a decrease in volume of approximately 10 %.

5.7 Fire resistance

Test the hose in accordance with the method described in [Annex A](#).

5.8 Effect of ozone

The hose shall be tested as described in ISO 7326:2006, Method 1. The sample shall show no visible cracks at $\times 7$ magnification.

5.9 Fuel permeation

The permeation rate for the hoses shall be determined according to the method specified in [Annex B](#) or an equivalent test method. The hoses shall be classified in the following way and marked in accordance with [Clause 6](#):

Type 1: hoses with a permeation rate of 100 g/m^2 or less per 24 h.

Type 2: hoses with a permeation rate of over 100 g/m² per 24 h, up to and including 300 g/m² per 24 h.

5.10 Cold-flex test

For straight hoses of 19 mm inside diameter and less, condition three hose samples for 5 h at $-20\text{ °C} \pm 2\text{ °C}$. Flex in the cold chamber through 180° from the centreline to a diameter of 10 times the maximum outside diameter of the hose. The flexing shall take place within 4 s and the hose shall not fracture or show any cracks, checks or break in the tube or cover.

For straight hoses larger than 19 mm inside diameter and all pre-formed hoses, prepare three samples $(100 \pm 5)\text{ mm} \times (6 \pm 1)\text{ mm}$ from the whole hose wall and condition them for 5 h at $-20\text{ °C} \pm 2\text{ °C}$ in an unrestrained loop, positioned between two jaws 50 mm wide and 64 mm apart. While in the cold chamber, bring the jaws together rapidly until they are 25 mm apart. The samples shall not fracture or show any cracks, checks or breaks.

5.11 Abrasion test — 38 mm and larger fuel-fill hose with helical wire embedded reinforcement

Hose samples of 38 mm inner diameter shall be selected for the test. Larger bore hose sizes to be qualified by the test shall not have a cover thickness or construction less than those of the test samples.

Three identical 38 mm bore hose samples shall be tested. Condition hose for at least 24 h at $23\text{ °C} \pm 2\text{ °C}$ and $50\% \pm 5\%$ relative humidity. The test hose shall be mandrel- (core-) supported and rotated at a constant speed of $80\text{ r/min} \pm 2\text{ r/min}$. Subject hose to a laterally moving abrasive surface, i.e. 80 grit aluminium oxide (Al_2O_3) emery cloth, parallel to the longitudinal axis of the hose. The abrasive surface shall be $(25 \pm 5)\text{ mm} \times (75 \pm 5)\text{ mm}$ affixed to a hard surface which will cycle back and forth $75\text{ mm} \pm 5\text{ mm}$ in each direction while loaded with a constant normal force of $45\text{ N} \pm 5\text{ N}$. One test cycle shall equal one 360° rotation of the outside diameter of the hose and one back and forth movement of the abrasive surface. After 1 000 cycles, the three test samples shall have no helical wire reinforcement exposed at the point of contact with the abrasive surface.

5.12 Dry heat resistance

After heat ageing for 70 h at $100\text{ °C} \pm 2\text{ °C}$, samples taken from the cover material shall not have a reduction in tensile strength of more than 20 % of the tested value or a reduction in elongation at break of more than 50 %.

5.13 Oil resistance test

After 70 h immersion in reference oil ISO 1817:2011, oil number 3 at $100\text{ °C} \pm 2\text{ °C}$, samples taken from the tube shall not have a reduction of tensile strength or elongation at break exceeding 40 %, or a volumetric change outside the range of -5% to $+25\%$ of the pre-immersion values. Samples taken from the cover material shall not have a volumetric change outside the range of 0 % to $+100\%$.

5.14 Adhesion test

The force required to separate a 25 mm width sample of bonded adjacent layers, such as the tube and cover of hose material, by tensile force on partially separated layers applied in opposite directions, at $23\text{ °C} \pm 2\text{ °C}$, shall be not less than 27 N.

6 Marking

To comply with this International Standard, a hose shall be marked at least every 0,3 m with the following:

- the name or trademark of the manufacturer or supplier;
- the last two figures of the year of manufacture;

- the inner diameter, in millimetres;
- “ISO 7840 - A1” or “ISO 7840 - A2”.
- E10/B10 compatible

NOTE 1 “A” is used to designate a fire-resistant type of fuel hose. “1” is used to designate a fuel hose with a fuel permeation rate of 100 g/m² or less per 24 h. “2” is used to designate a fuel hose with a fuel permeation rate of 300 g/m² or less per 24 h.

