INTERNATIONAL STANDARD

ISO 7203-2

Third edition
2019-07

Fire extinguishing media — Foam concentrates —

Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids

Agents extincteurs — Émulseurs —

Partie 2: Spécifications pour les émulseurs moyen et haut foisonnements destinés à une application par le haut sur les liquides non miscibles à l'eau

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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 (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 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 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 7203-2:2011), which has been technically revised.

The main changes compared to the previous edition are:

— addition of Clause 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 having just one datum;

— correction of several figures;

— the extension of Annex H by a scheme of a decision tree and the modification of the acceptable temperature range for testing fire performance;

— removal of Annex "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 K, which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.

Fire extinguishing media — Foam concentrates —

Part 2: Specification for medium- and high-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 medium- or high-expansion foams or both 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 liquid. Those foams that comply with ISO 7203-1 are also suitable for top application to fires of water-immiscible liquids.

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 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 7203-1, *Fire extinguishing media — Foam concentrates — Part 1: Specification for low-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 is targeting 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
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 Classification and uses of foam concentrates

4.1 Classification

The foam concentrate shall be classified as medium- or high- expansion or both and shall comply with the appropriate requirements.

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 sea water shall be identical.

5 Tolerance of the foam concentrate to freezing and thawing

Before and after temperature conditioning in accordance with A.2, the foam concentrate, if claimed by the supplier not to be adversely affected by freezing and thawing, shall show no visual sign of stratification and non-homogeneity, 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 the foam concentrate

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 “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 “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 the foam concentrate

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

12.1 Medium-expansion foam concentrates — 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 of H.2.4, shall have an expansion of not less than 21 when tested in accordance with Annex F.

12.2 High-expansion foam concentrate — 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 of I.2.4, shall have an expansion of not less than 201 when tested in accordance with Annex G.

13 Test fire performance

The foam produced from the foam concentrate with potable water, and if appropriate, with the synthetic sea water according to H.2.4 and/or I.2.4, shall have an extinguishing performance class and burn-back resistance level as specified in Table 1 when tested in accordance with Annex H or Annex I, or both, as appropriate.

Table 1 — Test fire performance

Types of expansion foam	Medium-expansion foam	High-expansion foam
Extinction time, seconds	Not more than 120	Not more than 150
1 % burn-back time, seconds	Not less than 30	Not applicable

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, as appropriate, the words "medium" or "high", or "medium and high" and "expansion foam concentrate";

b) 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 should occur;

e) recommended storage temperature and temperature of use;

f) if the concentrate complies with Clause 5, 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) 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.

NOTE 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 complying with ISO 7203-1 shall also be marked “low-expansion”.

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 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 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.

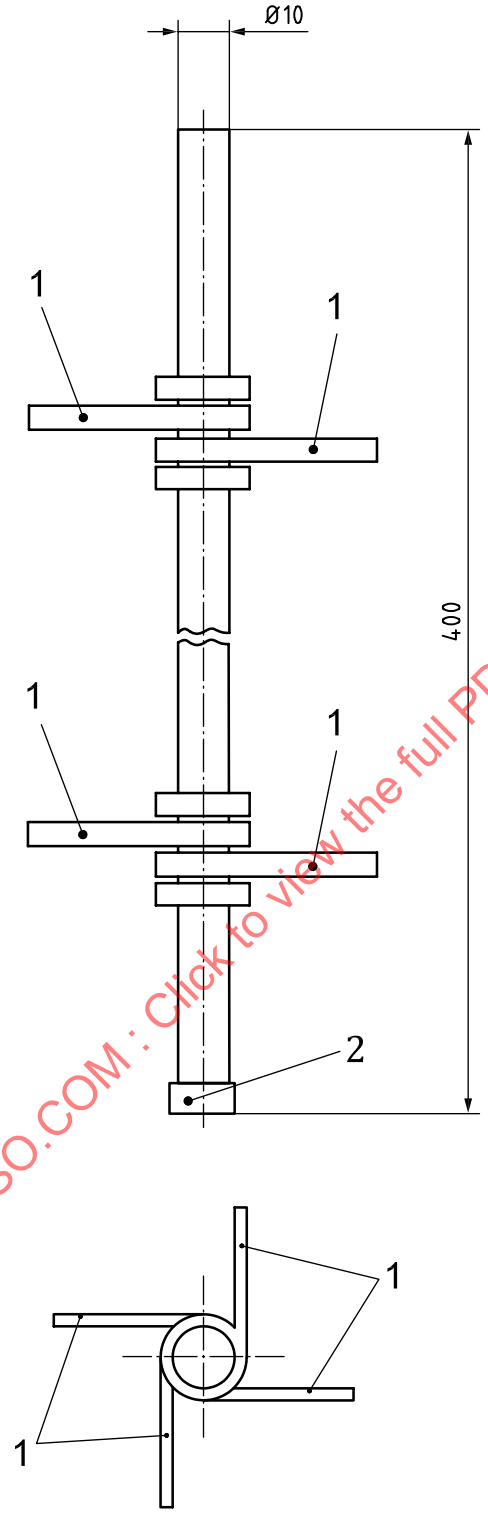
To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, the spacers ensuring it remains approximately on the central 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 the sediment can or cannot 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 gives 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 which 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 which 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).

h) 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, 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 the 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):

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

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 for medium-expansion foam concentrates

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-making equipment, with nozzle as shown in Figures F.2 and F.3 which, when tested with water, has a flow rate of between 3,1 l/min and 3,4 l/min at a nozzle pressure of (500 ± 10) kPa [(5,0 ± 0,1) bar].

