INTERNATIONAL STANDARD

ISO 7203-3

Second edition
2011-08-01

Fire extinguishing media — Foam concentrates —

Part 3:

Specification for low-expansion foam concentrates for top application to water-miscible liquids

Agents extincteurs — Émulseurs —

Partie 3: Spécifications pour les émulseurs bas foisonnement destinés à une application par le haut sur les liquides miscibles à l'eau

Reference number
ISO 7203-3:2011(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 7203-3 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 6, *Foam and powder media and fixed firefighting system using foam and powder*.

This second edition cancels and replaces the first edition (ISO 7203-3:1999), which has been technically revised.

ISO 7203 consists of the following parts, under the general title *Fire extinguishing media — Foam concentrates*:

- *Part 1: Specifications for low-expansion foam concentrates for top application to water-immiscible liquids*
- *Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids*
- *Part 3: Specification for low-expansion foam concentrates for top application to water-miscible liquids*

Introduction

Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting reignition. They can also be used to prevent the ignition of flammable liquids and, in certain conditions, extinguish fires of solid combustibles.

Foams can be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject of other International Standards including ISO 5923, ISO 6183, ISO 7201-1, ISO 7201-2 and ISO 7202. A specification for foam systems [ISO 7076 (all parts)1)] designed in accordance with this part of ISO 7203 is being prepared and will be published as ISO 7076 (all parts).

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

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1) To be published.

INTERNATIONAL STANDARD **ISO 7203-3:2011(E)**

Fire extinguishing media — Foam concentrates —

Part 3:
Specification for low-expansion foam concentrates for top application to water-miscible liquids

1 Scope

This part of ISO 7203 specifies the essential properties and performance of liquid foam concentrates used to make low-expansion foams for the control, extinction and inhibition of reignition of fires of water-miscible liquids. Minimum performance on certain test fires is specified.

These foams are suitable for top application to fires of water-miscible liquids. Those foams that also comply with ISO 7203-1 are also suitable for top application to fires of water-immiscible liquids.

The foam concentrates can be suitable for use in non-aspirating sprayers or for subsurface application to liquid fires, but requirements specific to those applications are not included in this part of ISO 7203.

2 Normative references

The following referenced documents are indispensable for the application 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 7203-2, *Fire extinguishing media — Foam concentrates — Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids*

BS 5117-1.3, *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.

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
with expansion in the range 1 to 20, as applied to foam and to associated equipment, systems and concentrates

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

3.6
high-expansion
with expansion 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 concentration
P
foam concentrate derived from hydrolized protein materials

3.10
fluoroprotein foam concentrate
FP
protein foam concentrate with added fluorinated surface active agents

3.11
synthetic foam concentrate
S
foam concentrate 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 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 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 that has the ability to form an aqueous film on the surface of some hydrocarbons

3.15
foam solution
solution of foam concentrate 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
lowest temperature for use
temperature claimed by the manufacturer or supplier to be the lowest temperature at which the foam concentrate can be proportioned correctly using equipment normally available

4 Grades and uses of foam concentrates

4.1 Grades

Based on the test fire performance of the foam concentrate (see Clause 13), it shall be graded

- as class I or II for extinguishing performance;
- as level A, B or C 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 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 Annex B shall be tested for compliance with the appropriate requirements given in other clauses and subclauses of this part of ISO 7203 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 prepared in accordance with A.1 shall be dispersible through a 180 µm sieve, and the percentage volume of the 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 percentage volume of sediment shall be not more than 1,0 % when tested in accordance with Annex C.

7 Viscosity of the foam concentrate

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 $> 200\ \text{mm}^2\text{s}^{-1}$, 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 $375\ \text{s}^{-1}$, the container shall be marked: “Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment”.

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 Before temperature conditioning

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

10.2 Temperature sensitivity

The interfacial tension between the foam solution prepared from the foam concentrate, after temperature conditioning in accordance with A.2, 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 of the foam solution prepared from a concentrate claimed by the supplier to be “film-forming” before and after temperature conditioning in accordance with A.2, calculated in accordance with E.4, shall be positive.

NOTE Foam concentrates complying with Clause 11 are more likely to be of types AFFF or FFFP than of types FP, P or S.

12 Expansion and drainage of foam

12.1 Expansion

12.1.1 Limits

The difference between the expansion of 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 G.2.4, and the characteristic value shall be within either ± 20 % of the characteristic value or ± 1,0 of the characteristic value, whichever is the greater, when tested in accordance with Annex F.

12.2 Drainage

12.2.1 Limits

The difference between the drainage time of 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 G.2.4, and the characteristic value shall be within ± 20 % of the characteristic value when tested in accordance with Annex F.

13 Test fire performance

The foam produced from the solution prepared using the foam concentrate sampled in accordance with Annex B at the supplier's recommended concentration with potable water, and if appropriate at the same concentration with the synthetic sea water in accordance with F.4, shall have an extinguishing performance class and burn-back resistance level as specified in Table 1, when tested in accordance with G.1 and G.2.

Table 1 — Extinguishing performance classes and burn-back resistance levels

Times in minutes

Extinguishing performance class	Burn-back resistance level	Extinction time not more than	25 % burn-back time not less than
I	A	3	15
	B	3	10
	C	3	5
II	A	5	15
	B	5	10
	C	5	5

NOTE 1 The values obtained with sea water can differ from those obtained with potable water.

NOTE 2 Annex H describes a small-scale fire test which can be suitable for quality control purposes.

NOTE 3 Extinction time is the period from the start of foam application until the time when all flames are extinguished.

NOTE 4 25 % burn-back time is the period from the ignition of the burn-back pot until 25 % of the tray is covered by sustained 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 or II) and level (A, B, or C) of the foam concentrate and, if the concentrate complies with Clause 11, the words “aqueous film-forming”;

c) recommended usage 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, 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 and in normal usage, not present a significant toxic hazard to life in relation to the environment.

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.

14.1.2 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

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

14.3 Specification sheet

14.3.1 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, the words “This concentrate can require special proportioning equipment” shall be marked.

14.3.2 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, the words “Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment” shall be marked.

14.3.3 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 tightly closed containers.

NOTE Containers of capacity 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 effected by freezing and thawing, it is conditioned in accordance with 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.2.1 and A.2.2 as appropriate. Agitate 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 Tube, polyethylene, approximately 10 mm in diameter, approximately 400 mm long and sealed and weighted at one end, with suitable spacers attached; see Figure B.1 for a typical form.

B.1.3 Measuring cylinder, glass, of capacity 500 ml, 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, Section 1.3 (excluding 5.2).

