INTERNATIONAL STANDARD

ISO 7203-1

Third edition
2019-07

Fire extinguishing media — Foam concentrates —

Part 1:
Specification for low-expansion foam concentrates for top application to water-immiscible liquids

Agents extincteurs — Émulseurs —

Partie 1: Spécifications pour les émulseurs bas foisonnement destinés à une application par le haut sur les liquides non miscibles à l'eau

Reference number
ISO 7203-1:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

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 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 6, *Foam and powder media and firefighting systems using foam and powder.*

This third edition cancels and replaces the second edition (ISO 7203-1:2011), which has been technically revised.

The main changes compared to the previous edition are:

- addition of Part 4 containing specifications for Class A foam concentrates;
- extension of Clause 2;
- modification of Clause 12 to run two tests instead of one and take the average of both values instead of having just one datum;
- correction of figures;
- extension of Annex G by a scheme of a decision tree, and modification of the acceptable temperature range for testing fire performance;
- removal of Annex J: “Typical anticipated performance for various types of foam concentrate”.

A list of all parts in the ISO 7203 series can be found on the ISO website.

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

Firefighting foams are widely used to control and extinguish fires of Class B (flammable liquids) and/or Class A fuels (solid materials, usually of an organic nature) and for inhibiting reignition.

Foams can be used in combination with other extinguishing media, in particular halons, carbon dioxide and powders which are the subject of other International Standards, including, ISO 6183, ISO 7201-1, ISO 7201-2 and ISO 7202. A specification for foam systems can be found in ISO 7076.

Attention is drawn to Annex I, which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.

Fire extinguishing media — Foam concentrates —

Part 1:
Specification for low-expansion foam concentrates for top application to water-immiscible liquids

1 Scope

This document specifies the essential properties and performance of liquid foam concentrates used to make low-expansion foams for the control, the extinction and the inhibition of reignition of fires of water-immiscible liquids. Minimum performance on certain test fires is specified.

These foams are suitable for top application to fires of water-immiscible liquids. The foams that conform with ISO 7203-3 are also suitable for top application to fires of water-miscible liquids.

The foam concentrates can be suitable for use in non-aspirating sprayers or for subsurface application to liquid fires, but the requirements specific to those applications are outside the scope of this document.

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 304, *Surface active agents — Determination of surface tension by drawing up liquid films*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3219, *Plastics — Polymers/resins in the liquid state or as emulsions or dispersions — Determination of viscosity using a rotational viscometer with defined shear rate*

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 3506-1, *Mechanical properties of corrosion-resistant stainless steel fasteners — Part 1: Bolts, screws and studs*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 3734, *Petroleum products — Determination of water and sediment in residual fuel oils — Centrifuge method*

ISO 7203-2, *Fire extinguishing media — Foam concentrates — Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids*

ISO 7203-3, *Fire extinguishing media — Foam concentrates — Part 3: Specification for low-expansion foam concentrates for top application to water-miscible liquids*

BS 5117-1.3:1985, *Testing corrosion inhibiting, engine coolant concentrate ("antifreeze"). Methods of test for determination of physical and chemical properties. Determination of freezing point*

3 Terms and definitions

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

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

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1
characteristic value
value declared by the foam concentrate supplier for the chemical and physical properties and the performances of the foam, foam solution, and foam concentrate

3.2
25 % drainage time
time for 25 % of the liquid content of a foam to drain out

3.3
expansion
ratio of the volume of foam to the volume of the foam solution from which it was made

3.4
low-expansion
expansion (3.3) in the range 1 to 20, as applied to foam and to associated equipment, systems and concentrates

3.5
medium-expansion
expansion (3.3) in the range 21 to 200, as applied to foam and to associated equipment, systems and concentrates

3.6
high-expansion
expansion (3.3) greater than 200, as applied to foam and to associated equipment, systems and concentrates

3.7
foam
<firefighting> aggregate of air-filled bubbles formed from an aqueous solution of a suitable foam concentrate

3.8
concentrate
<foam> liquid that, when mixed with water in the appropriate concentration, gives a foam solution

3.9
protein foam concentrate
P
foam *concentrate* (3.8) derived from hydrolysed protein materials

3.10
fluoroprotein foam concentrate
FP
protein foam *concentrate* (3.8) with added fluorinated surface-active agents

3.11
synthetic foam concentrate
S
foam *concentrate* (3.8) based on a mixture of hydrocarbon surface-active agents and which can contain fluorocarbons with additional stabilizers

3.12
alcohol-resistant foam concentrate
AR
foam *concentrate* (3.8) resistant to breakdown when applied to the surface of alcohol or other water-miscible solvents

3.13
aqueous film-forming foam concentrate
AFFF
foam *concentrate* (3.8) based on a mixture of hydrocarbon and fluorinated surface-active agents with the ability to form an aqueous film on the surface of some hydrocarbons

3.14
film-forming fluoroprotein foam concentrate
FFFP
fluoroprotein foam *concentrate* (3.8) that has the ability to form an aqueous film on the surface of some hydrocarbons

3.15
foam solution
solution of foam *concentrate* (3.8) and water

3.16
forceful application
application of foam such that it falls directly onto the surface of a liquid fuel

3.17
gentle application
application of foam indirectly to the surface of a liquid fuel via a backboard, tank wall or other surface

3.18
sediment
insoluble particles in the foam concentrate

3.19
spreading coefficient
value calculated from the measured surface and interfacial tensions to indicate the ability of one liquid to spontaneously spread across the surface of another

3.20
temperature for use
maximum and minimum temperatures claimed by the manufacturer between which the foam concentrate is ready for use

3.21
fluorine-free foam concentrate
F3
foam *concentrate* (3.8) which does not form an aqueous film on hydrocarbon fuels, but which targets Class B performance at forceful application and which does not contain any fluorochemicals

3.22
Class A foam concentrate
foam *concentrate* (3.8) for use on *Class A fires* (3.23)

3.23
Class A fire
fire involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers

Note 1 to entry: Adapted from ISO 3941:2007, Clause 2.

Note 2 to entry: Class A fires involve solid materials, usually of an organic nature (such as vegetation, wood, cloth and paper), rubber, and some plastics, in which combustion can occur at or below the surface of the material, with or without the formation of glowing embers.

4 Grades and uses of foam concentrates

4.1 Grades

According to its test fire performance (see Clause 13), a foam concentrate shall be graded

- as Class I, II or III for extinguishing performance, and
- as Level A, B, C or D for burn-back resistance.

4.2 Use with sea water

If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and for use with sea water shall be identical.

5 Tolerance of foam concentrates to freezing and thawing

A foam concentrate that the supplier claims not to be adversely affected by freezing and thawing shall show no visual signs of either stratification or non-homogeneity before and after temperature conditioning in accordance with A.2, when tested in accordance with Annex B.

Foam concentrates complying with this clause shall be tested for compliance with the appropriate requirements given in other clauses of this document after freezing and thawing in accordance with A.2.1.

6 Sediment in foam concentrates

6.1 Sediment before ageing

Any sediment in the concentrate sampled in accordance with A.1 shall be dispersible through a 180 μm sieve, and the volume percentage of sediment shall be not more than 0,25 % when tested in accordance with Annex C.

6.2 Sediment after ageing

Any sediment in the concentrate aged in accordance with C.1 shall be dispersible through a 180 μm sieve, and the volume percentage of sediment shall be not more than 1,0 % when tested in accordance with Annex C.

7 Determination of viscosity

7.1 Newtonian foam concentrates

The viscosity of the foam concentrate at the lowest temperature for use claimed by the manufacturer shall be determined in accordance with ISO 3104. If the viscosity is greater than 200 mm^2s^{-1}, the container shall be marked as follows: “This concentrate can require special proportioning equipment”.

7.2 Pseudo-plastic foam concentrates

The viscosity of the foam concentrate shall be determined in accordance with Annex D. If the viscosity at the lowest temperature for use is greater than or equal to 120 mPa*s at 375/s, the container shall be marked as follows: “This concentrate can require special proportioning equipment”.

NOTE Pseudo-plastic foam concentrates are a particular class of non-Newtonian foam concentrates and have a viscosity that decreases with increasing shear rate at constant temperature.

8 pH of foam concentrates

8.1 pH limits

The pH of the foam concentrate, before and after temperature conditioning in accordance with A.2, shall be not less than 6,0 and not more than 8,5 at (20 ± 2) °C.

8.2 Sensitivity to temperature

The difference in pH between before and after temperature conditioning shall not be greater than 1,0 pH units.

9 Surface tension of the foam solution

9.1 Before temperature conditioning

The surface tension of the foam solution prepared from the concentrate, before temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be within ±10 % of the characteristic value when determined in accordance with E.2.

