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Fire protection — Foam fire extinguishing systems —

Part 4: High expansion foam equipment

Protection contre l'incendie — Systèmes d'extinction d'incendie à mousse —

Partie 4: Équipement pour mousse à haut foisonnement

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Foreword

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

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

The committee responsible for this document is ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 6, *Foam and powder media and firefighting systems using foam and powder*.

ISO 7076 consists of the following parts, under the general title *Fire protection — Foam fire extinguishing systems*:

— *Part 1: Foam proportioning equipment*

— *Part 2: Low expansion foam equipment*

— *Part 3: Medium expansion foam equipment*

— *Part 4: High expansion foam equipment*

— *Part 5: Fixed compressed air foam equipment*

— *Part 6: Vehicle mounted compressed air foam systems*

Fire protection — Foam fire extinguishing systems —

Part 4: High expansion foam equipment

1 Scope

This part of ISO 7076 specifies requirements and test methods for high expansion foam equipment of fixed-foam extinguishing systems for indoor or outdoor use or both.

2 Normative references

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

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals*

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 180, *Plastics — Determination of Izod impact strength*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

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

ISO 272, *Fasteners — Hexagon products — Widths across flats*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 885, *General purpose bolts and screws — Metric series — Radii under the head*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

ISO 1179-1, *Connections for general use and fluid power — Ports and stud ends with ISO 228-1 threads with elastomeric or metal-to-metal sealing — Part 1: Threaded ports*

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

ISO 4759-1, *Tolerances for fasteners — Part 1: Bolts, screws, studs and nuts — Product grades A, B and C*

ISO 7005-1, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

ISO 7076-2:2012, *Fire protection — Foam fire extinguishing systems — Part 2: Low expansion foam equipment*

ISO 7203-2:2011, *Fire extinguishing media — Foam concentrates — Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ASTM D638, *Standard test method for tensile properties of plastics*

ASTM G155, *Standard practice for operating xenon arc light apparatus for exposure of non-metallic materials*

3 Terms and definitions

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

3.1
high expansion foam
foam which has an expansion greater than 200

3.2
50 % drainage time
time for 50 % of the liquid content of a foam to drain out

4 Requirements

4.1 Connections

4.1.1 Permanent connections and joints

Permanent joints shall conform to ISO 7-1, ISO 228-1, ISO 1179-1, ISO 7005-1 or ISO 7005-2, as applicable, or shall conform to other technical specifications valid in the place of use where International Standards are not applicable.

4.1.2 Bolting of pressure-retaining parts

Bolts, nuts or studs or both used to fasten pressure-retaining parts shall conform to ISO 272, ISO 885 and ISO 4759-1, or shall conform to other technical specifications valid in the place of use where International Standards are not applicable.

4.2 Parts for removal during routine field maintenance

4.2.1 Removal

Parts intended for removal during routine field maintenance shall be accessible, removable and replaceable without damage using appropriate tools normally used by the trade, or special tools recommended by the component manufacturer.

4.2.2 Re-assembly

The design and construction of any part intended for removal during routine field maintenance shall be such that it cannot be re-assembled in a manner other than as intended.

4.3 Corrosion resistance of metal parts

Those parts of components that are exposed to foam concentrate or foam solution shall be resistant to corrosion from that exposure.

Those parts of components that are intended to freely move during operation or bear against, rotate within, or slide on stationary parts shall be of a corrosion-resistant material.

NOTE Bronze is a typical material that has corrosion-resistant properties when exposed to foam concentrate or foam solution.

4.4 Elastomeric joint rings

4.4.1 General

Elastomeric joint rings shall have the following properties when tested in accordance with ISO 37 and ISO 48.

a) For as-received silicone rubber with basic constituent of poly-organo-siloxane, a minimum tesnsile strength of 3,4 MPa, a minimum ultimate elongation of 100 %, and a hardness within ±5 units of the manufacturer's specification.

b) For as-received fluoroelastomers, a minmum tensile of 6,9 MPa, a minimum ultimate elongation of 150 %, and a hardness within ±5 units of the manufacturer's specification.

c) For as-received natural rubber and as-received synthetic rubber other than silicone or fluoroelastomers, a minmum tensile of 8,3 MPa, a minimum ultimate elongation of 150 % ,and a hardness within ±5 units of the manufacturer's specification.