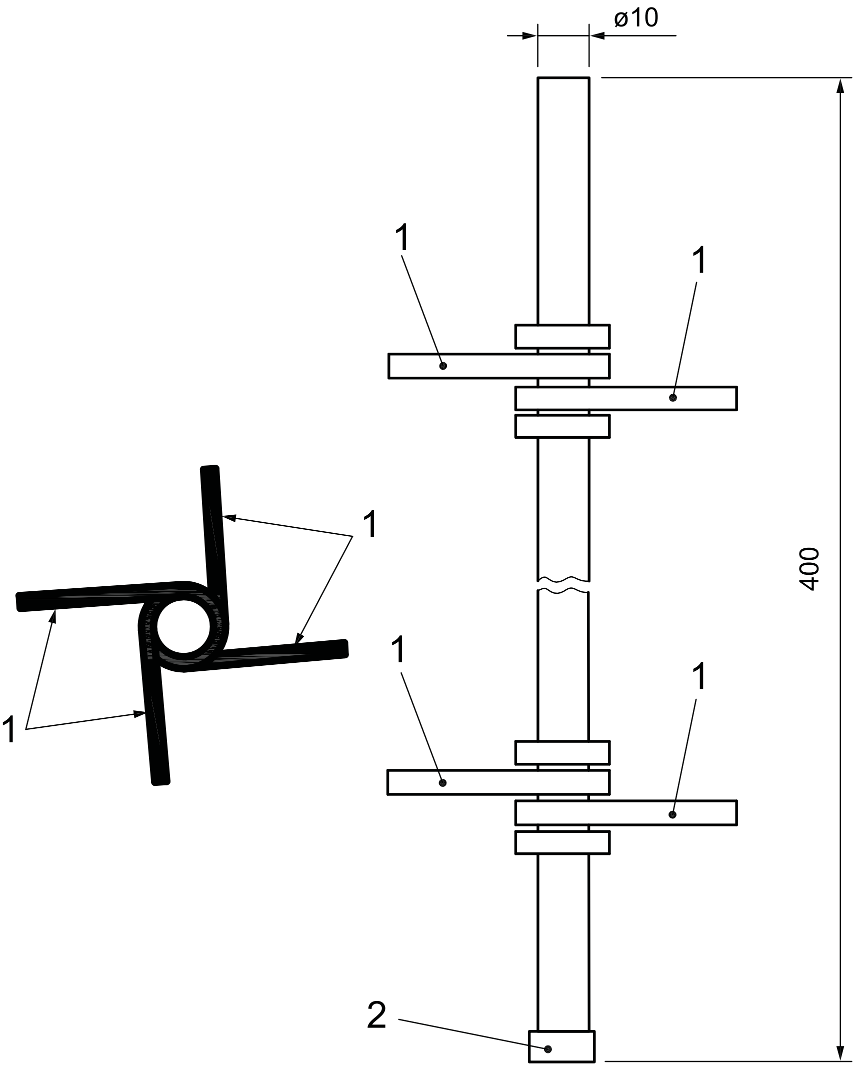
To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, with the spacers to ensure that it remains approximately on the 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 millimeters



Key

1 spacers (e.g. plastics cable strap)

2 weight at sealed end

Figure B.1 — Typical form of polyethylene tube

Annex C
(normative)

Determination of percentage of sediment

C.1 Sampling

Use a sample prepared in accordance with A.1. Ensure that any sediment is dispersed by agitating 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.

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

NOTE A centrifuge and tubes in accordance with ISO 3734 are suitable.

C.2.3 Sieve, of nominal aperture size 180 µm, in accordance 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 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 that decreases with increasing shear rate at constant temperature.

D.2 Viscosity determination

D.2.1 Apparatus

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

D.2.1.1 Viscometer, rotational, fitted with a temperature control unit that can maintain the sample temperature within ±1 °C of the required temperature, in accordance with ISO 3219 with the following parameters:

— maximum shear stress: ≥ 75 Pa;

— maximum shear rate: ≥ 600/s.

D.2.2 Test temperature

The viscosity of the foam concentrate shall be measured at temperatures from 20 °C to and including the lowest temperature for use claimed by the manufacturer in steps 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 applied in the apparatus.

The test should be performed in accordance with 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 (period of 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 least at 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/s. Calculate the apparent viscosity, v, expressed in millipascal-seconds, from Equation (D.1):

$$v = 1000 \times \frac{s_1}{s_2} \tag{D.1}$$

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 the test temperature (°C), shear rate (1/s), shear stress (Pa), and apparent viscosity (mPa·s).

Annex E
(normative)

Determination of surface tension, interfacial tension and spreading coefficient

E.1 Reagents

E.1.1 Foam concentrate solution, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696:1987 and 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, between the solution (E.1.1) and cyclohexane (E.1.2) from Equation (E.1):

$$S = Y_\mathrm{c} - Y_\mathrm{f} - Y_\mathrm{i} \tag{E.1}$$

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; stainless steel, aluminium, brass and plastics are suitable materials for the collection surface; see Figure F.2.

F.1.3 Foam-making nozzle, that, 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]; see Figure F.3.

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

F.2 Temperature conditions

Carry out the tests under the following temperature conditions:

- air (20 ± 5) °C;
- foam solution (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 vessel internally and weigh it. Record the mass as m_1. Set up the foam equipment and adjust the nozzle pressure within the range (630 ± 30) kPa [(6,3 ± 0,3) bar] to give a flow rate of 11,4 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 and strike the foam surface level with the rim. Weigh the vessel and record the mass m_2.

Calculate the expansion, E, from Equation (E.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 the graduated measuring cylinder to measure the 25 % drainage time. Adjust the drainage facility such that the drained foam solution can flow out whilst preventing the passage of foam.

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

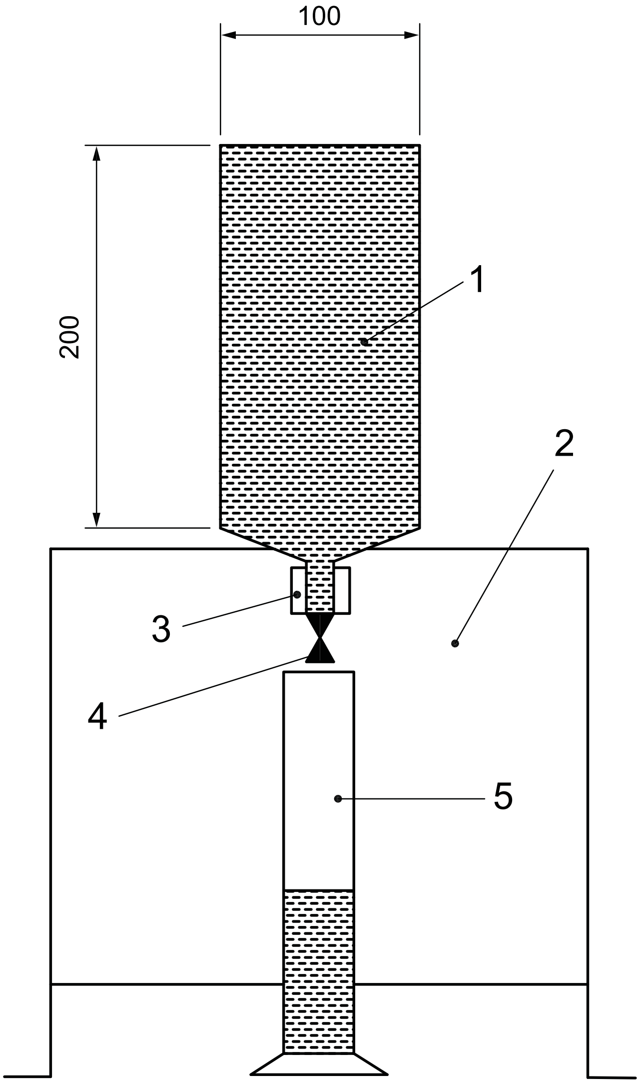
F.4 Simulated sea water

Prepare the simulated sea water by dissolving the components listed in Table F.1.