9.2 Temperature sensitivity

The surface tension of the foam solution prepared from the concentrate, after temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be determined in accordance with E.2.

The value obtained after temperature conditioning shall not be less than 0,95 times, or more than 1,05 times, the value obtained before temperature conditioning.

10 Interfacial tension between the foam solution and cyclohexane

10.1 General

Interfacial tension shall only be tested on foam agents which are declared by the manufacturer to be aqueous film-forming.

10.2 Before temperature conditioning

Before temperature conditioning in accordance with A.2, the difference between a) the interfacial tension between the foam solution prepared from the foam concentrate and cyclohexane (when determined in accordance with E.3) and b) the characteristic value for interfacial tension shall not exceed 1,0 mN/m or 10 % of the characteristic value, whichever is greater.

10.3 Temperature sensitivity

After temperature conditioning in accordance with A.2, the interfacial tension between the foam solution prepared from the foam concentrate and cyclohexane shall be determined in accordance with E.3.

The two values obtained before and after temperature conditioning shall not differ by more than 0,5 mN/m.

11 Spreading coefficient of the foam solution on cyclohexane

The spreading coefficient shall only be tested on foam agents which are declared by the manufacturer to be aqueous film-forming.

Before and after temperature conditioning in accordance with A.2, the spreading coefficient of the foam solution prepared from a concentrate claimed by the supplier to be film-forming shall be positive when calculated in accordance with E.4.

NOTE Foam concentrates conforming with this clause are more likely to be of type AFFF or FFFP than of type FP, P, F3 or S.

12 Expansion and drainage of foam

12.1 General

Either of the following tests shall be conducted twice with potable water and if appropriate twice with synthetic sea water, and the average of both series shall be recorded.

12.2 Expansion limits

The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water according to G.2.4, shall have an average expansion within either ±20 % of the characteristic value or ±1,0 of the characteristic value, whichever is greater, when tested in accordance with Annex F.

12.3 Drainage limits

The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water according to G.2.4, shall have a 25 % average drainage time within ±20 % of the characteristic value when tested in accordance with Annex F.

13 Test fire performance

The foam produced from the foam concentrate with potable water and, if appropriate, with the synthetic sea water according to G.2.4, shall have an extinguishing performance class and burn-back resistance level as specified in Table 1 when tested in accordance with G.2 and G.3, G.2 and G.4, or G.2 and G.3 plus G.4, as appropriate.

Table 1 — Maximum extinction times and minimum burn-back times

Durations expressed in minutes

Extinguishing performance class	Burn-back resistance level	Gentle application test (See G.4)		Forceful application test (See G.3)	
		Extinction time not more than	25 % burn-back time not less than	Extinction time not more than	25 % burn-back time not less than
I	A	Not applicable		3	10
	B	Not applicable	15	3	Not applicable
	C		10	3	
	D		5	3	
II	A	Not applicable		4	10
	B	Not applicable	15	4	Not applicable
	C		10	4	
	D		5	4	
III	B	5	15	Not applicable	
	C	5	10		
	D	5	5		

NOTE 1 There is no burn-back resistance Level A for Class III.

NOTE 2 Extinction time is the period from the start of foam application until the time when all flames are extinguished.

NOTE 3 25 % burn-back time is the period from the ignition of the burn-back pot fuel until 25 % of the tray is covered by sustained flames or by "flare up" flames.

14 Marking, packaging and specification sheet

14.1 Marking

14.1.1 The following information shall be marked on the shipping container:

a) designation (identifying name) of the concentrate and the words "low-expansion foam concentrate";

b) Class (I, II or III) and Level (A, B, C or D) of the foam concentrate and, if the concentrate complies with Clause 11, the words "aqueous film-forming";

c) recommended concentration for use (most commonly 1 %, 3 %, or 6 %);

d) any tendency of the foam concentrate to cause harmful physical effects, the methods required to avoid them and the first aid treatment if they occur;

e) recommended storage temperature and temperature of use;

f) if the concentrate complies with Clause 5, it shall be marked with the words; "Not affected by freezing and thawing"; or, if the foam concentrate does not comply with Clause 5, the words "Do not freeze";

g) nominal quantity in the container;

h) supplier's name and address;

i) batch number;

j) it shall be marked with the words "Not suitable for use with sea water" or "Suitable for use with sea water", as appropriate.

WARNING — It is extremely important that the foam concentrate, after dilution with water to the recommended concentration, shall not, in normal usage, present a significant toxic hazard to life in relation to the environment.

The recommended storage temperature and temperature of use are the same if the product is marked “Do not freeze”.

14.1.2 Markings on shipping containers shall be permanent and legible.

14.1.3 It is recommended that non-Newtonian concentrates be appropriately identified.

14.1.4 Foam concentrates in accordance with ISO 7203-2 shall also be marked “medium-expansion” or “high-expansion” or both.

14.1.5 Foam concentrates in accordance with ISO 7203-3 shall also be marked “alcohol resistant”.

14.2 Packaging

The packaging of the foam concentrate shall ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with the supplier's recommendations.

14.3 Specification sheet

14.3.1 If requested by the user, the supplier shall provide a list of the characteristic values.

14.3.2 If the foam concentrate is Newtonian and the viscosity at the lowest temperature for use is more than 200 mm^2/s when measured in accordance with ISO 3104, it shall be marked with the words, “This concentrate can require special proportioning equipment”.

14.3.3 If the foam concentrate is pseudo-plastic and the viscosity at the lowest temperature for use is greater than or equal to 120 mPa s at 375/s, it shall be marked, “This concentrate can require special proportioning equipment”.

14.3.4 It is recommended that non-Newtonian concentrates be appropriately identified.

Annex A
(normative)

Preliminary sampling and conditioning of the foam concentrate

A.1 Preliminary sampling

The sampling method shall ensure representative samples, whether taken from a bulk container or from a number of individual packages.

Store samples in fully closed containers.

NOTE Containers with a capacity of 20 l are suitable.

A.2 Conditioning of foam concentrate

A.2.1 If the supplier claims that the concentrate is not adversely affected by freezing and thawing, condition the concentrate sample through four cycles of freezing and thawing, generally as described in B.2, before conditioning in accordance with A.2.2. If the foam concentrate is adversely affected by freezing and thawing, it shall be conditioned according to A.2.2 without prior freezing and thawing.

A.2.2 Condition the concentrate in the sealed container for 7 d at (60 ± 2) °C, followed by 1 d at (20 ± 5) °C.

A.3 Subsequent testing

Test samples shall be prepared in accordance with A.1, or A.1 and A.2 as appropriate. Shake the sample container before sampling for further tests.

Annex B
(normative)

Determination of tolerance to freezing and thawing

B.1 Apparatus

The usual laboratory apparatus and, in particular, the following:

B.1.1 Freezing chamber, capable of achieving the temperatures required in B.2.

B.1.2 Polyethylene tube, approximately 10 mm in diameter, approximately 400 mm-long and sealed and weighted at one end, with suitable spacers attached.

Figure B.1 shows a typical form.

B.1.3 Measuring cylinder, glass, of 500 ml capacity, approximately 400 mm-high and approximately 65 mm in diameter, with a stopper.

B.2 Procedure

Set the temperature of the freezing chamber (B.1.1) to at least 10 °C below the freezing point of the sample, measured in accordance with BS 5117-1.3, excluding 5.2.

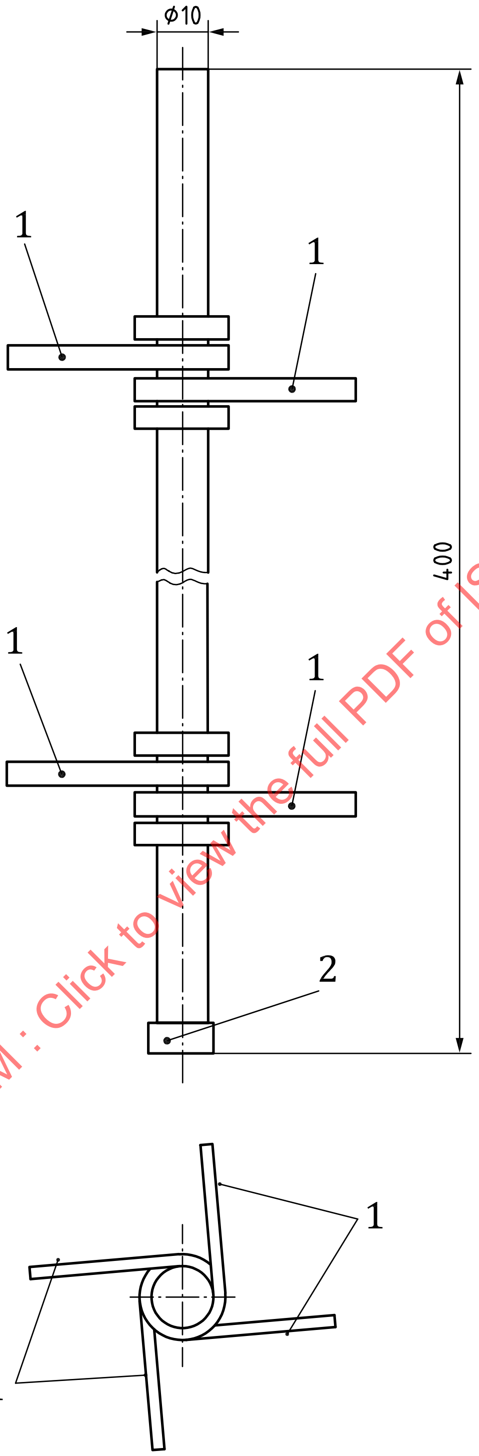
To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, the spacers ensuring it remains approximately on the central axis of the cylinder. Fill the cylinder and fit the stopper.