F.1.3 Stop watch, or other timing device.

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

F.3.1 Prepare two samples of foam concentrate in accordance with Annex A. Condition one in accordance with Annex A.

F.3.2 Carry out the remainder of the procedure for each sample on the same day. Prepare a foam solution of each sample following the supplier's recommendations for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to make up the foam solutions and, if the supplier claims that the concentrate is suitable for sea water, also make foam solutions at the same concentration using the synthetic sea water prepared in accordance with F.4. The concentration used in synthetic sea water shall be the same as the concentration used in potable water.

F.3.3 Wet the vessel internally and weigh it. Record the mass as m_1. Set up the foam equipment and adjust the nozzle pressure to within the range (500 ± 10) kPa [(5,0 ± 0,1) bar] to give a flow rate between 3,1 l/min and 3,4 l/min. With discharge facility closed, collect foam, taking care that voids are not formed in the vessel, and start the timing device when the vessel is half full. As soon as the vessel is full, stop

collecting foam and strike the foam surface level with the rim, and clean the exterior surface of the vessel of foam. Weigh the vessel and record the mass as m_2.

Calculate the expansion, E, from Formula (F.1):

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

where

V is the vessel volume, expressed in litres;

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 and measure the 25 % and 50 % drainage time. Determine the drainage either by placing the vessel on a set of scales and recording the mass loss or by collecting the drained foam solution in a measuring cylinder. Adjust the drainage facility such that the drained foam solution can flow out but the passage of foam is prevented. For each sample carry out the test three times.

F.3.4 For each sample, calculate the mean values of the three tests for the expansion and 25 % and 50 % drainage time.

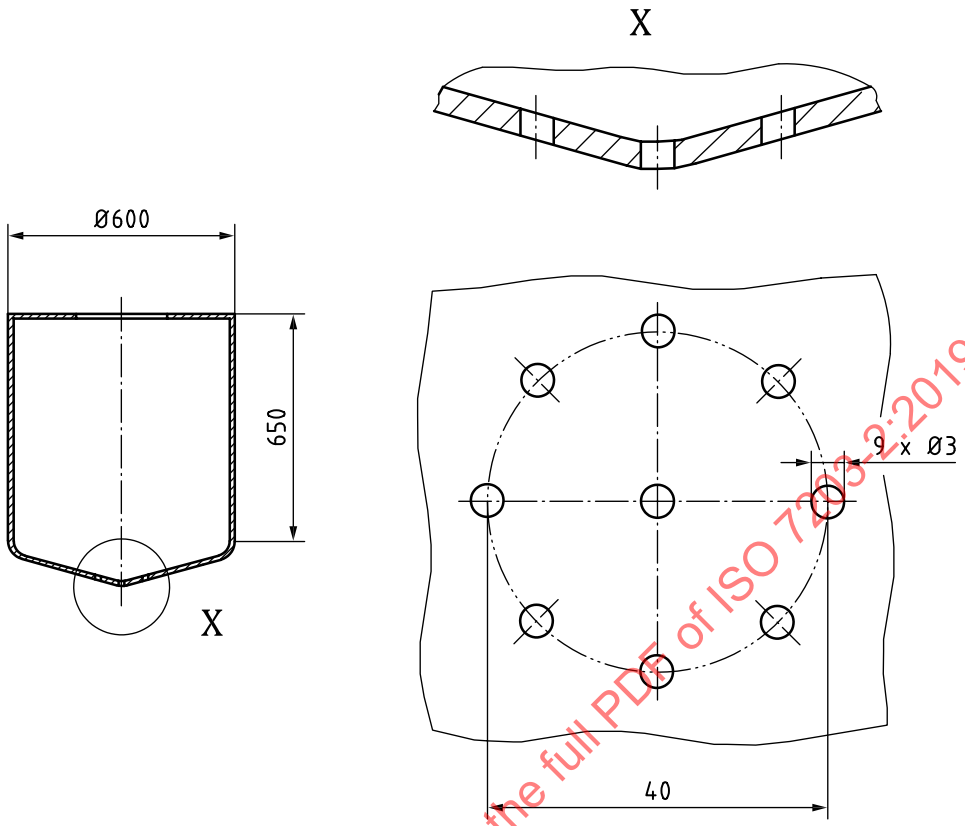
F.4 Synthetic sea water

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

Table F.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	—

Dimensions in millimetres



Key

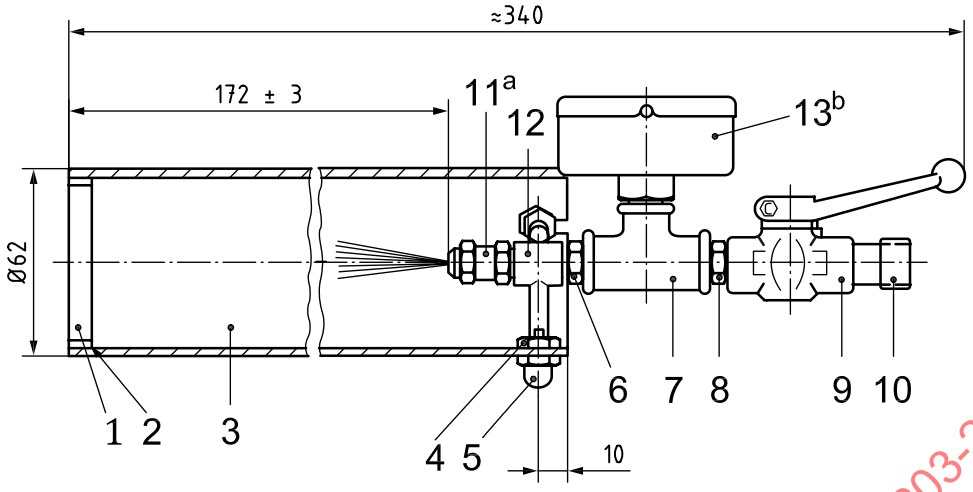
1 bottom discharge facility

NOTE 1 All dimensions are nominal.