Table F.1 — Components of simulated sea water

Mass percentage	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	—

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

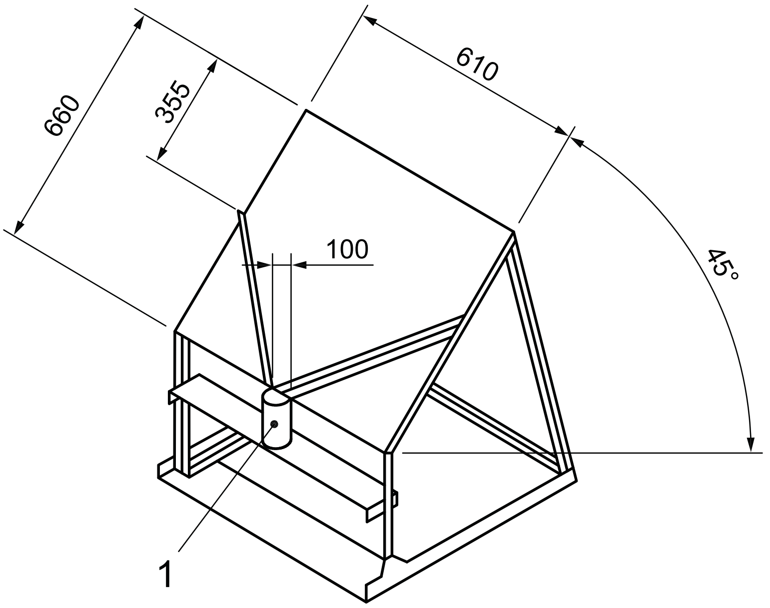
4 discharge outlet closure

5 graduated measuring cylinder

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

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

Nominal dimensions in millimetres unless otherwise specified

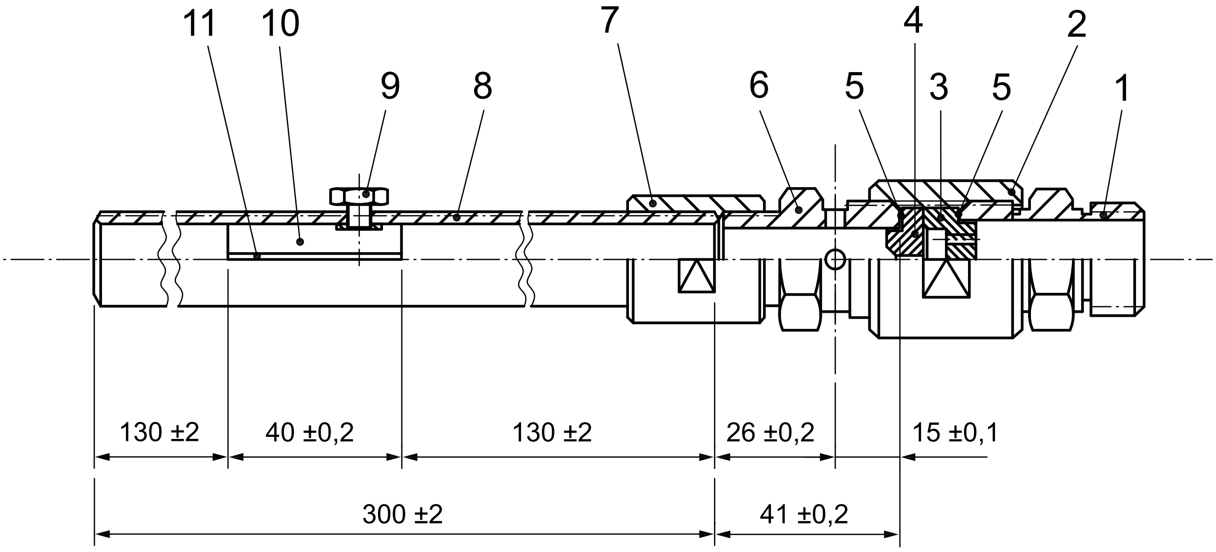


Key

1 collecting vessel

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

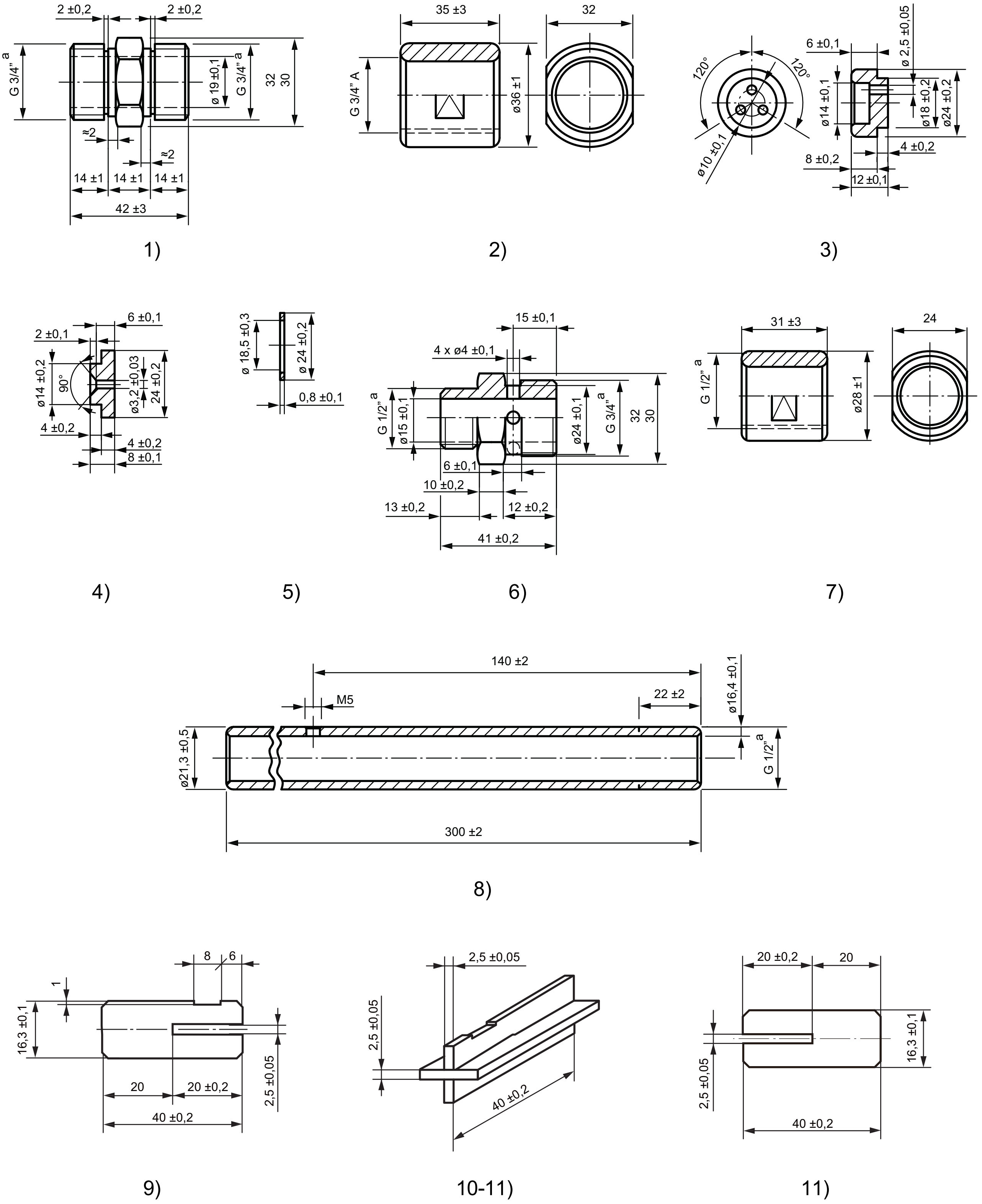
Dimensions in millimetres unless otherwise specified



a) General arrangement

Figure F.3 — Foam-making nozzle (*continued*)

Dimensions in millimetres unless otherwise specified



1) 2) 3)

4) 5) 6) 7)

8)

9) 10-11) 11)

b) Details

a ISO 228-1:2000

Figure F.3 — Foam-making nozzle *(concluded)*

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 part of ISO 7203. It is recommended that they be carried out at the end of the test program to avoid the expense of unnecessary testing.

Testing at temperatures above the range required by this part of ISO 7203 can result in poor performance, and precludes conformity with this part of ISO 7203.

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 one test with potable water on propan-2-one (acetone) and one test with potable water on propan-2-ol (isopropanol, isopropyl alcohol, IPA). If both tests are successful, or if both tests are unsuccessful, terminate the test series. If one test is unsuccessful, repeat that test. The concentrate conforms to Clause 13 if the first two tests are successful, or if one of the first two tests is successful, and the repeat test is successful.

G.2.1.2 Foam concentrates compatible with sea water

Conduct one test with potable water on propan-2-one (acetone), and one test with potable water on propan-2-ol (isopropanol, isopropyl alcohol, IPA). If both tests are successful, carry out one test with the simulated sea water in accordance with F.4 on propan-2-one (acetone), and one test with the simulated sea water in accordance with F.4 on propan-2-ol (isopropanol, isopropyl alcohol, IPA). If all tests are successful, terminate the test series. If one of the potable water tests is not successful, repeat that test. If one of the simulated sea water tests is not successful, repeat that test. The concentrate conforms to Clause 13 if all four tests have been successful or, in the case of one or two unsuccessful results, the repeat or repeats has or have been successful.