Place the cylinder in the freezing chamber, cool it and maintain at the required temperature for 24 h. At the end of this period, thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature of (20 ± 5) °C.

Repeat three times to give four cycles of freezing and thawing before testing.

Examine the sample for stratification and non-homogeneity.

Nominal dimensions in millimetres



Key

1 spacers (e.g. plastic cable strap)

2 mass at sealed end

Figure B.1 — Typical form of polyethylene tube

Annex C
(normative)

Determination of volume percentage of sediment

C.1 Sampling

Use a sample prepared in accordance with A.1. Ensure that any sediment is dispersed by shaking the sample container. Take two samples, testing one immediately and the other after ageing for (24 ± 2) h at (60 ± 2) °C in a filled container without access to air.

C.2 Apparatus

The usual laboratory apparatus and, in particular, the following:

C.2.1 Centrifuge tubes, graduated.

Centrifuge tubes complying with ISO 3734 are suitable.

C.2.2 Centrifuge, operating at (6 000 ± 600) m/s^2.

A centrifuge complying with ISO 3734 is suitable.

C.2.3 Sieve, of nominal aperture size 180 μm, complying with ISO 3310-1.

C.2.4 Wash bottle, plastic.

C.3 Procedure

Centrifuge each sample of the concentrate for (10 ± 1) min. Determine the volume of the sediment and record it as a percentage of volume of the centrifuged sample volume.

Wash the contents of the centrifuge tube (C.2.1) onto the sieve (C.2.3) and check whether or not the sediment can be dispersed through the sieve by the jet from the plastic wash bottle (C.2.4).

Annex D
(normative)

Determination of viscosity for pseudo-plastic foam concentrates

D.1 General

This annex specifies the procedure for determining the viscosity for pseudo-plastic foam concentrates. The procedure is described in ISO 3219.

NOTE Pseudo-plastic foam concentrates are a particular class of non-Newtonian foam concentrate and have a viscosity that decreases with increasing shear rate at constant temperature.

D.2 Viscosity determination

D.2.1 Apparatus

The usual laboratory apparatus and the following:

D.2.1.1 Rotational viscometer, in accordance with ISO 3219, with the following parameters:

— maximum shear stress of ≥75 Pa;

— maximum shear rate of ≥600/s.

The viscometer shall be fitted with a temperature control unit that can maintain the sample temperature within ±1 °C of the required temperature.

D.2.2 Test temperatures

The viscosity of the foam concentrate shall be measured from 20 °C down to, and including, the lowest temperature for use claimed by the manufacturer, in increments of 10 °C. Use a fresh sample for each temperature.

D.2.3 Viscosity measurement

If the sample contains suspended air bubbles, the sample shall be centrifuged for 10 min using the apparatus specified in C.2.1 and C.2.2 before the sample is placed in the apparatus.

The test should be performed according to the following test procedure.

a) Adjust the temperature control unit.

b) Set the gap.

c) Apply the sample.

d) Wait a minimum of 10 min (with no shear) to reach temperature equilibrium.

e) Pre-shear for 1 min at 600/s.

f) Wait 1 min without shearing.

g) Measure the shear stress for 10 s at each shear rate, starting at the lowest shear rate (preferably at 75/s).

Measure the shear stress at a minimum of eight different shear rates over the range 0/s to 600/s, e.g. 75/s, 150/s, 225/s, 300/s, 375/s, 450/s, 525/s and 600/s. Calculate the apparent viscosity, v, expressed in millipascal-seconds, as given in Formula (D.1):

$$v = 1\,000 \times \frac{s_1}{s_2} \tag{D.1}$$

where

s_1 is the shear stress, expressed in pascals;

s_2 is the shear rate, expressed in reciprocal seconds.

D.2.4 Results

Report the results as a table including test temperature, expressed in degrees Celsius, the shear rate, expressed in reciprocal seconds, the shear stress, expressed in reciprocal seconds, and apparent viscosity, expressed in millipascal-seconds.

Annex E
(normative)

Determination of surface tension, interfacial tension and spreading coefficient

E.1 Reagents and materials

E.1.1 Solution of foam concentrate, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696:1987 and with surface tension not less than 70 mN/m.

NOTE The solution can be made up in a 100 ml volumetric flask, using a pipette to measure the foam concentrate.

E.1.2 Cyclohexane, of purity not less than 99 %, for interfacial tension and spreading coefficient only.

E.2 Procedure for surface tension

Determine the surface tension of the solution (E.1.1) at a temperature of (20 ± 1) °C, using the ring method in accordance with ISO 304.

E.3 Procedure for interfacial tension

After measuring the surface tension in accordance with E.2, introduce a layer of cyclohexane (E.1.2) at (20 ± 1) °C onto the foam solution (E.1.1), being careful to avoid contact between the ring and the cyclohexane. Wait (6 ± 1) min and then measure the interfacial tension.

E.4 Spreading coefficient

Calculate the spreading coefficient, S, expressed in millinewtons per metre (mN/m), between the solution (E.1.1) and cyclohexane (E.1.2) from Formula (E.1):

$$S = Y_c - Y_f - Y_i \qquad \text{(E.1)}$$

where

Y_c is the surface tension of the cyclohexane, expressed in millinewtons per metre;

Y_f is the surface tension of the foam solution, expressed in millinewtons per metre;

Y_i is the interfacial tension between the foam solution and cyclohexane, expressed in millinewtons per metre.

Annex F
(normative)

Determination of expansion and drainage time

F.1 Apparatus

The usual laboratory apparatus and, in particular, the following:

F.1.1 Collecting vessel, plastic, cylindrical, of volume known to ±1 %, equipped with a bottom discharge facility, as shown in Figure F.1.

F.1.2 Foam collector, for expansion and drainage measurement, as shown in Figure F.2.

Stainless steel, aluminium, brass and plastic are suitable materials for the collection surface.

F.1.3 Foam-making nozzle, as shown in Figure F.3, which, when tested with water, has a flow rate of 11,4 l/min at a nozzle pressure of (630 ± 30) kPa [(6,3 ± 0,3) bar].

F.1.4 Foam solution tank, connected to the nozzle.

F.2 Temperature conditions

Carry out the tests under the following temperature conditions:

- air temperature: (20 ± 5) °C;
- foam solution temperature: (17,5 ± 2,5) °C.

F.3 Procedure

Check that the pipework and hose from the foam solution tank (F.1.4) to the nozzle (F.1.3) is completely full of solution. Set up the nozzle horizontally, directly in front of the foam collector (F.1.2), with the front of the nozzle (3 ± 0,3) m from the top edge of the collector. Wet the collecting vessel (F.1.1) internally and weigh it; record the mass as m_1. Set up the foam-making nozzle and adjust the nozzle pressure to give a flow rate of 11,4 l/min. Discharge foam and adjust the height of the nozzle so that the discharge strikes the collector centrally. Keep the nozzle horizontal. Stop foam discharge and rinse all the foam from the collector. Check that the foam solution tank is full. Start discharging foam and, after (30 ± 5) s to allow the discharge to stabilize, place the collecting vessel, with the discharge outlet closed, below the collector. As soon as the vessel is full, remove it from the collector, strike the foam surface level with the rim and start the clock. Weigh the full vessel; record the mass as m_2.