4.4.2 Resistance to aging

When tested in accordance with ISO 188, the physical properties of elastomeric joint rings after oven ageing at 100 °C ± 2 °C for 70 h shall be at least 60 % of the as-received tensile strength and elongation values. Any change in the hardness shall not exceed 5 % of the as-received value.

4.4.3 Resistance to exposure to liquids

Elastomeric joint rings shall have the following properties when tested in accordance with ISO 1817.

a) The physical properties of a material in continuous contact with foam liquid concentrate, after exposure to the foam liquid concentrate at 70 °C ± 2 °C for 60 days shall be at least 60 % of the as-received tensile strength and elongation values;

b) The physical properties of a material in continuous contact with the foam solution, after exposure to the foam solution at 70 °C ± 2 °C for 60 days shall be at least 60 % of the as-received tensile strength and elongation values.

NOTE For a material that is in continuous contact with either foam liquid concentrate or foam solution, compliance with 4.4.3 a) is considered representative of 4.4.3 b).

4.5 Plastics and reinforced resin materials

4.5.1 General

Plastic or reinforced resin components, which are essential to the operation or safety of the product, shall meet the relevant requirements of 4.5.2 and 4.5.3.

4.5.2 Resistance to ageing

After ageing in accordance with 5.2 and the appropriate sections of ISO 179-1, ISO 180 and ISO 527-1, specimens of plastics and reinforced resin materials used for components shall

a) have a tensile strength of no less than 50 % of the value before exposure,

b) have an elongation at break of no less than 50 % of the value before exposure, or

c) have an impact strength of no less than 50 % of the value before exposure (this method is relevant to stiff plastics, i.e. flexible plastics shall be evaluated using the tensile test), and

d) show no signs of cracking.

4.5.3 Resistance to exposure to liquids

Plastics and reinforced resin materials which come into contact with foam concentrate, foam solution or water after exposure to the particular liquid in accordance with 5.3 and the appropriate sections of ISO 179-1, ISO 180 and ISO 527-1, shall

a) have a tensile strength of no less than 50 % of the value before exposure,

b) have an elongation at break of no less than 50 % of the value before exposure, or

c) have an impact strength of no less than 50 % of the value before exposure (this method is relevant to stiff plastics, i.e. flexible plastics shall be evaluated using the tensile test), and

d) show no signs of cracking.

4.6 Strength

4.6.1 The pressure-retaining equipment shall withstand, without rupture, an internal hydrostatic pressure of four times the maximum working pressure for a period of 5 min when tested as specified in 5.4. The test in 5.4 is a laboratory test that chooses one sample from 100 or less manufactured.

4.6.2 The calculated design load of any fastener, neglecting the force required to compress the gasket, shall not exceed the minimum tensile strength specified in ISO 898-1 and ISO 898-2 when the equipment is pressurized to four times the maximum working pressure. The area of the application of pressure shall be calculated as follows.

a) If a full-face gasket is used, the area of application of pressure is that extending out to a line defined by the inner edge of the bolts.

b) If an “O”-ring seal or ring gasket is used, the area of application of force is that extending out to the centre line of the “O”-ring or gasket.

4.7 Leak resistance

The pressure-retaining equipment, shall withstand, for 5 min without leakage, an internal hydrostatic pressure of 1,5 times the maximum working pressure specified by the manufacturer, when tested in accordance with 5.5.

4.8 Discharge coefficient (K factor)

The discharge coefficient (K factor) shall be within ±5 % of the value stated by the manufacturer when determined in accordance with 5.6.