G.2.2 Temperature and wind speed

Carry out the tests under the following conditions:

— air temperature	(15 ± 5) °C;
— fuel 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) foam solution temperature;

e) wind speed;

f) 90 % control time;

g) 99 % control time;

h) extinction time;

i) 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 I 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 the simulated sea water in accordance with G.4.

G.2.5 Fuel

Use propan-2-one (acetone) of not less than 99 % purity.

Use propan-2-ol (isopropanol, isopropyl alcohol, IPA) of not less than 99 % purity.

G.3 Fire test

G.3.1 Apparatus

The usual laboratory apparatus and, in particular, the following

G.3.1.1 **Fire tray**, circular, of stainless steel grade 314 with dimensions as follows:

— internal diameter at rim	(1 480 ± 15) mm;
— depth	(150 ± 10) mm;
— foam solution temperature	(17,5 ± 2,5) mm;
— nominal thickness of steel wall	2,5 mm.

The tray shall have a vertical stainless steel backboard (1 ± 0,05) m high and (1 ± 0,05) m long fitted as closely as possible along the curved top of the curved wall, or formed by an extension of the wall.

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

G.3.1.2 Foam making equipment, as described in F.1.3.

G.3.1.3 Burn-back pot, stainless steel, of nominal thickness 2,5 mm, diameter (300 ± 5) mm and height (250 ± 5) mm.

G.3.2 Test procedure

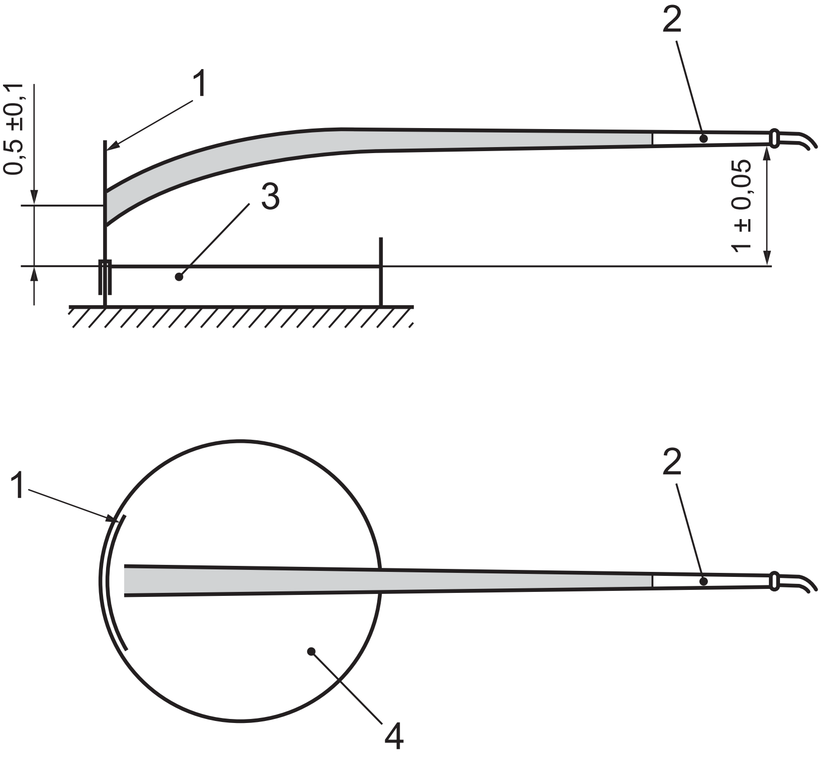
Place the tray directly on the ground and ensure that it is level. Set up the foam nozzle horizontally (1 ± 0,05) m above the fuel level in a position where the central part of the foam discharge will strike the centre axis of the backboard (0,5 ± 0,1) m above the fuel level (see Figure G.1). Clean the tray. Add (125 ± 5) l of fuel.

Ignite the fuel, not less than 3 min and not more than 5 min after adding it. Start foam application (120 ± 2) s after full involvement of the surface of the fuel. Readjust nozzle to ensure that the jet continues to hit the centre of the backboard. If the foam concentrate is claimed to be class 1, apply foam for (180 ± 2) s. If the foam concentrate is claimed to be class 2, apply foam for (300 ± 2) s. If the fire within the fire tray 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 all flames are extinguished within the fire tray. If a fire remains only on the outside of the tray after foam application, this fire shall be manually extinguished before starting the burn-back test.

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

NOTE During foam application, some foam can overflow from the fire tray, possibly carrying burning fuel. It is advisable to mount the test fire tray within a non-combustible bunded or dyked area to contain any foam overflow.

All dimensions in metres



Key

1	backboard
2	foam nozzle
3	fuel
4	fire tray

Figure G.1 — Test fire arrangement

Annex H
(informative)

Small-scale fire test

H.1 General

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

This 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 in H.3.

H.2 Apparatus

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

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

— 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.

The fire tray shall have a vertical backboard 2,5 mm thickness, 600 mm long and 300 mm high formed by an extension of the wall opposite to the nozzle.

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 which extracts the smoke without interfering with the fire.

H.2.2 Burn-back pot, brass, with a turned over rim, and 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 the burn-back pot using a metal rod.

H.2.3 Foam making nozzle, with a nominal flow rate of 5,0 l/min at 700 kPa (7 bar) when tested with water; see Figure H.2. It is fitted with an adjustable collar to allow ejecting foam from the side of the nozzle and, thus, vary the foam flow rate through the outlet. The foam flow rate can also be controlled by adjusting the pressure applied to the foam solution.

H.2.4 Fuel, consisting of propan-2-one (acetone) or propan-2-ol (isopropanol, isopropyl alcohol, IPA) of not less than 99 % purity.

H.3 Test procedure

H.3.1.1 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.

H.3.1.2 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 H.2).

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 (1,625 ± 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.