Calculate the expansion, E, as given in Formula (F.1):

$$E = \frac{V}{m_2 - m_1} \tag{F.1}$$

where

V is the volume, expressed in litres, of the collecting vessel (F.1.1);

m_1 is the mass, expressed in kilograms, of the empty vessel;

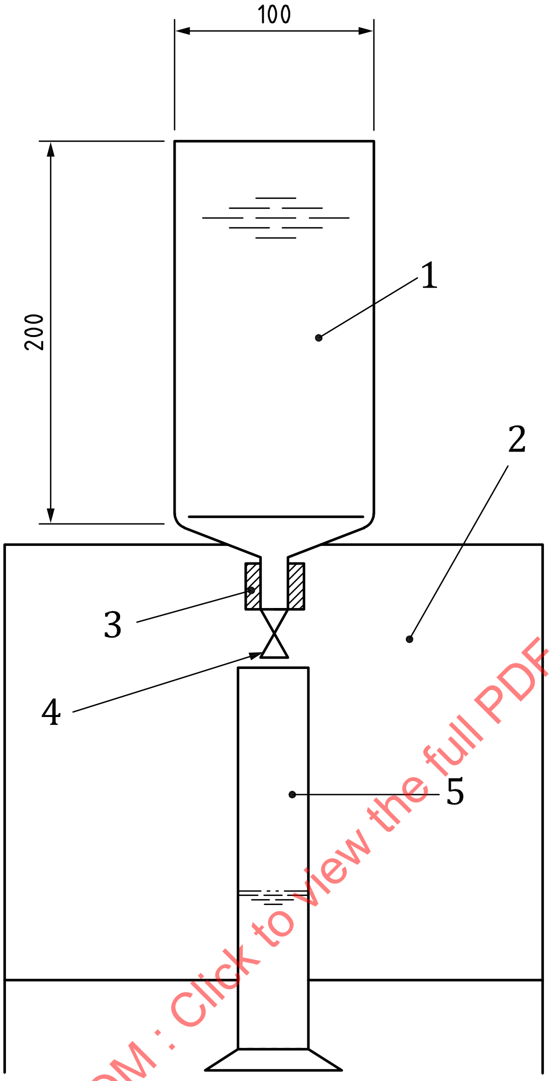
m_2 is the mass, expressed in kilograms, of the full vessel.

Assume that the density of the foam solution is 1,0 kg/l.

Open the drainage facility (see F.1.1) and collect the foam solution in a graduated measuring cylinder to measure the 25 % drainage time. Adjust the drainage facility such that the drained foam solution can flow out but the passage of foam is prevented.

NOTE This can be achieved by controlling the level of the liquid/foam interface in the plastic tube at the outlet.

Nominal dimensions in millimetres



Key

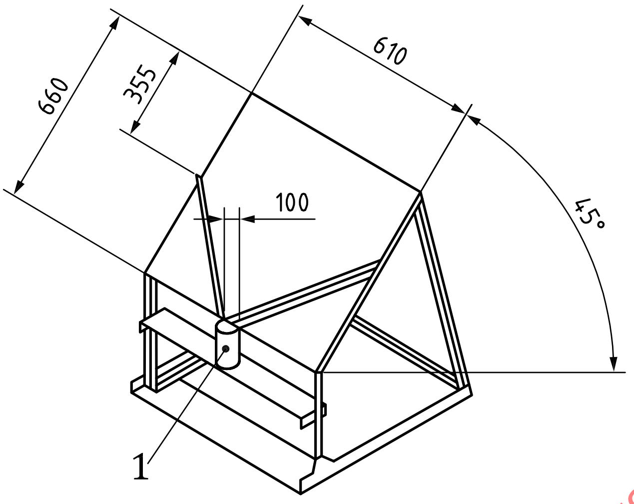
1	collecting vessel
2	stand
3	transparent tube, 30 mm to 50 mm-long, 6 mm to 8 mm bore
4	discharge outlet closure
5	graduated measuring cylinder

NOTE 1 The nominal base angle of the pot is 11°.

NOTE 2 Inserting an aperture size 125 µm-sieve between bottom outlet of the collecting vessel 1 and upper side of the discharge outlet closure 4, can effectively separate foam from draining liquid hence provide more stable results.

Figure F.1 — Collecting vessel for determination of expansion and drainage time

Nominal dimensions in millimetres

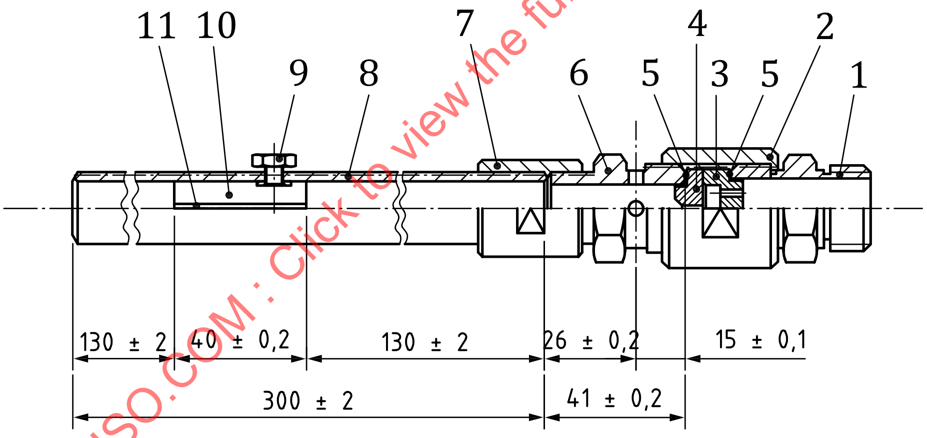


Key

1 collecting vessel

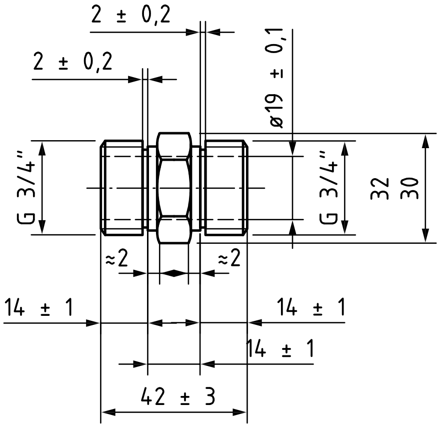
Figure F.2 — Foam collector for expansion and drainage measurement

Dimensions in millimetres

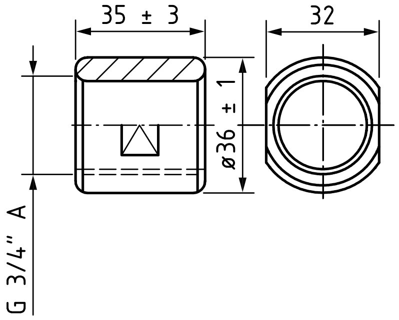


a) General arrangement

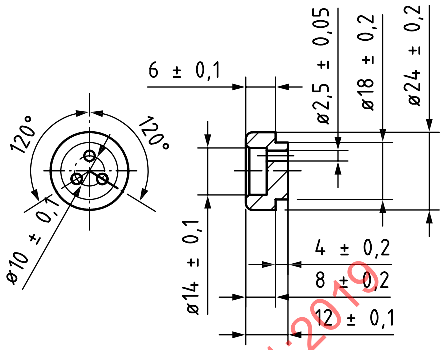
Dimensions in millimetres unless otherwise specified



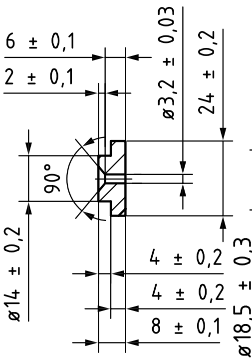
1)



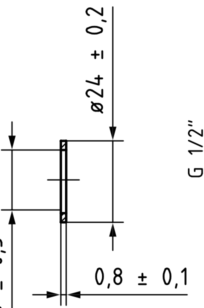
2)



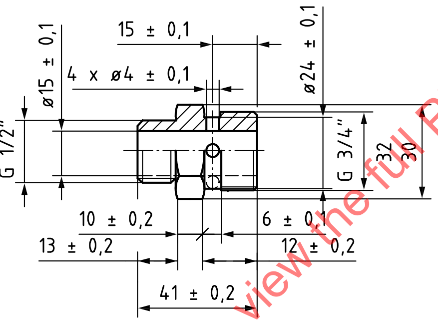
3)



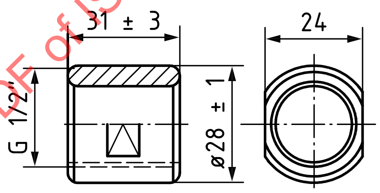
4)