NOTE 2 Nominal volume is 200 l.

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

Dimensions in millimetres



Key

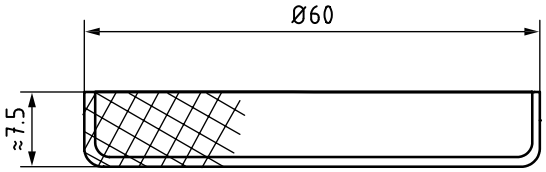
		Number	Size
1	ring	1	
2	net	1	
3	pipe	1	
4	nut	1	
5	acorn nut	1	M6M 6
6	nipple	3	MHM 6
7	tee	1	G-1/4″-1/8″
8	nipple	1	G-1/4″
9	valve	1	G-1/4″
10	nipple	1	G-1/4″
11	nozzle	1	G-1/4″-3/8″
12	collar	1	G-1/8″ GG3,5
13	pressure gauge	1	12
		1	G-1/4″ 1-1,6 MPa D = 40

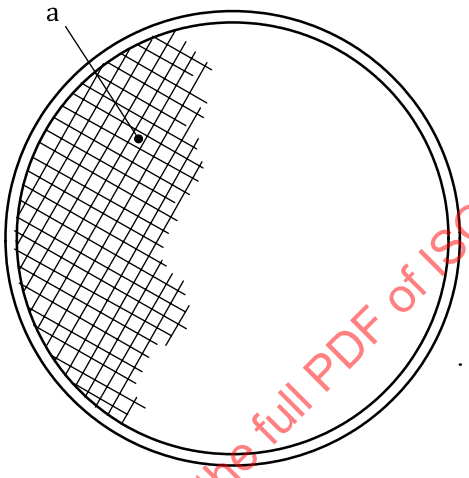
a The nozzle shall be coaxial with the barrel of the foam branch.

b The pressure gauge shall be positioned so as not to interfere with the air inlet of the branch.

Figure F.2 — Medium-expansion foam-making nozzle

Dimensions in millimetres





Key

[a] The screen shall be 24 mesh per inch, with a wire diameter of 0,4 mm.

Figure F.3 — Net (2)

Annex G
(normative)

Determination of expansion and drainage time for high-expansion foam concentrates

G.1 Apparatus

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

G.1.1 Collecting vessel (see Figure G.1), of volume, *V*, of approximately 500 l and that is accurately known to ±5 l, equipped with a drain at the base.

G.1.2 High-expansion foam generator, with nozzle as shown in Figures G.2, G.3 and G.4 that, when tested with water, has a flow rate of between 6,0 l/min and 6,2 l/min at a nozzle pressure of (500 ± 10) kPa [(5,0 ± 0,1) bar].

G.1.3 Stop watch, or other timing device.

G.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.

G.3 Procedure

G.3.1 Prepare two samples of foam concentrate in accordance with Annex A. Condition one in accordance with Annex A.

G.3.2 Carry out the remainder of the procedure for each sample on the same day. Prepare a foam solution of each sample following the supplier's recommendations for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to make up the foam solutions and, if the supplier claims that the concentrate is suitable for sea water, also make foam solutions at the same concentration using the synthetic sea water prepared in accordance with G.4. The concentration used in synthetic sea water shall be the same as the concentration used in potable water.

G.3.3 Wet the vessel internally and weigh it. Record the mass as m_1. Set up the foam equipment and adjust the nozzle pressure within the range (500 ± 10) kPa [(5,0 ± 0,1) bar] to give a flow rate of between 6,0 l/min and 6,2 l/min. With the drain at the base closed, collect foam, taking care that voids are not formed in the vessel. Start the timing device when the vessel is half full. As soon as the vessel is full, stop

collecting foam, strike the foam surface level with the rim, and clean the exterior surface of the vessel of foam. Weigh the vessel and record the mass as m_2.

Calculate the expansion, E, from Formula (G.1):

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

where

V is the vessel volume, expressed in litres;

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 and measure the 25 % and 50 % drainage time. Determine the drainage either by placing the vessel on a set of scales and recording the mass loss or by collecting the drained foam solution in a measuring cylinder. Adjust the drainage facility such that the drained foam solution can flow out but the passage of foam is prevented. For each sample, carry out the test three times.

G.3.4 For each sample, calculate the mean values of the three tests for the expansion and the 25 % and 50 % drainage time.