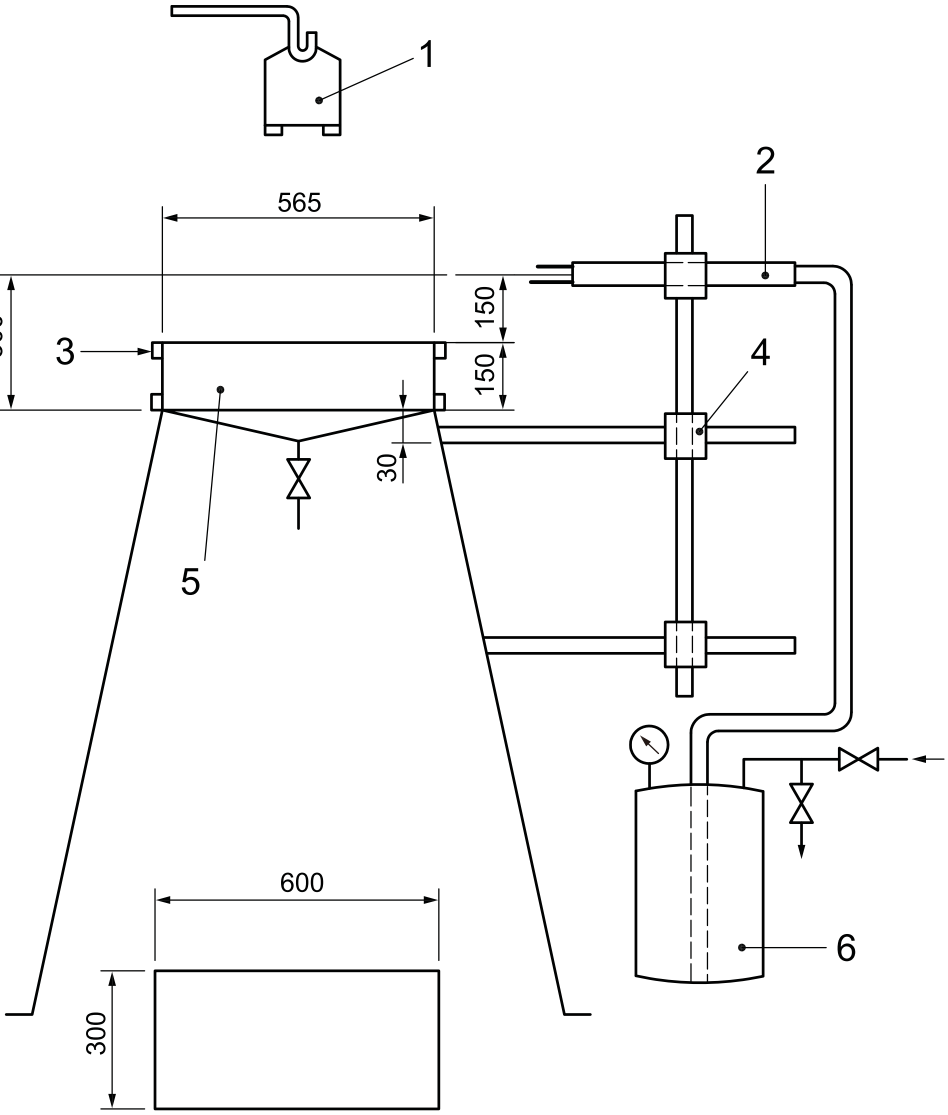
H.3.1.3 Fire test

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 fuelling, ignite the fuel and allow to burn for (120 ± 2) s before starting foam application. Apply foam for (120 ± 2) s to the centre of the backboard and record the times from the start of foam application to 90 % control, 99 % control and complete extinction. If complete extinction is not obtained within (120 ± 2) s, apply the foam for a further (120 ± 2) s.

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 the time taken from positioning of the burn-back pot to permanent, full re-involvement of the fire tray surface in flames as the burn-back time.

Dimensions in millimetres



Key

1 burn-back pot

2 foam nozzle

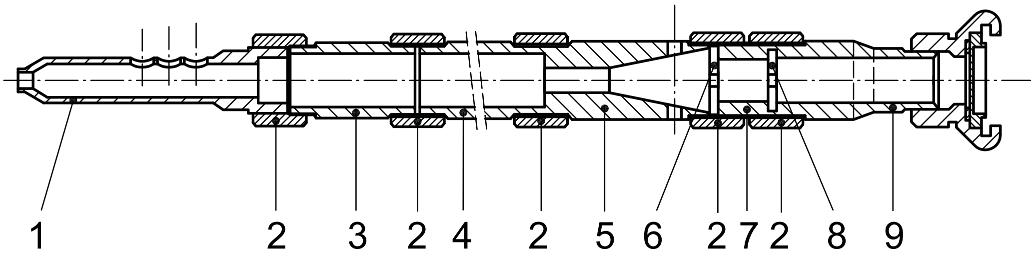
3 backboard

4 adjustable boss

5 fire tray

6 foam solution

Figure H.1 — Small scale fire test

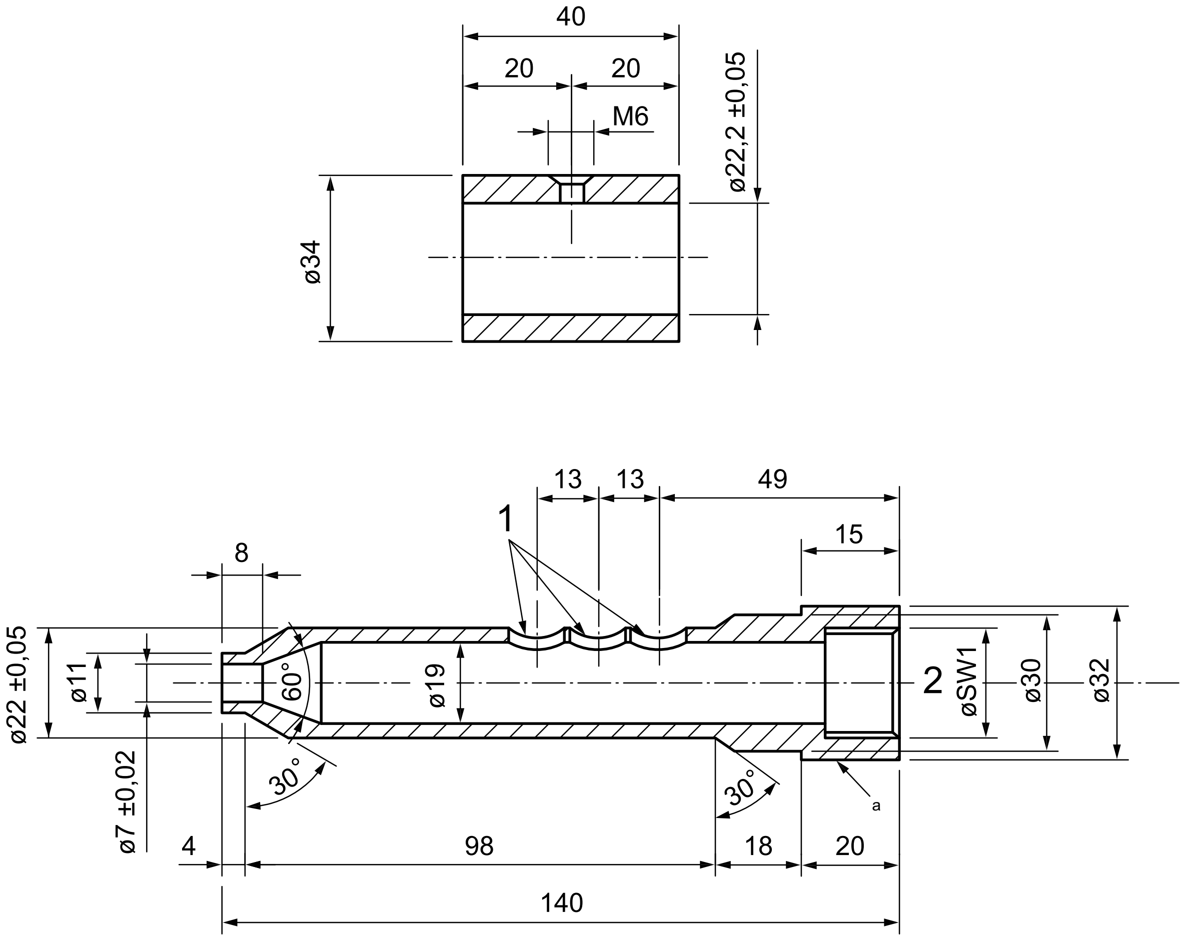


Key

1 nozzle with foam diverter (see Figure H.3)
2 coupling (see Figure H.4)
3 mixing tube (see Figure H.5)
4 stabilizing tube (see Figure H.6)
5 Venturi (see Figure H.7)
6 orifice plate G (see Figure H.8)
7 spacing piece (see Figure H.9)
8 orifice plate P (see Figure H.10)
9 inlet (see Figure H.11)

Figure H.2 — Foam making nozzle for small-scale fire test

Dimensions in millimetres unless otherwise specified



Key

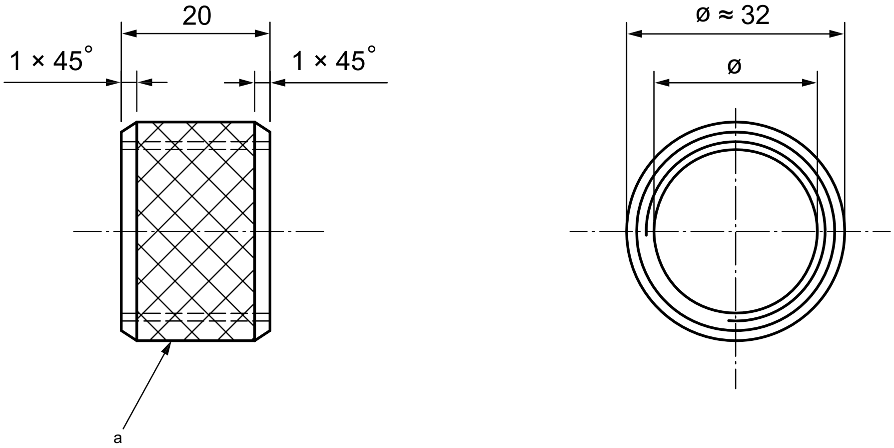
1 3 holes Ø *H*

2 16 threads

[a] Knurled.