4.9 Foam quality and foam capacity

4.9.1 The expansion and drainage time of foam produced by high expansion foam equipment, using the foam concentrate recommended by the manufacturer, shall conform to the values stated by the equipment manufacturer when tested in accordance with 5.7.

4.9.2 The equipment shall produce its specified capacity with each concentrate and at each concentration ratio recommended by the manufacturer when tested in accordance with 5.7.

4.10 Water flow

The high expansion foam equipment shall show no loose parts or leakage when tested in accordance with 5.8.

4.11 Operation reliability

The spring, slider and other movable parts of high expansion foam equipment shall be tested individually in accordance with 5.9. After testing, the movable parts shall be reinstalled in the high expansion foam equipment, and the equipment shall operate properly.

4.12 Stress corrosion

After being subjected to the conditions described in 5.10, a brass part containing greater than 15 % zinc shall comply with the following requirements:

a) show no evidence of cracking when examined using 25x magnification, or

b) if there is evidence of cracking of pressure-retaining equipment, comply with 4.6 at 2 times the maximum working pressure rather than 4 times the maximum working pressure, or

c) if there is evidence of cracking of equipment that is not pressure-retaining, comply with 4.10.

4.13 Salt-spray corrosion

After being subjected to the condition described in 5.11, equipment constructed from metallic parts using combinations of brass, bronze or ferrous metals shall show no destruction or damage which impairs function.

4.14 Light and water exposure

Following light and water exposure for 720 h, as specified in 5.12, an exterior polymeric or fibreglass component part or samples prepared from the same exterior polymeric or fibreglass component material shall comply with the following requirements:

a) shall show no evidence of cracking;

b) a component part that needs not be cut or altered in order to be subjected to the exposure shall function as intended when operated at its maximum inlet pressure and maximum flow rate for 2 min;

c) a component part that needs to be cut or altered in order to be subjected to the exposure shall have physical properties not less than 60 % of the original as-received physical properties when subjected to tensile tests described in ASTM D638.

4.15 Heat and fire resistance

After being subjected to the condition described in 5.13, foam discharge devices intended to be installed in the area of fire shall

a) show no destruction or damage which impairs function, and

b) meet the requirements of 4.8 and 4.9 .

5 Test methods

5.1 General

The following tests shall be carried out for each type of high expansion foam equipment.

Tests shall be carried out at ambient temperatures of 20 °C ± 10 °C, unless other temperatures are indicated. Unless stated otherwise, the tolerances given in Annex A shall apply.

5.2 Ageing test for plastics and reinforced resin materials

Place five specimens of the material under test in an air tolerance oven at 100 °C ± 2 °C for 90 d. Allow to cool in air at 23 °C ± 3 °C for 24 h ± 4 h before testing.

NOTE Certain plastics require a lower oven temperature. In such cases, if the acceleration factors are unknown, it is assumed that the lowering of the temperature by 10 °C implies a doubling of the ageing time.

5.3 Liquid exposure test

Immerse five samples in foam concentrate or foam solution with which the material comes into contact, in accordance with ISO 175, for 210 d at 50 °C ± 2 °C. The type of foam concentrate and the parameters of foam solution shall be recommended by the equipment manufacturer.

NOTE For a sample that is in continuous contact with either foam concentrate or foam solution, compliance with the test in foam concentrate is considered representative of the test in foam solution.

5.4 Equipment pressurization test

The high expansion foam equipment shall be fastened in the test device. Any materials or parts that are not capable of withstanding test pressure should be removed or replaced by suitable ones. Blank off or plug all orifices. Fill the high expansion foam equipment with water, close the vent air and pressurize the hydrostatic pressure four times the maximum working pressure and maintain this pressure for 5 min. The test results shall meet the requirements of 4.6.