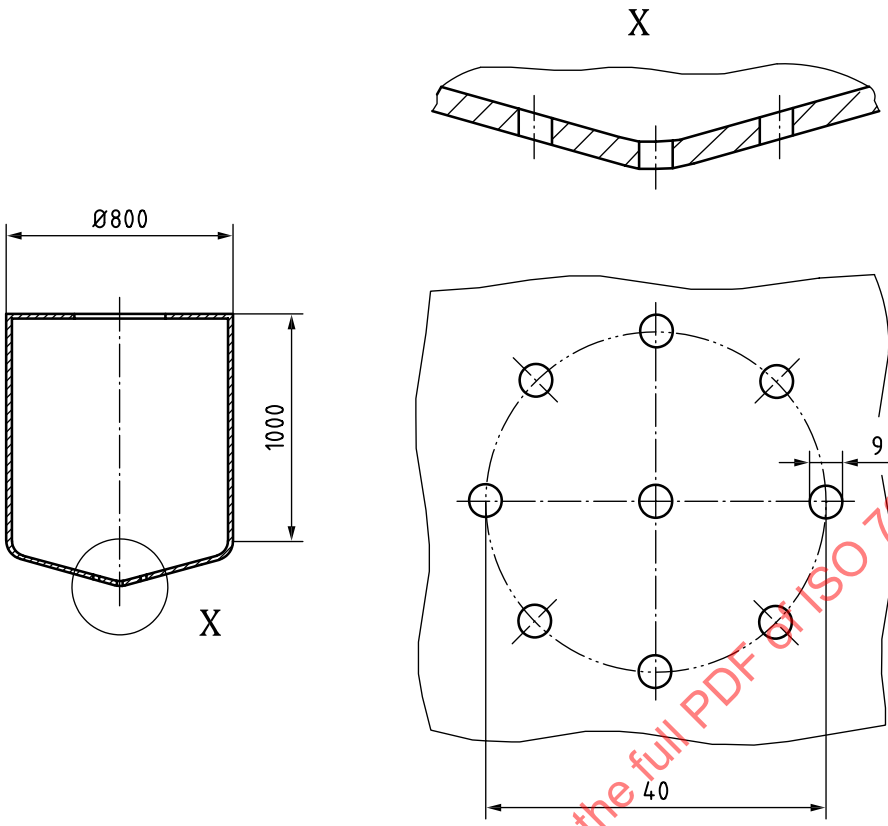
G.4 Synthetic sea water

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	—

Dimensions in millimetres



Key

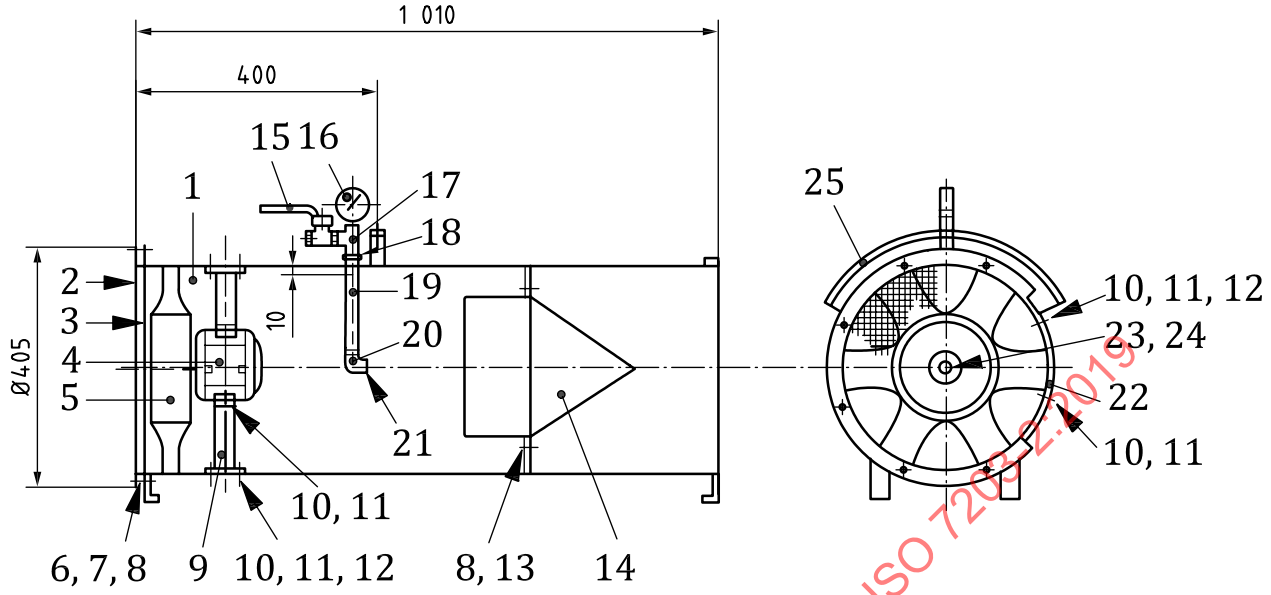
1 bottom discharge facility

NOTE 1 All dimensions are nominal.

NOTE 2 Nominal volume is 500 l.