Figure H.3 — Sleeve and item 1 — Nozzle with foam diverter

Dimensions in millimetres unless otherwise specified



a Coarse-knurled.

Figure H.4 — Item 2 — Coupling

Dimensions in millimetres unless otherwise specified

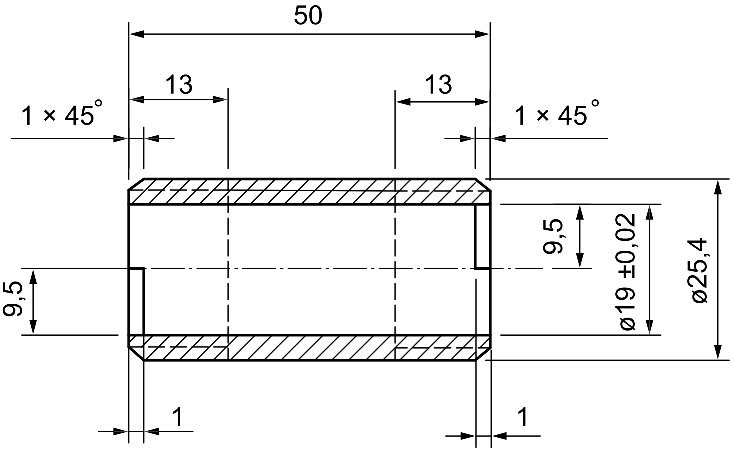
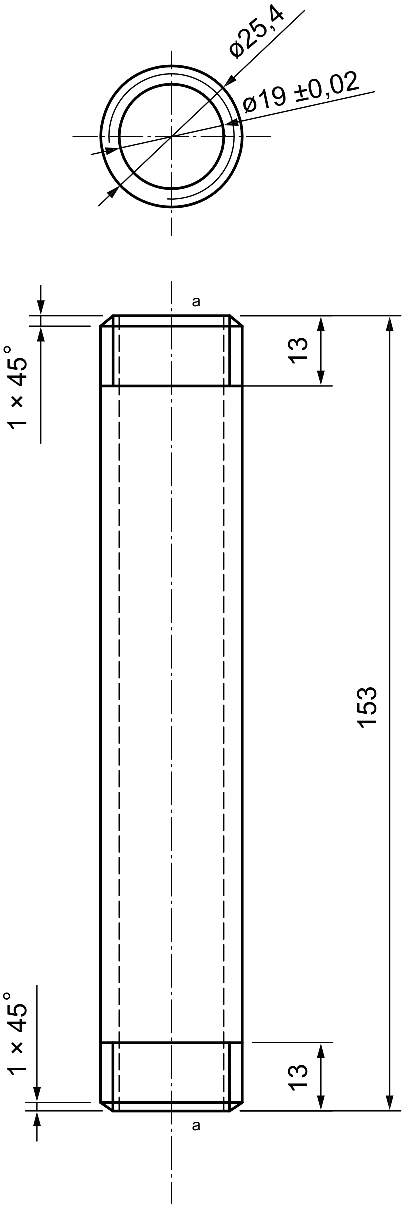


Figure H.5 — Item 3 — Mixing tube

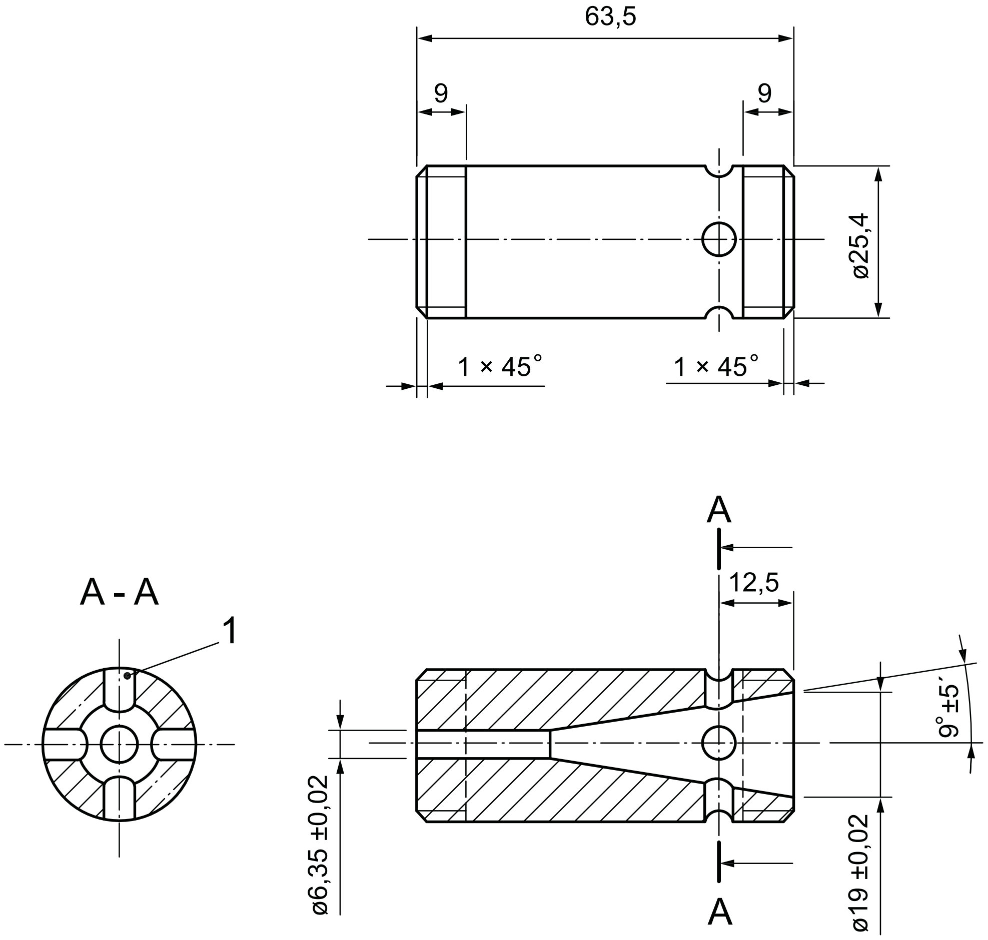
Dimensions in millimetres unless otherwise specified



[a] Chamfer each end 1 × 45°. End faces shall be at 90° to axis. Thread: Whitworth, 16 tpi.