NOTE 2 “E10” is used to designate a fuel hose resistant to petrol blended with 10 % ethanol and “B10” is used to designate a fuel hose resistant to diesel blended with 10 % FAME.

The marking shall be in letters and figures at least 3 mm high and shall withstand washing with ordinary detergents.

Additional information may be included in the marking.

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Annex A (normative)

Fire test

A.1 Principle

The hose filled with heptane is subjected to fire. The hose shall withstand the test for 2,5 min without leakage after ignition of the fuel in the tray.

A.2 Sampling

At least three hose samples shall be tested in turn.

A.3 Equipment

The test shall be performed in a sheltered area free from draught, permitting a free inflow of air during the test, at a temperature of $+ 20\text{ °C} \pm 5\text{ °C}$. The test equipment shall be designed to conform to that shown in [Figure A.1](#). The fuel tray shall be square, 350 mm × 350 mm, with vertical sides. Commercial heptane with a distillation interval of 80 °C to 110 °C is used as fuel. The fuel and water temperature shall be $+ 20\text{ °C} \pm 2\text{ °C}$.

A.4 Test procedure

A.4.1 Preparation

Mount the test equipment to conform to [Figure A.1](#). Non-measurable draught effects in the area could influence the flame and if so, the position of the fuel tray shall be changed, in order to as far as possible embrace the hose and one of its ends in the flame.

The hose end-connections to the test fixture ([Figure A.1](#)) shall be made as specified in 5.4 of ISO 10088:—.

A.4.2 Test

Fill the hose with fuel by opening the tank valve. Ensure that no air is left in the hose. Adjust the fuel level to 900 mm.

Pour 0,5 l of water and 1 l of heptane into the fuel tray and ignite the heptane. The fuel tray shall be placed so that two of the sides are parallel with the test object. Ensure that a stable flame is maintained and that the flame embraces the hose and one of its fittings for the duration of the test.

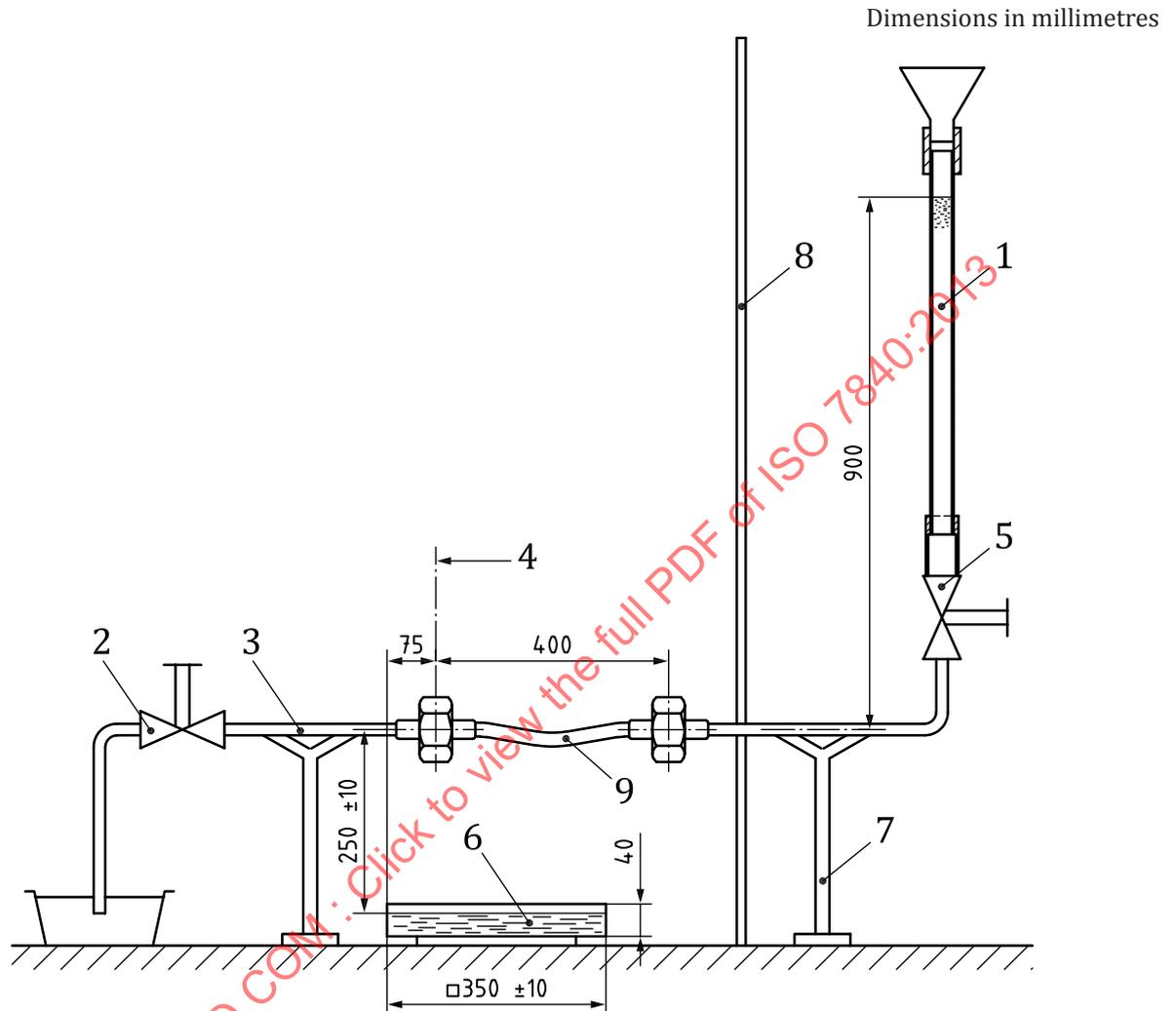
Allow the heptane to burn and record the time to leakage.