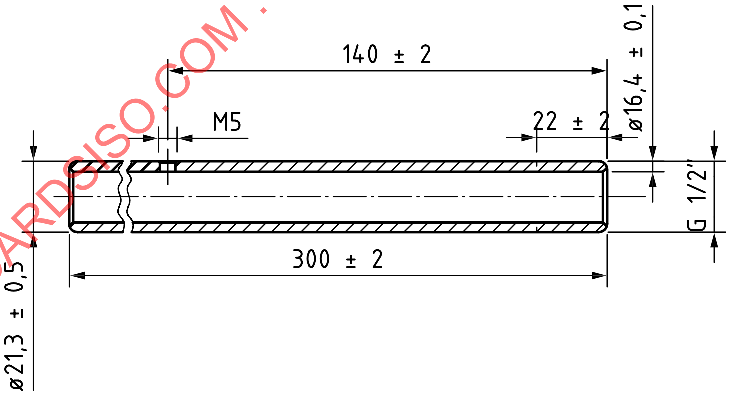
5)



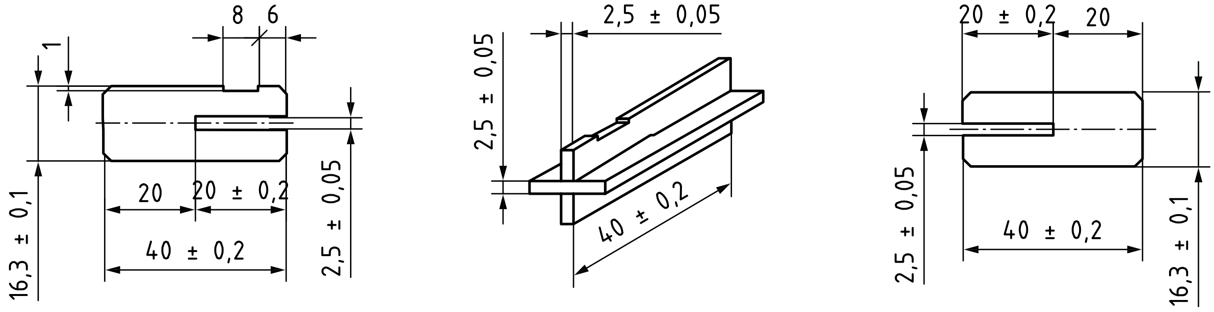
6)



7)



8)



9) **10-11)** **11)**

b) Details

NOTE The numbers underneath the figures refer to the numbers in Figure F.3 a).

Figure F.3 — Foam-making nozzle

Annex G
(normative)

Determination of test fire performance

G.1 General

This annex specifies the procedure for determining the test fire performance for low-expansion foam concentrates. The tests described in this annex are more expensive and time-consuming than the other tests described in this document. It is recommended that they be carried out at the end of the test programme, so as to avoid the expense of unnecessary testing.

Testing at temperatures above the range required by this document can result in poor performance and does not result in conformity to this document.

G.2 General conditions

G.2.1 Test series and criteria for success

G.2.1.1 Foam concentrates not compatible with sea water

Conduct two or three tests (the third test is not necessary if the first two are both successful or if neither is successful). The concentrate conforms to Clause 13 if two tests are successful.

G.2.1.2 Foam concentrates compatible with sea water

Conduct one test with potable water (test 1) and the other (test 2) with synthetic sea water of the composition given in G.5. If both are successful, repeat the test with the greater of the two extinction times (test 3). If the extinction times are identical, repeat the sea water test. If the repeat test is successful, the test series is complete.

If the repeat test is unsuccessful, carry out a further repeat test (test 4). If that test then fails, terminate that series.

If one of the first two tests (test 1 or 2) is not successful, repeat that test. If this repeat test is successful, conduct a second repeat test; otherwise terminate the test series. The concentrate conforms to Clause 13 if three tests are successful.

Figure G.1 gives a graphic version of the decision tree.

G.2.1.3 Decision tree fire test protocol

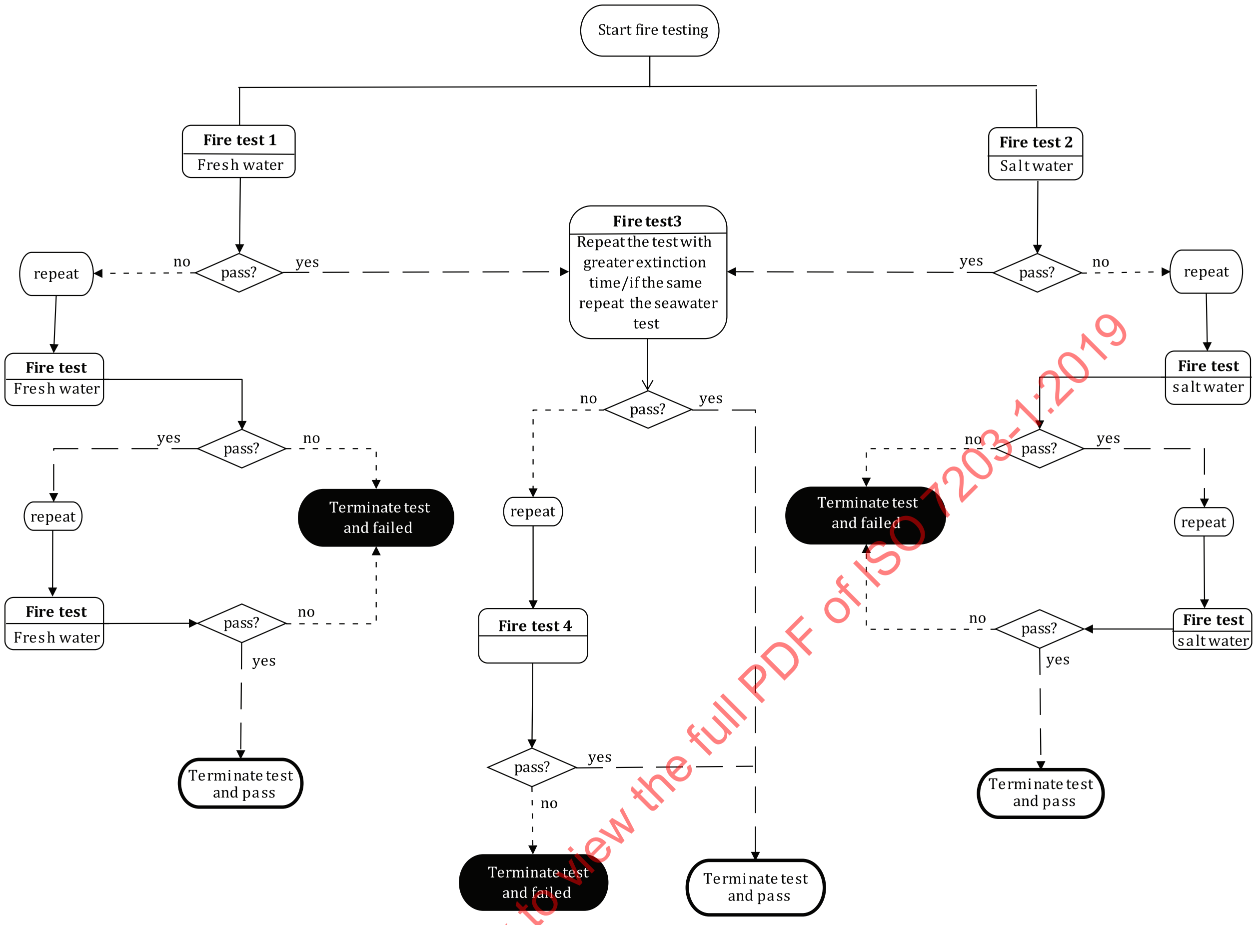


Figure G.1 — Decision tree for fire performance test on water-immiscible fuels

G.2.2 Temperature and wind speed

Carry out the tests under the following conditions:

- air temperature: (5 – 40) °C;
- fuel temperature: (17,5 ± 2,5) °C;
- water temperature: (17,5 ± 2,5) °C;
- foam solution temperature: (17,5 ± 2,5) °C;
- maximum wind speed in the proximity of the fire tray: 3 m/s.

NOTE If necessary, some form of wind-screen can be used.

G.2.3 Records

During the fire test, record the following:

a) location;

b) air temperature;

c) fuel temperature;

d) water temperature;

e) foam solution temperature;

f) wind speed;

g) 90 % control time;

h) 99 % control time;

i) extinction time;

j) 25 % burn-back time.

NOTE 90 % control time and burn-back time can be determined either visually by an experienced person or from thermal radiation measurements. Annex H gives details of a method suitable for low-expansion foams.

G.2.4 Foam solution

Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc.

Use potable water to prepare the foam solution and, if the supplier claims that the concentrate is suitable for use in sea water, make a second foam solution at the same concentration using synthetic sea water in accordance with G.5.