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

Dimensions in millimetres

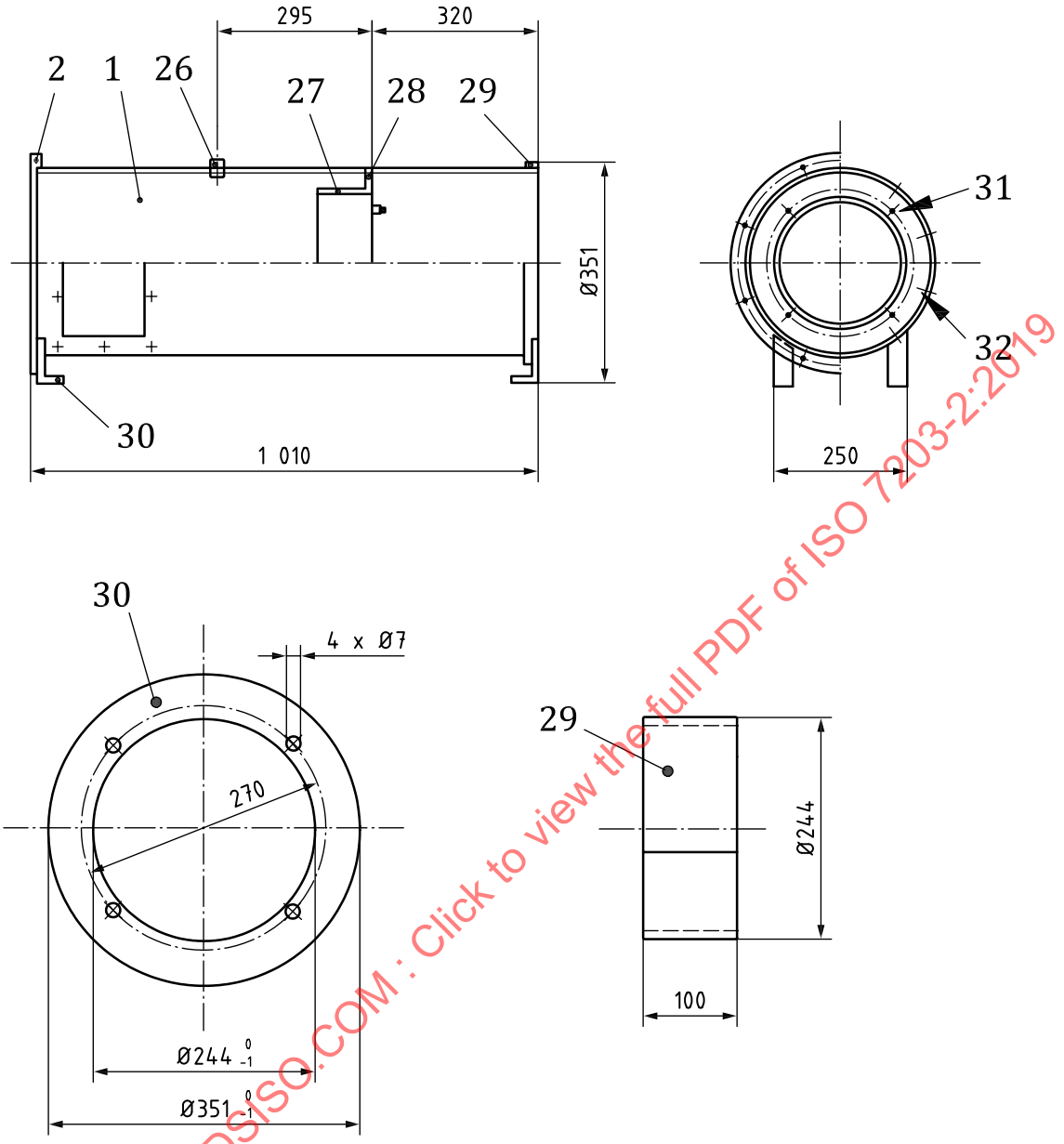


Key

		Number	Dimension	Material
1	housing	1		
2	ring	1		
3	perforated plate	1		
4	motor (1 400 rpm; 0,3 HP; 50 Hz; 3 ph; 380 VAC)	1	1 mm	SS 1312
5	fan (1 400 rpm; 7,5 mm water, 2 000 m^3/h)		Ø405 mm, Ø10 × 12	
6	screw	1		
7	nut	1		
8	washer	8	M6S 6 × 16	SS 2343
9	support	8	M6M 6	SS 2343
10	screw	8	RB 6,4	SS 2343
11	washer	2		
12	nut	20	M6S 6 × 14	SS 2343
13	nut	20	RB 8,4	SS 2343
14	screen	6	M6M 8	SS 2343
15	valve	4	MVM-K 6	SS 2343
16	pressure gauge	1		
17	tee	1	OLO R ¼″	
18	nipple	1	Ø63R¼″,0-10 bar	galvanized
19	pipe	1		galvanized
20	bend	2		
21	nozzle	1		
22	inspection cover	1		galvanized
23	screw	1	¼″HH 6,5	
24	washer	1		
25	handle	1	M6S 5 × 16	SS 2343
		1	Ø18/5,5 × 2	SS 2343