The test is terminated when leakage occurs or when 2,5 min have elapsed.

If the flame is very unstable during the test and if it does not expose the test hose to a full extent during at least 75 % of the test lapse, or if the time to leakage in any test deviates by more than 30 s from the determined mean value, another two hose samples shall be tested.

After each test, the fuel lines and fuel tray shall be cooled to a temperature of $+ 20\text{ °C} \pm 5\text{ °C}$ before a new test object is mounted and water and fuel, respectively, are refilled.

WARNING — Large flames and burning waste fuel could occur at leakage, therefore the test shall be performed in a non-combustible environment and with personnel equipped with protective equipment and fire-fighting equipment.



Key

- 1 glass tube
- 2 discharge valve
- 3 fuel line, steel pipe
- 4 hose end, mounted without axial stress
- 5 fuel valve
- 6 fuel tray 0,5 l water, 1 l heptane
- 7 steel stand
- 8 metallic heat shield
- 9 hose sample subject to test

Figure A.1 — Test set-up

Annex B (normative)

Fuel permeation test (or equivalent test method)

B.1 Principle

Pieces of the hose to be tested shall be filled with test fuel for 40 days and stored at a temperature of $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ before the test begins. Then the test pieces are filled with test liquid and the liquid lost by permeation during time periods of 24 h is determined by weighing for 15 consecutive days or until a peak has been established.

B.2 Sampling

Three test pieces of the hose shall be tested simultaneously. The test pieces shall be $300\text{ mm} \pm 3\text{ mm}$ long.

B.3 Equipment

The test equipment shall be as shown in [Figure B.1](#).

A well ventilated, draught-free test chamber, temperature controlled to $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$, shall be used for the testing.

The glass pipes shown in [Figure B.1](#) shall have a tight fit to the inside of the tested hose. The pipe in the lower end of the hose shall be impermeably tight in its lower end. The plug in the upper end of the upper pipe shall have a capillary canal that minimizes ventilation but allows air to replace fuel lost by permeation during the test.

B.4 Test procedure

Fill the test hoses with Test Liquid C as specified in ISO 1817:2011 and store them for 40 days in air at a temperature of $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

Empty the liquid out and assemble the test hoses and glass pipes as shown in [Figure B.1](#). Fill the hoses and pipes with Test Liquid C as specified in ISO 1817:2011 up to a level $70\text{ mm} \pm 5\text{ mm}$ above the upper end of the hose. Fit the plug with the capillary pipe.

Weigh the assembly with an accuracy of 0,01 g. Store the assembly in a vertical position for 24 h at standard laboratory temperature and weigh the assembly again. Record the loss of mass.

Empty the liquid out. Repeat the 24 h permeation test 15 times or until a maximum permeation has been established.

Calculate the average value of the three highest mass loss values recorded. Calculate the permeation rate, in grams per square metre per 24 h, based on this average mass loss, the inner diameter of the hose and the effective length of the hose between the inner ends of the glass pipes.