Figure H.6 — Item 4 — Stabilizing tube

Dimensions in millimetres unless otherwise specified

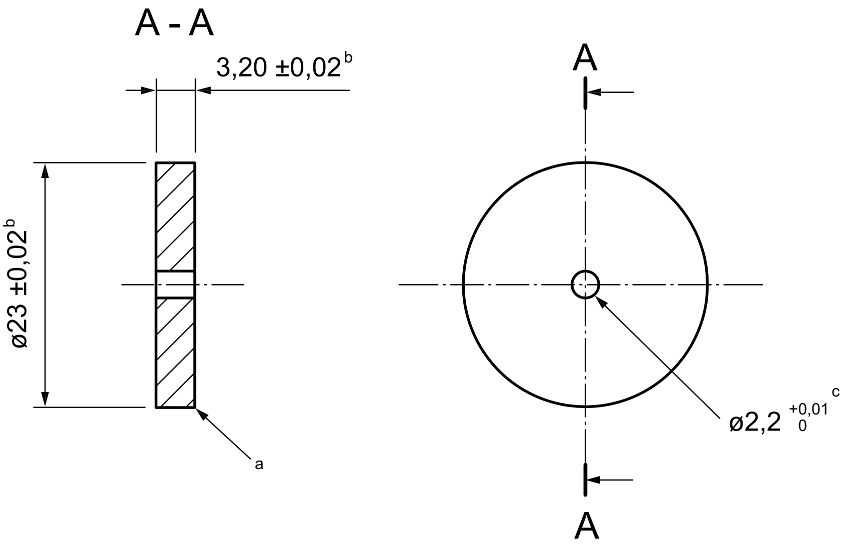


Key

1 four holes, Ø 6 at 90° in same plane

Figure H.7 — Item 5 Venturi

Dimensions in millimetres



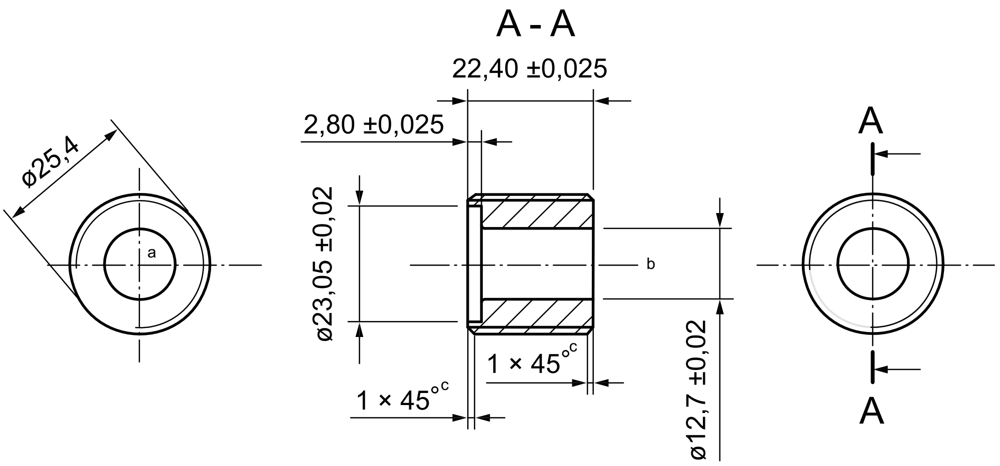
[a] Slight radius.

[b] Faces parallel to within 0,02.

[c] Hole concentric with O.D. to within 0,02. Hole at 90 °to each face within 0,01.

Figure H.8 — Item 6 — Orifice plate G

Dimensions in millimetres unless otherwise specified



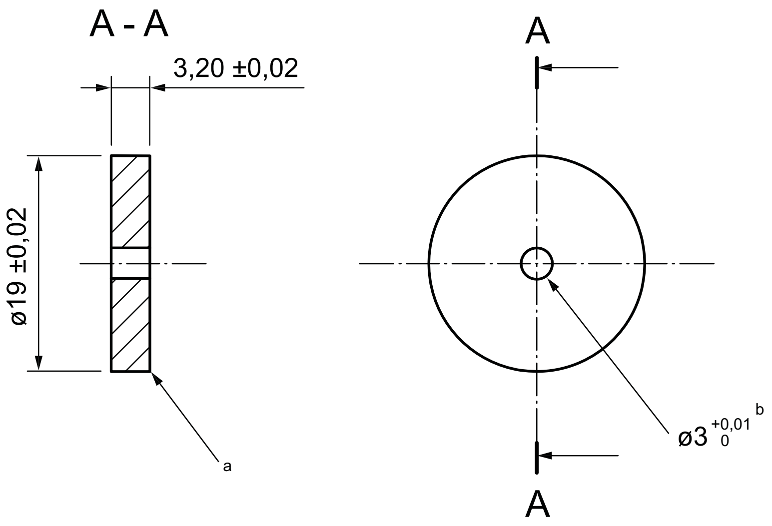
[a] Bore and counter bore concentric to O.D. within 0,02.

[b] Counter bore face parallel to end face within 0,02. Counter bore faces and end faces square with axis to within 0,01.

[c] Chamfer thread edges 1 × 45°. Leave other edges sharp.

Figure H.9 — Item 7 — Spacing piece

Dimensions in millimetres

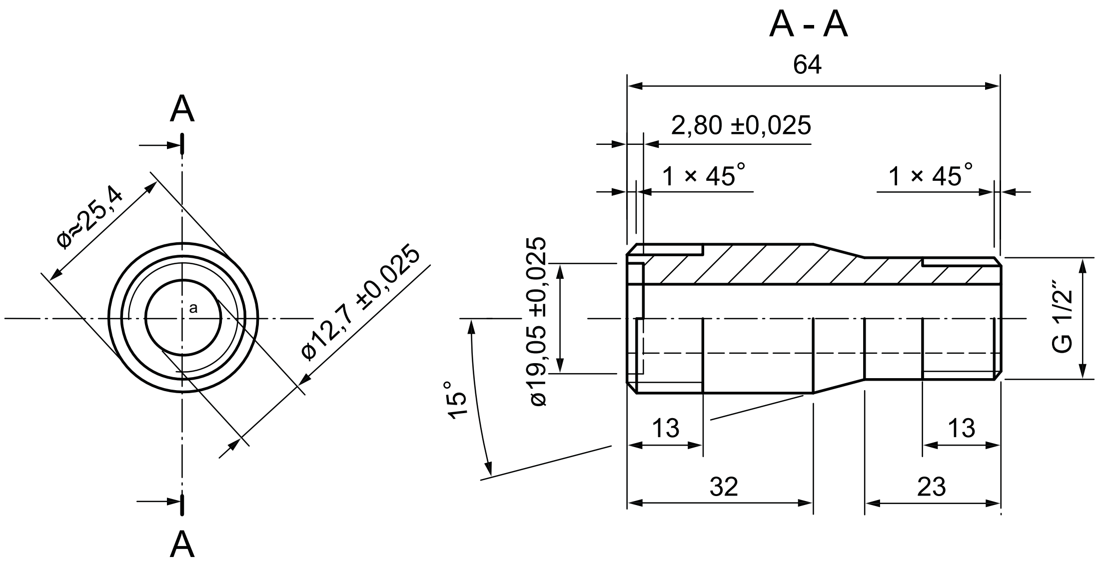


[a] Slight radius.

[b] Faces parallel to within 0,02. Hole concentric with O.D. to within 0,02. Hole at 90° to each face within 0,01.

Figure H.10 — Item 8 — Orifice plate P

Dimensions in millimetres unless otherwise specified



[a] Bore and counter bore concentric to O.D. within 0,02.

Figure H.11 — Item 9 — Inlet

Annex I
(informative)

Description of a radiation measurement method

I.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 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 [8] for details. The method is suitable for low- and medium-expansion foams but not for high-expansion foams.

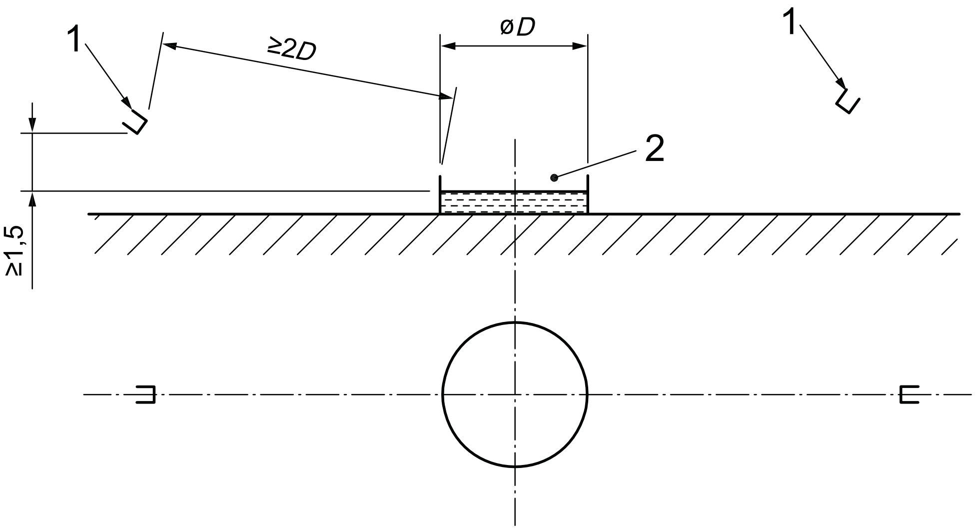
I.2 General arrangement of test

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



Key

1 radiometer

2 circular fire tray

Figure I.1 — Location of radiometers for recoding heat radiation during fire performance tests

I.3 Technical data for radiometers

Two radiometers2) of type Gordon or Schmidt-Boelter 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 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).