Figure G.2 — High-expansion foam generator — General arrangement

Dimensions in millimetres

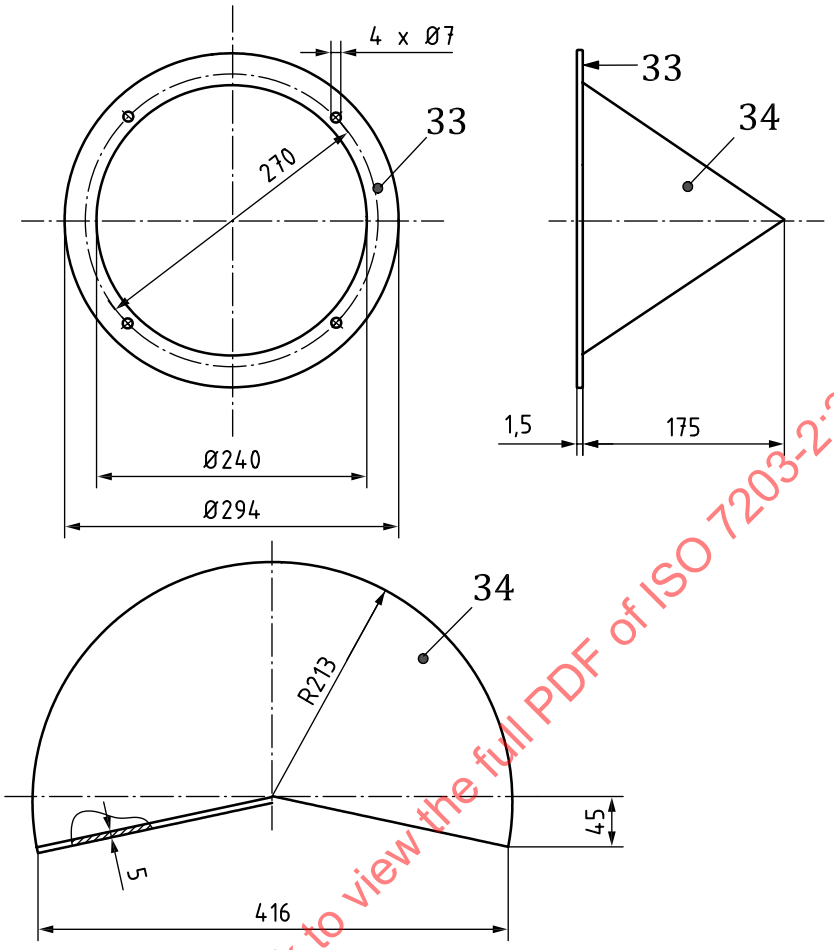


Key

1	housing (2 mm plate)
2	ring
26	collar
27 and 28	screen supports (2 mm plate)
29	bar reinforcement
30	legs
31	screw
32	nut

Figure G.3 — High-expansion foam generator — Housing (1)

Dimensions in millimetres



Key

33 support ring (1,5 mm plate)

34 perforated screen (0,7 mm plate, 2 mm holes at 3 mm pitch)

Figure G.4 — High-expansion foam generator — Screen (14)

Annex H
(normative)

Determination of test fire performance for medium-expansion foam concentrates

H.1 General

This annex specifies the procedure for determining the test fire performance for medium-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 will not result in conformity to this document.

H.2 General conditions

H.2.1 Test series and criteria for success

H.2.1.1 Foam concentrates not compatible with sea water

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

H.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 F.4. 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 H.1 gives a graphic version of the decision tree.