G.2.5 Fuel

Use an aliphatic hydrocarbon mixture having physical properties according to the following specification:

a) distillation range: 84 °C to 105 °C;

b) maximum difference between initial and final boiling points: 10 °C;

c) maximum aromatic content: 1 % mass fraction;

d) density at 15 °C: (700 ± 20) kg/m^3.

NOTE 1 The normal value of surface tension of the aliphatic hydrocarbon mixture measured in accordance with G.2.1 is 21 mN/m to 22 mN/m.

NOTE 2 Typical fuels meeting this specification are certain solvent fractions sometimes referred to as commercial heptane.

G.3 Forceful application fire test

G.3.1 Apparatus

The usual laboratory apparatus and the apparatus listed in G.4.1, except that the tray does not have a backboard.

G.3.2 Procedure

Set up the tray and nozzle generally in accordance with G.4.2 but position the nozzle so that the central part of the foam discharge falls directly on the fuel surface at a point (1 ± 0,1) m from the edge of the tray furthest from the nozzle (see Figure G.1).

Ignite the fuel not more than 300 s after adding it and allow to burn for (60 ± 2) s after full involvement of the surface of the fuel. Apply foam for (180 ± 2) s. If the fire is extinguished prior to the end of foam application, record the extinction time as the period from the start of foam application until the time when all flames are extinguished.

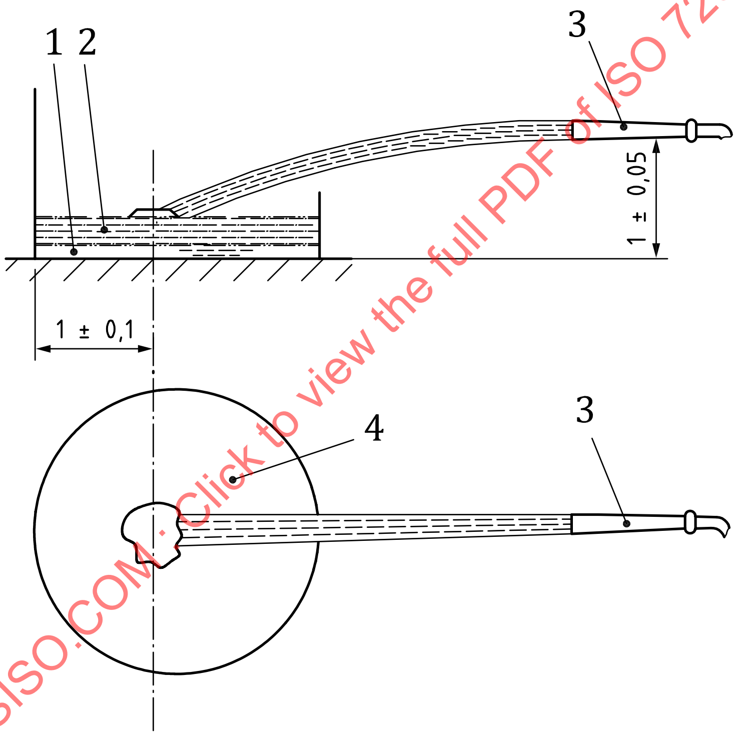
Stop applying foam and, if the fire is not extinguished, wait to see if any remaining flickers of flame are extinguished and record the extinction time.

(300 ± 10) s after stopping foam application, place the burn-back pot containing (2 ± 0,1) l of fuel in the centre of the tray and ignite. Visually estimate when 25 % of the tray is covered by sustained flames or by “flare up” flames (see NOTE), ignoring any faint, barely visible, or transient flames. Record the time elapsed since ignition of the burn-back pot as the 25 % burn-back time.

NOTE During the burn-back test, a “flare up” can occur, in which large flames can be sustained for periods typically ranging from 30 s to 3 min before decreasing in intensity.

If the burn-back at forceful application is less than 10 min the burn-back rating shall be evaluated in a separate fire test with gentle application.

Dimensions in metres



Key

1 water

2 fuel

3 foam-making nozzle

4 tray

Figure G.2 — Test fire arrangement for forceful application

G.4 Gentle application fire test

G.4.1 Apparatus

The usual laboratory apparatus and, in particular, the following.

G.4.1.1 Circular fire tray, stainless steel grade X5CrNi18-10 (ISO 3506-1: A2; ASTM: 304304; UNS: S30400), with dimensions as follows:

- internal diameter at rim: (2 400 ± 25) mm;
- depth: (200 ± 15) mm;
- nominal thickness of steel wall: 2,5 mm.

G.4.1.2 Backboard, vertical, stainless steel grade X5CrNi18-10 (ISO 3506-1: A2; ASTM: 304304; UNS: S30400), (1 ± 0,05) m high and (1 ± 0,05) m long and 2,5 mm thick, fitted as closely as possible along the top of the tray wall, or formed by an extension of the tray wall.

NOTE The tray has an area of approximately 4,52 m^2.

G.4.1.3 Foam-making equipment, as described in F.1.3.

G.4.1.4 Burn-back pot, stainless steel grade X5CrNi18-10 (ISO 3506-1: A2; ASTM: 304304; UNS: S30400), of nominal thickness 2,5 mm, diameter (300 ± 5) mm and height (250 ± 5) mm.

G.4.2 Test procedure

Place the tray directly on the ground and ensure that it is level. Set up the foam nozzle horizontally, (1 ± 0,05) m above the fuel level, in a position where the central part of the foam discharge strikes the centre axis of the backboard (0,5 ± 0,1) m above the fuel level (see Figure G.2). Clean the tray. Add approximately 90 l of water and check that the base is completely covered. Add (144 ± 5) l of fuel, to give approximately 150 mm between the fuel surface and the top of the tray wall.

Ignite the fuel not less than 3 min, and not more than 5 min, after adding it. Start foam application (60 ± 2) s after full involvement of the surface of the fuel. Readjust the nozzle to ensure that the jet continues to hit the centre of the backboard. Apply foam for (300 ± 2) s. If the fire is extinguished, record the extinction time as the period from the start of foam application and until the time when all flames are extinguished.

NOTE 1 If a foam has achieved a burn-back resistance Level A at extinguishing performance Class I or II on the forceful application test, it is not necessary to test it using gentle application.

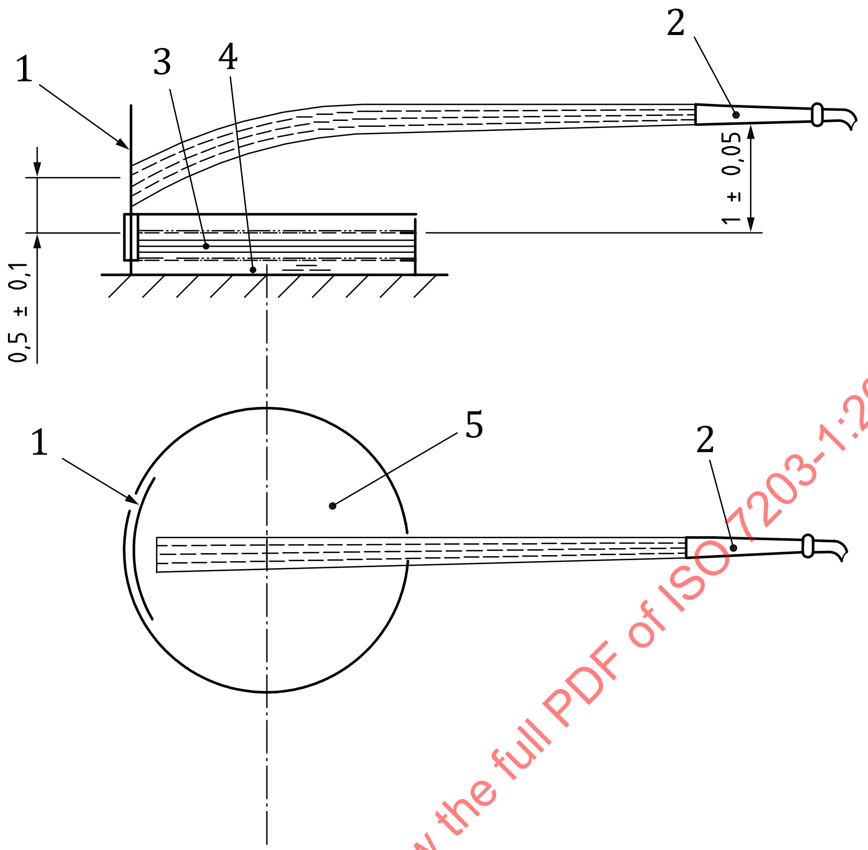
NOTE 2 Extinction is not required for foams that have successfully extinguished the forceful application test of G.3 without achieving burn-back resistance level A.