5.5 Leak resistance test

The high expansion foam equipment shall be installed on the pipeline. Blank off or plug all orifices, leaving one connection for pressurization and an outlet fitted with a suitable valve for venting air. Fill the equipment with water, close the air vent and pressurize from zero, at a rate not exceeding 0,2 MPa/s (2 bar/s), to not less than 1,5 times the maximum working pressure and maintain for 5 min. The test results shall meet the requirements of 4.7.

5.6 Flow coefficient measurement

Measurement is to be taken with either water or foam solution. The high expansion foam equipment shall be installed in the pipeline as intended. The diameter of the inlet pipe shall be the same or much larger than that of the discharge orifice of the foam equipment. Record flow rates at the minimum, approximate median and maximum inlet pressures or more than these three inlet pressures.

The discharge coefficient (K factor) shall be calculated using the formula given in ISO 7076-2:2012, 3.2, and the mean value of the K factor shall meet the requirement of 4.8.

5.7 Measurement of foam capacity and foam quality

The equipment shall be installed in the pipework as it intend used. Foam concentrate recommended by the equipment manufacturer shall be used. The temperature of foam concentrate shall within the ranges specified by the foam concentrate supplier.

The enclosure used for determining expansion ratio and foam capacity shall be of a minimum of 3 m × 3 m in area and of a height sufficient to contain a minimum 60 s of foam discharge at the specified pressure. The length and width of the enclosure shall be measured prior to the tests and the enclosure area calculated. For fixed high expansion foam equipment, test shall be conducted with the equipment mounted at the top of the enclosure; for the portable equipment, test shall be conducted with the equipment mounted in any convenient means to simulate being hand held. Foam is to be discharged at the minimum, normal and maximum inlet pressure. For each test, the flow rate, inlet pressure, time and corresponding depth of foam shall be recorded, and the foam solution flow rate (if applicable) and foam volume calculated. The foam capacity and the expansion ratio then shall be calculated.

A foam collecting vessel as shown in ISO 7203-2:2011, Annex G shall be used to collect foam for determining drainage time. The vessel shall be weighted to the nearest 0,05 kg prior to the test. Foam is to be discharged at the minimum, normal and maximum inlet pressure. With discharge facility of the vessel closed, collect foam, 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. Open the drainage facility and measure the 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.

Test result shall meet the requirement of 4.9.

5.8 Water flow test

The high expansion foam equipment shall be installed in the pipeline as its intended use. The test sample shall be subject to continuous water flow test for 10 min with 110% of the highest inlet pressure as specified by the manufacturer. The test results shall meet the requirements of 4.10.

5.9 Operation reliability test

Subject the spring or slider in the normal mounting to 500 cycles of normal operation (such as stretch and slide). The components shall not be operated at a rate exceeding six cycles per minute. The test results shall meet the requirements of 4.11

5.10 Stress corrosion test

Each test sample shall be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses shall be applied to the sample prior to and be effective during the test. Samples with threads, intended to be used for installing the product in the field, shall have the threads engaged and tightened to the torque specified in Table 1. All factory installed threads shall be torqued to the maximum specified by the equipment manufacturer. Pipe sealing materials and/or pipe joint sealing compounds shall not be used on the threads. There shall be provisions in the test chamber to prevent droplets of condensation from falling from the top of the enclosure directly onto the samples. Such shield or other means shall be constructed of glass or other non-reactive materials. The samples shall be exposed to the moist ammonia-air mixture maintained in a glass chamber with a known volume. Aqueous ammonia having a density of 0,94 g/cm^3 shall be maintained in the bottom of the chamber, 40 mm to 50 mm below the bottom of the samples.

A volume of aqueous ammonia equal to 10 L/m^3 of the test chamber volume results in approximately the following atmospheric concentrations: 35 % ammonia, 5 % water vapour, and 60 % air. Prior to beginning the exposure, the chamber shall be conditioned to a temperature of 34 °C ± 2 °C for a period of not less than 1 h, and shall be maintained as such throughout the exposure period. The moist ammonia-air mixture shall be maintained at essentially atmospheric pressure. Provision shall be made for venting the chamber, such as by the use of a capillary tube, to avoid pressure build-up.