H.2.2 Decision tree fire test protocol

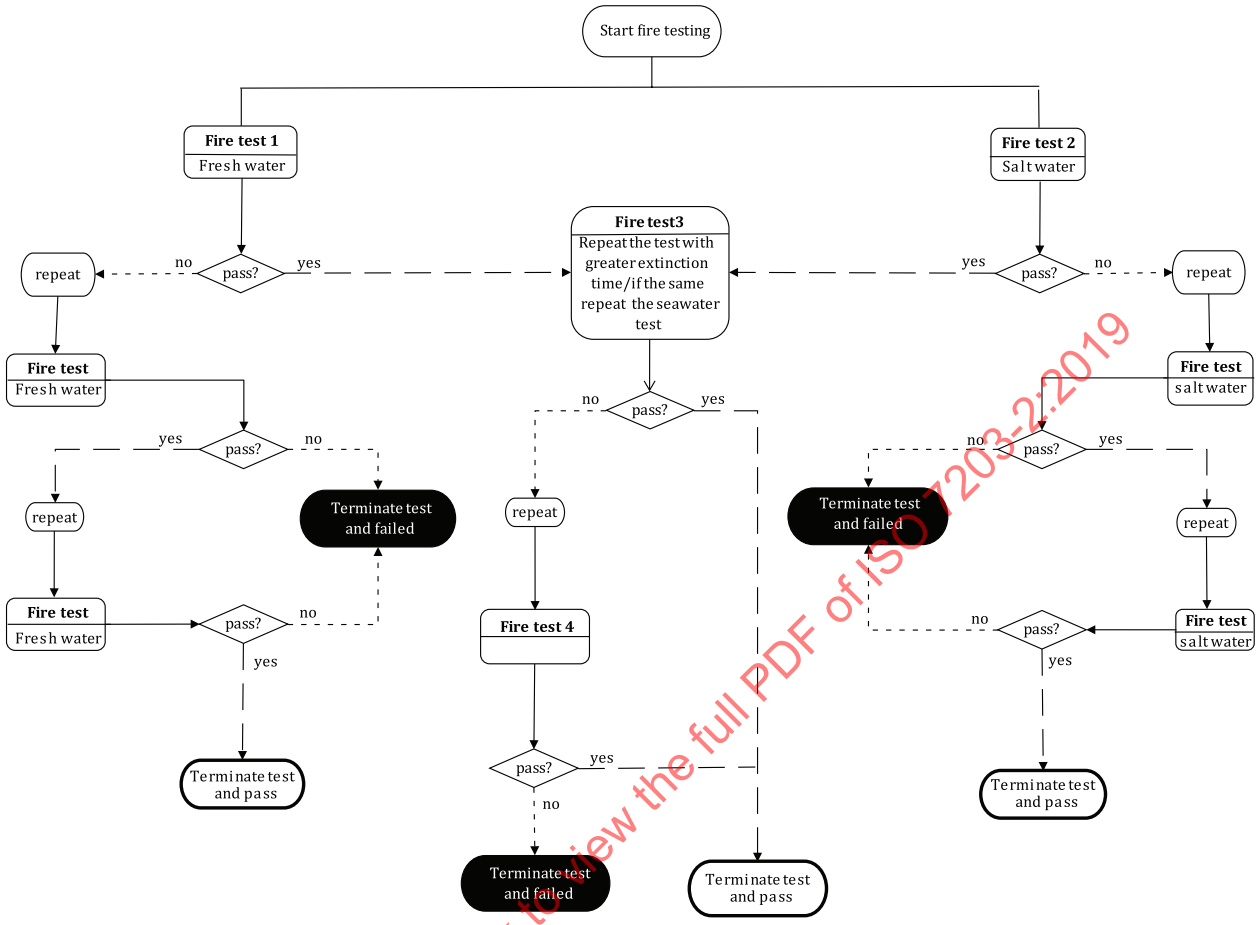


Figure H.1 — Decision tree for fire performance test on water-immiscible fuels

H.2.3 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.

H.2.4 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) 1 % burn-back time.

It is recommended that the time is recorded at 1 % burn-back. Control times and burn-back time can be determined either visually by an experienced person or from thermal radiation measurements. Annex J gives details of a method suitable for medium-expansion foams.

H.2.5 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.4.

H.2.6 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 H.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.

H.3 Fire test

H.3.1 Apparatus

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

H.3.1.1 Circular fire tray, stainless steel grade X5CrNi18-10 (ISO 3506: A2; ASTM: 304304; UNS: S30400), with dimensions as follows:

— internal diameter at rim (1 480 ± 15) mm;

— depth (150 ± 10) mm;

— nominal thickness of steel wall 2,5 mm

NOTE The tray has an area of approximately 1,73 m^2.

H.3.1.2 Foam-making equipment, as described in F.1.2.

H.3.1.3 Burn-back pot, stainless steel grade X5CrNi18-10 (ISO 3506: A2; ASTM: 304304; UNS: S30400), of nominal thickness 2,5 mm, diameter (150 ± 5) mm and height (150 ± 5) mm, with a bracket so that it can be suspended directly on the rim of the fire tray.

The upper rim of the burn-back pot shall be level with, and in contact with, the upper rim of the fire tray.

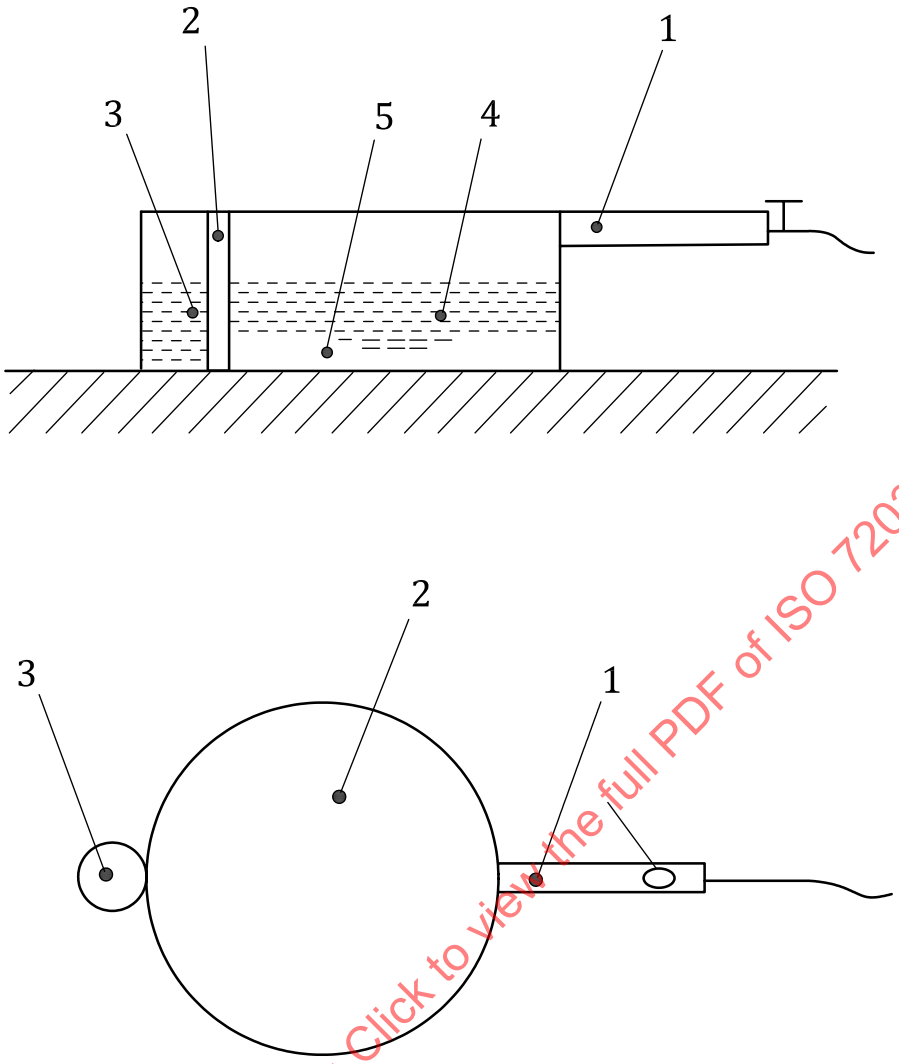
H.3.2 Test procedure

Place the tray directly on the ground and ensure that it is level. Add approximately 30 l of water and (55 ± 2) l of fuel to give a nominal 50 mm fuel depth, with approximately 100 mm between the fuel surface and the upper rim of the tray wall.