NOTE 3 Foams that do not extinguish the gentle application test of this clause can have a reduced burn-back resistance level because of flames remaining after foam application.

If the fire is not extinguished within (300 ± 2) s and the foam has not achieved extinguishing performance Class I or II, terminate the test.

After an additional (300 ± 10) s, place the burn-back pot, containing (2 ± 0,1) l of fuel, in the centre of the tray and ignite. Record the 25 % burn-back time.

Dimensions in metres



Key

1 backboard (non-integral type shown)
2 foam-making nozzle
3 fuel
4 water
5 tray

Figure G.3 — Test fire arrangement for gentle application

G.5 Synthetic sea water

Prepare the synthetic sea water by dissolving the components as given in Table G.1.

Table G.1 — Components of synthetic sea water

Percent mass fraction	Component	Chemical formula
2,50	Sodium chloride	$NaCl$
1,10	Magnesium chloride	$MgCl_2 \cdot 6H_2O$
0,16	Calcium chloride	$CaCl_2 \cdot 2H_2O$
0,40	Sodium sulfate	Na_2SO_4
95,84	Potable water	—

Annex H
(informative)

Description of a radiation measurement method

H.1 Evaluation

Radiation measurement is a convenient and objective way to monitor the performance of a foam during the fire performance test. It reduces the requirement for visual observations (except for flame flickers and the time necessary for complete extinction).

This annex describes the equipment and procedure used in a series of tests in one testing laboratory, and the methods used to interpret and present the results. See Reference [7] for additional details. The method is suitable for low- and medium-expansion foams but not for high-expansion foams.

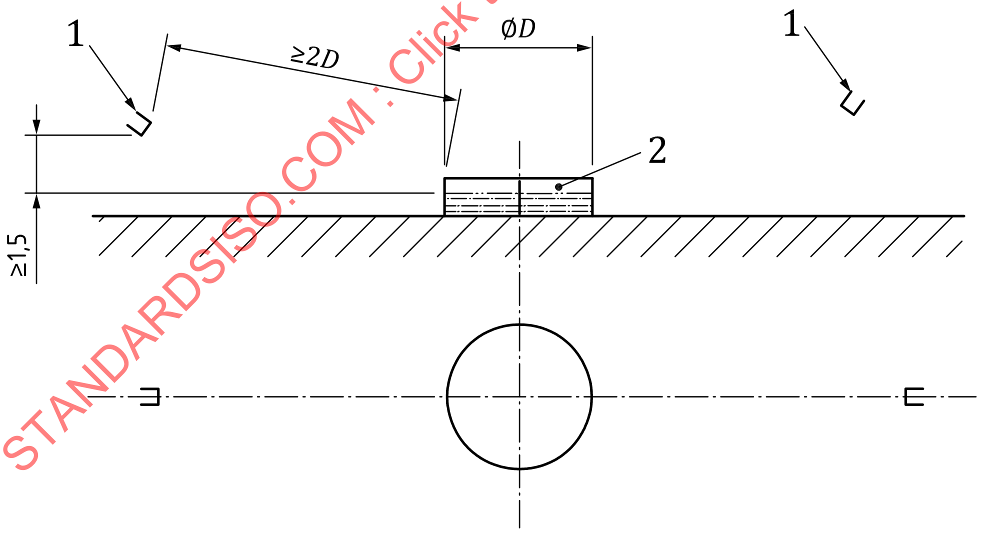
H.2 General arrangement of test

Radiometers should be placed diametrically in relation to the tray, as shown in Figure H.1. The distance between the meters and the rim of the tray should be not less than twice the diameter, *D*, of the tray; the height above the rim should be not less than 1,5 m.

NOTE The maximum distance is limited by the sensitivity of the radiometers.

Radiation levels should be recorded continuously or with intervals not exceeding 1 s.

Dimensions in metres



Key

1 radiometer

2 circular fire tray

Figure H.1 — Location of radiometers for recording heat radiation during fire performance tests

H.3 Technical data for radiometers

Two radiometers of the Gordon or Schmidt-Boelter[1] type should be used. The meters should be cooled with water. The temperature of the cooling water should be (30 ± 10) °C, held constant during the measurements.

The radiometers absorb at least 90 % of the incoming radiation within the range of wavelengths 0,6 µm to 15 µm.

For a fully developed fire, the radiometer reading should be not less than 0,6 times the full scale.

The radiometers should have maximum non-linearity of ±3 % of nominal range of measurement, and a maximum response time of 2 s (up to 63 % of full response).

A radiometer with a protective glass may be used, provided that the requirements on spectral sensitivity are satisfied. If it is considered necessary, the utilization of the range of measurement specified above may be changed if the radiometers have a better linearity. Less than 40 % utilization is not advisable, as the influence of background radiation can have too great an effect.

H.4 Procedure

Correct the output from the two radiometers by deducting the background radiation recorded from 5 s to 10 s after the moment of complete extinction.

Determine the average value of the two radiometers.

Determine the average value of time of recorded radiation during the 25 s period beginning at 30 s before the start of the foam application and ending 5 s before the start of the foam application (see Figure H.2).

Determine the relative radiation by dividing the output by the average value obtained in accordance with the preceding paragraph.

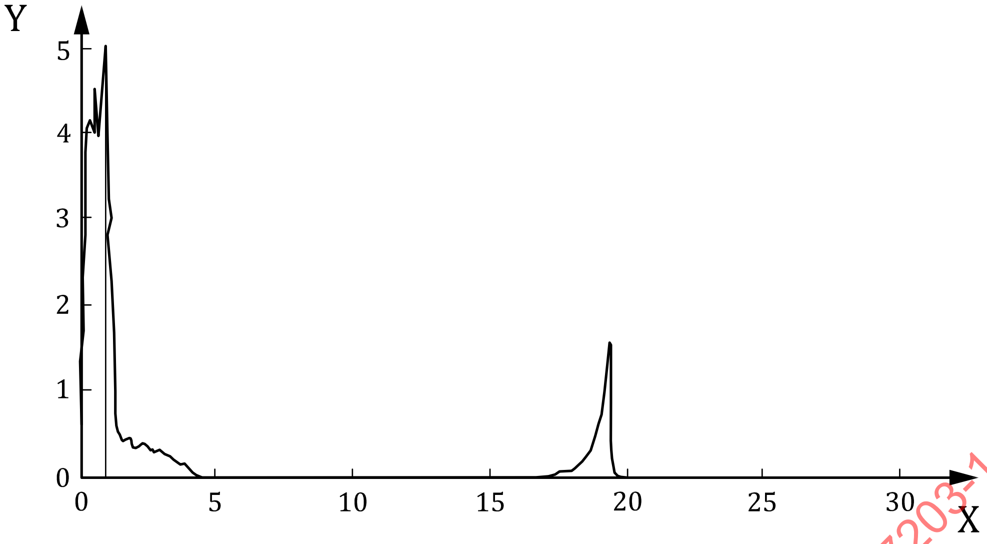
The instantaneous radiation values are subject to random fluctuation. A smoother curve, which facilitates interpretation, can be obtained by plotting radiation values averaged over a period of ±5 s for each time value.

The adjusted relative radiation is shown for the extinguishing test in Figure H.3 and for the burn-back test in Figure H.4. A control of 90 % is equivalent to the relative radiation 0,1.

The description above implies that computer-controlled measuring practices should be applied.

---

[1] The Medtherm Series 64 supplied by Medtherm Corp., PO Box 412, Huntsville, AL, USA is an example of a suitable product (apparatus) available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product (apparatus).