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

I.4 Procedure

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

Determine the average value of the two radiometers.

Determine the average value of time of recorded radiation during the 25 s period from 30 s to 5 s before the start of the foam application (see Figure I.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 I.3 and for the burn-back test in Figure I.4. A control of 90 % is equivalent to the relative radiation 0,1.

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

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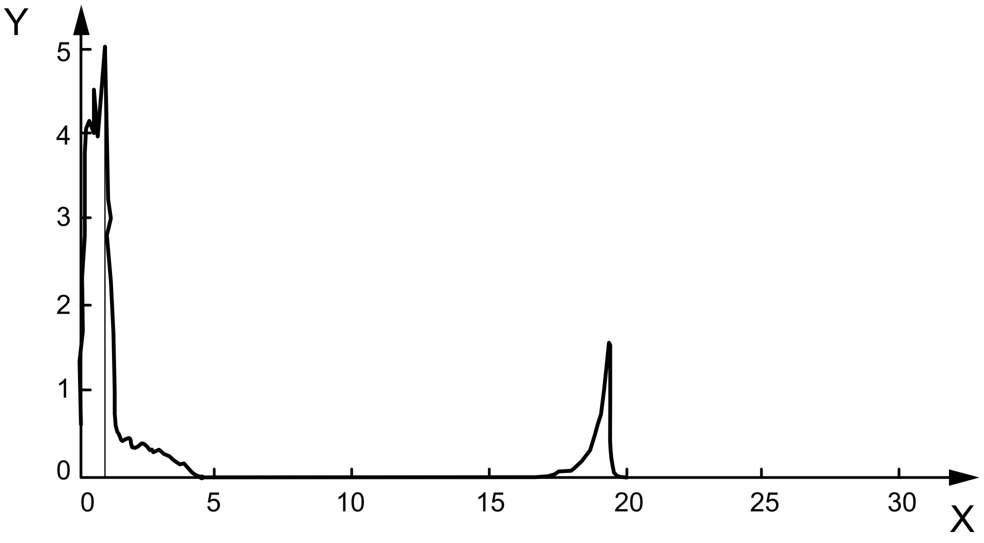
2) The Medtherm Series 64 supplied by Medtherm Corp., P.O.Box 412, Huntsville, AL. USA is an example of a suitable apparatus available commercially. This information is given for the convenience of users of this part of ISO 7203 and does not constitute an endorsement by ISO of this apparatus.



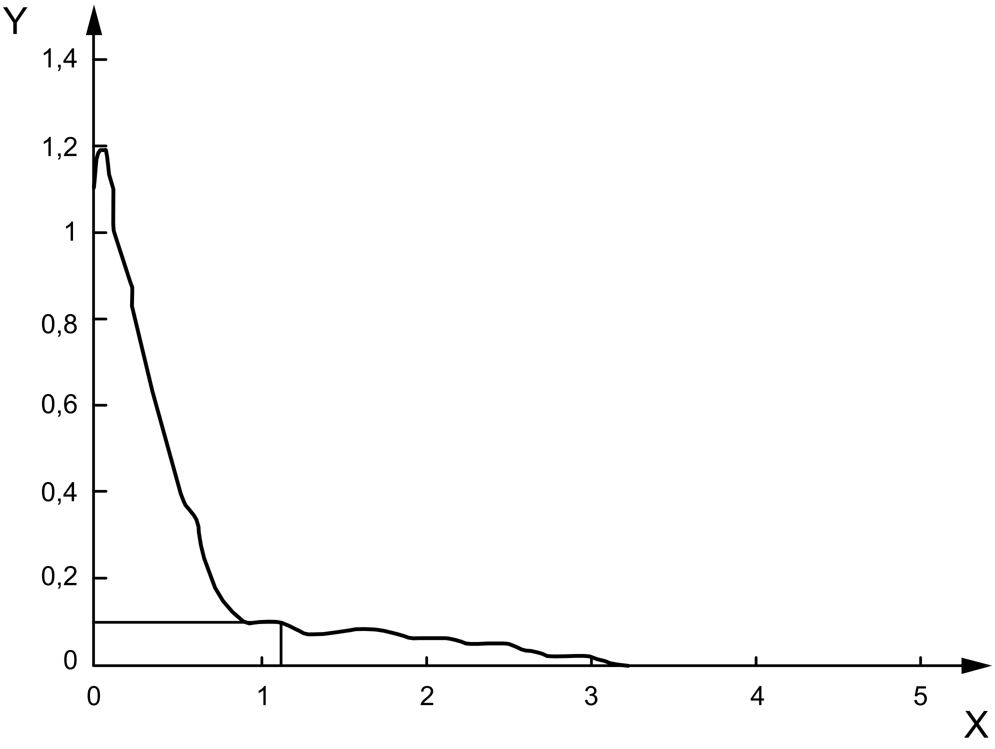
Key

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 I.2 — Typical absolute radiation levels throughout a test



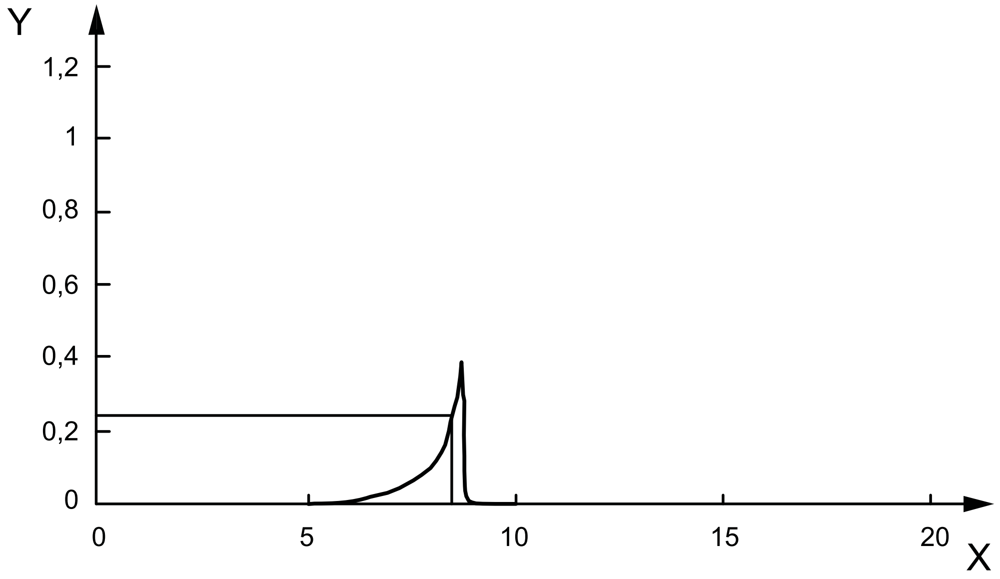
Key

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 I.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 I.4 — Typical relative radiation levels during burn-back

Annex J
(informative)

Compatibility

J.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.

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

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

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

d) 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 in efficiency.

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

J.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.

Bibliography

[1] ISO 228-1:2000, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

[2] ISO 5923, *Fire protection — Fire extinguishing media — Carbon dioxide*

[3] ISO 6183:2009, *Fire protection equipment — Carbon dioxide extinguishing systems for use on premises — Design and installation*

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[5] ISO 7201-2:1991, *Fire extinguishing media — Halogenated hydrocarbons — Part 2: Code of practice for safe handling and transfer procedures of halon 1211 and halon 1301*

[6] ISO 7202:1987, *Fire protection — Fire extinguishing media — Powder*

[7] ISO 7076 (all parts)[3], *Fire protection — Foam fire extinguishing systems*

[8] Nordtest Method NT Fire 023 (available from Nordwest, Postbox 22, FIN-00341 Helsink Finland)

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[3] To be published.

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