Suspend the burn-back pot containing (0,9 ± 0,1) l of fuel on the sheltered side of the fire tray.

Ignite the fuel not less than 3 min and not more than 5 min after adding it. Not less than 45 s after full involvement of the surface of the fuel, mount the medium-expansion nozzle horizontally on the rim of the tray, as shown in Figure H.2. Start foam application (60 ± 2) s after full involvement. Apply foam for (120 ± 2) s. Record the extinction time as the time after the start of foam application at which all flames in the fire tray are extinguished. Following foam application, allow the fire in the burn-back pot to burn until sustained flames appear above the foam blanket. Record this time as the 1 % burn-back time.

If the burn-back pot is extinguished due to overflow of foam during foam application, re-ignite it immediately.



Key

1 foam-making nozzle
2 tray
3 burn-back pot, suspended outside tray
4 fuel
5 water

Figure H.2 — Test fire arrangement for medium-expansion foam

Annex I
(normative)

Determination of test fire performance for high-expansion foam concentrates

I.1 General

This annex specifies the procedure for determining the test fire performance for high-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 will not result in conformity to this document.

I.2 General conditions

I.2.1 Test series and criteria for success

I.2.1.1 Foam concentrates not compatible with sea water

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

I.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.4. 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 I.1 gives a graphic version of the decision tree.

I.2.2 Decision tree fire test protocol

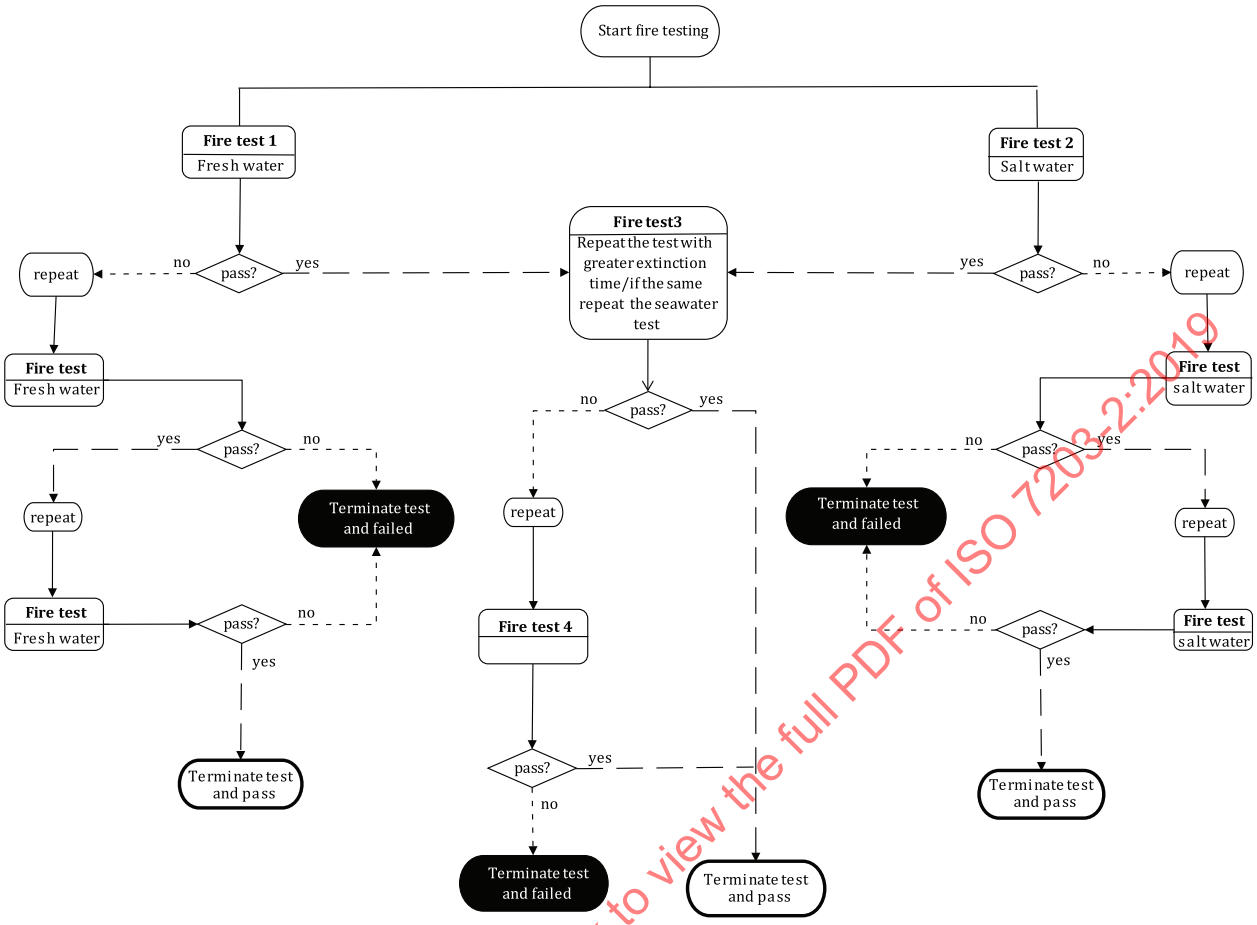


Figure I.1 — Decision tree for fire performance test on water-immiscible fuels

I.2.3 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.

I.2.4 Records

During the fire test, record the following:

a) location;

b) air temperature;