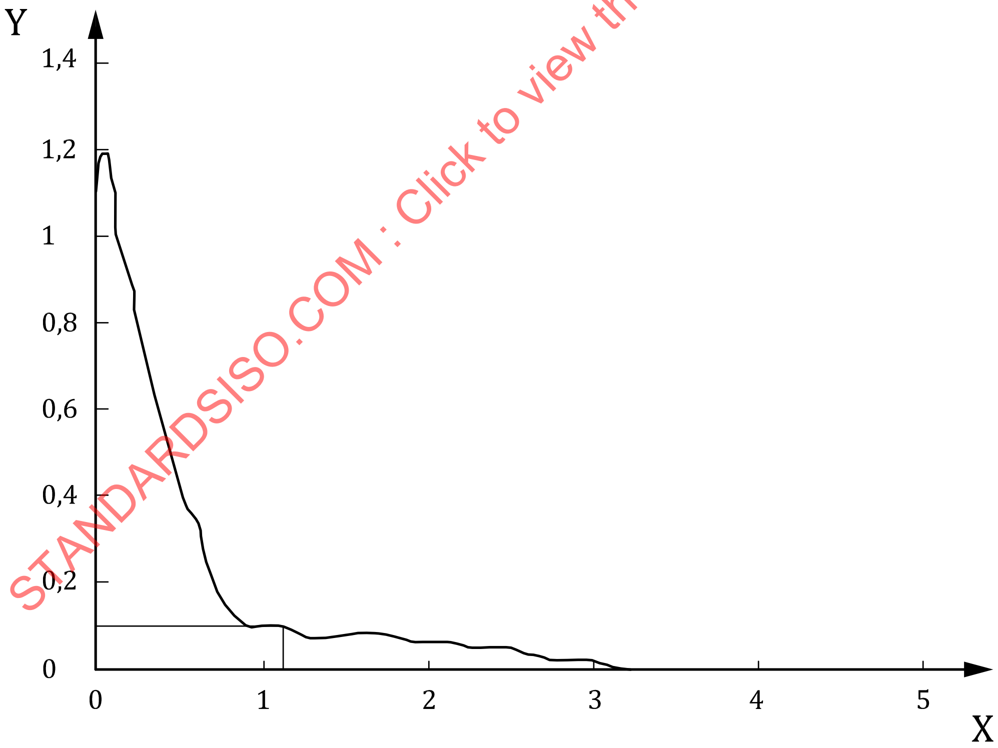
Key

X time, expressed in minutes

Y radiation, expressed in kilowatts per square metre

NOTE Foam application starts at 1 min and stops at 5 min. The burn-back test starts at 15 min.

Figure H.2 — Typical absolute radiation levels throughout a test



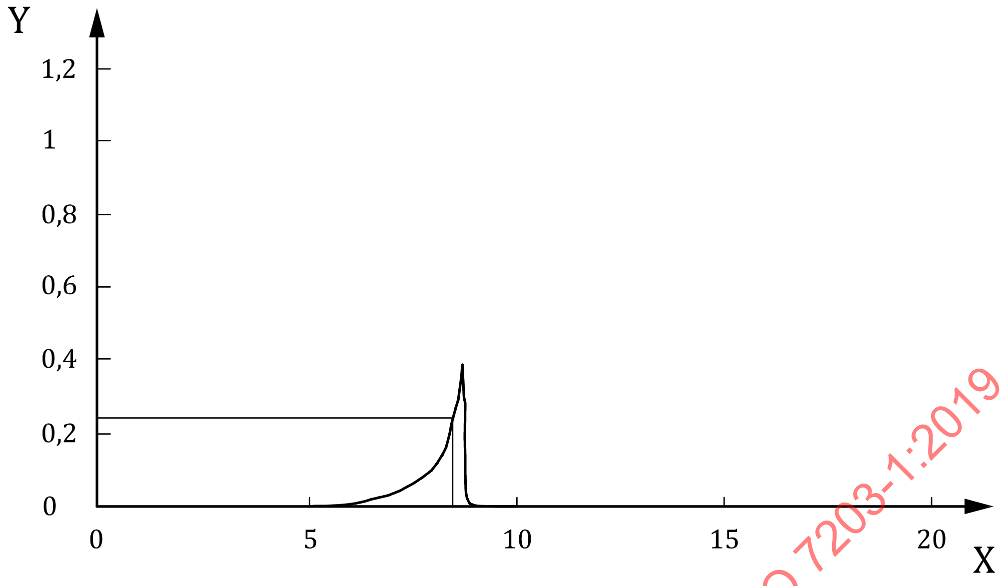
Key

X time, expressed in minutes

Y relative radiation, dimensionless

NOTE Foam application starts at 0 min and stops at 4 min. 90 % control is achieved at about 1 min 8 s.

Figure H.3 — Typical relative radiation levels during extinction



Key

X	time, expressed in minutes
Y	relative radiation, dimensionless

NOTE Burn-back starts at 0 min. 25 % burn-back is at about 8 min 30 s.

Figure H.4 — Typical relative radiation levels during burn-back

Annex I
(informative)

Compatibility

I.1 Compatibility between foam concentrates and fire extinguishing powders

Where foam and powder might be applied simultaneously or successively, users should ensure that any unfavourable interaction does not cause an unacceptable loss of efficiency.

The small-scale fire-test detailed in Annex H may be used to evaluate the compatibility of foam concentrates and powders.

This test is carried out on the foam in question, and then repeated after the fuel has been covered in powder as follows.

(500 ± 1) g powder is weighed into a 180 µm sieve, placed on a sheet of paper or cardboard.

The sieve is held over the fuel, and the cardboard or paper removed.

The powder is then evenly distributed over the surface of the fuel from a height of (150 ± 10) mm.

The fuel is lit not more than 60 s after the powder has been spread over the surface of the fuel.

If the increase in extinction time is equal to or greater than 25 % longer than the result without powder, then the combination of powder and foam may be considered to lead to an unacceptable loss of efficiency.

Likewise, a reduction in burn-back time by 25 % or more when powder is used indicates that the foam and powder are incompatible.

I.2 Compatibility between foam concentrates

Foam concentrates of different manufacture, grade or class are frequently incompatible and should not be mixed, unless it has first been established that an unacceptable loss of efficiency does not result.

Annex J
(informative)

Small-scale fire test

J.1 General

Annex G describes large-scale fire tests for type approval. This annex describes a small-scale fire test which can be suitable for quality control purposes.

The test should not be run outdoors as the results are very sensitive to any kind of air flow.

To analyse the compatibility between foams and dry chemical powder, this test should be repeated according to the procedure given in J.3.

J.2 Apparatus

J.2.1 Fire tray, circular, brass, as shown in Figure J.1, with a turned-over rim and a drain point with valve at the centre of the conical base, with dimensions as follows:

— internal diameter at rim: (565 ± 5) mm;

— height of vertical wall: (150 ± 5) mm;

— height of conical base: (30 ± 5) mm;

— thickness of vertical wall: (1,2 ± 0,2) mm.

NOTE The tray has an area of approximately 0,25 m^2.

The fire tray is supported approximately 1 m above the ground on a steel frame with four legs. The tray is normally placed beneath a suitable fume extraction hood that can extract the smoke without interfering with the fire.

J.2.2 Burn-back pot, brass, with a turned-over rim, fitted with four studs at the base to give an overall height of (96 ± 2) mm, with dimensions as follows:

— internal diameter at rim: (120 ± 2) mm;

— internal depth: (80 ± 2) mm;

— thickness of wall: (1,2 ± 0,2) mm.

A chain fitted to the rim allows lifting of the burn-back pot using a metal rod.

J.2.3 Foam-making nozzle, as shown in Figure J.2, which has a nominal flow rate of 5,0 l/min at 700 kPa (7 bar) when tested with water.

It is fitted with an adjustable collar to allow ejection of the foam from the side of the nozzle and, thus, variation of the foam flow rate through the outlet. The foam flow rate can also be controlled by adjusting the pressure applied to the foam solution.

J.2.4 Fuel, consisting of an aliphatic hydrocarbon mixture as specified in G.2.5.

J.3 Test procedure

J.3.1 Test conditions

Carry out the test under the following conditions:

- air temperature: (15 ± 5) °C;
- fuel temperature: (17,5 ± 2,5) °C;
- foam solution temperature: (17,5 ± 2,5) °C.

J.3.2 Set-up

Position the foam nozzle horizontally with the by-pass holes in the adjustable collar facing downwards at a height of (150 ± 5) mm above the rim of the fire tray (see Figure J.1).

Prepare the foam solution following the recommendations of the supplier for concentration, maximum premix time, compatibility with test equipment, avoiding contamination by other types of foam, etc.

Set the nozzle pressure to 700 kPa (7 bar) and the foam flow rate to (0,75 ± 0,025) kg/min by adjusting the collar and, if necessary, reducing the nozzle pressure. It is convenient to collect the foam in a tared vessel for 6 s and to weigh it to calculate the flow rate.

Position the nozzle while keeping it horizontal so that the foam strikes the centre of the fire tray. Shut off the foam discharge. Clean the tray and close the drain valve.

J.3.3 Fire test

Place (9 ± 0,1) l of fuel in the tray, and (0,3 ± 0,01) l of fuel in the burn-back pot.

(120 ± 2) s after fueling, ignite the fuel and allow to burn for (60 ± 2) s before starting foam application. Apply foam for (120 ± 2) s to the centre of the tray and record the times from the start of foam application to 90 % control, 99 % control, and complete extinction.

At the end of foam application, ignite the fuel in the burn-back pot, and (60 ± 2) s after the end of foam application, lower the pot into the centre of the tray with a metal rod, taking care not to allow foam to enter the pot. Record as the burn-back time the time taken from positioning of the burn-back pot to permanent full re-involvement of the fire tray surface in flames.