The test exposure shall be 10 d. Upon removal, samples shall be rinsed in potable water and air-dried. After a 2 d to 4 d drying period, visual examination of the samples shall be made. After exposure, the equipment shall comply with the requirement of 4.12.

Table 1 — Torque requirements for threaded connections

Nominal thread size mm	Torque N-m
3	11
6	20
10	27
13	46
19	68
25	136
32	164
38	175
50	186
64	198
76	203
102	215

5.11 Salt-spray corrosion test

During the corrosive exposure, a metallic part is to be connected to a typical pipe fitting or hose coupling to simulate field installation, unless it is to be marked to specify fitting or coupling material or both.

The specimens shall be subjected to a salt spray using the equipment specified in ISO 9227 and a salt solution having a mass fraction of 20 % sodium chloride in distilled water. The pH of the collected salt solution shall be between 6,5 and 7,2 and the density shall be between 1,126 g/ml and 1,157 g/ml when atomized at 35 °C ± 2 °C. A suitable means of controlling the atmosphere in the chamber shall be provided.

Suspend the specimens in their intended operating position and expose them to the salt spray (fog) in a chamber having a volume of at least 0,4 m^3. Maintain the exposure zone at a temperature of 35 °C ± 2 °C. Record the temperature at least once per day. Salt solution shall be supplied from a recirculation reservoir through air-aspirating nozzles, at a pressure between 0,07 MPa (0,7 bar) and 0,17 MPa (1,7 bar). Collect salt solution run-off from exposed samples to make sure that it is not returned to the reservoir for recirculation. Shield specimens from condensate drippage. Collect fog from at least two points in the exposure zone to determine the rate of application and salt concentration.

Expose the specimens to the salt spray for a period of 10 d. After this period, remove the specimens from the fog chamber and allow them to dry for 2 d to 4 d at a temperature not exceeding 20 °C ± 5 °C in an atmosphere having a relative humidity no greater than 70 %. Tested samples shall remain fully functional and exhibit no corrosion, galvanic action, loss of legibility of markings, or separation of protective coatings, which impair functionality. Superficial discoloration with no substantial attack of the underlying material shall be acceptable. Test results shall meet the requirements of 4.13.

5.12 Light and water exposure test

The light and water exposure shall be conducted in accordance with Cycle 1 described in ASTM G155. Test results shall meet the requirements of 4.14.

5.13 Heat and fire resistance

Foam discharge devices complete with their foam solution piping and wiring shall be suspended 3 000 mm ± 100 mm above a 4,5 m^2 ± 0,1 m^2 fire test tray containing 350 l ± 5 l of n-heptane fuel, which is shielded to ensure flame impingement on the device. After ignition of the fuel, the device shall be exposed to the flames for 5 min ± 10 s. The test results shall meet the requirements of 4.15.

6 Marking

The marking of the high expansion foam equipment shall be non-detachable, non-flammable, permanent and legible. The high expansion foam equipment shall be marked with:

a) name or trademark of the manufacturer;

b) name of product;

c) model designation (type);

d) working pressure(s);

e) nominal flow rate;

f) date of production;

g) if evaluated for specific pipe fitting or hose coupling material(s), then the equipment shall be marked to specify the pipe fitting or hose coupling material(s).

7 Manufacturer's installation and operation instructions

Installation instructions, including any special dimensional, orientation or access requirements, as well as the foam liquid concentrate intended for use with the equipment, shall be provided by the manufacturer. Instructions shall be provided in each shipping container or attached to each component.

Annex A
(normative)

Tolerances

Unless stated otherwise, the tolerances given in Table A.1 shall apply.

Table A.1 — Tolerances

Parameter	Tolerance	
Angle	±2°	
Frequency (Hz)	±5 % of value	
Length	±2 % of value	
Volume	±5 % of value	
Pressure	±3 % of value	
Temperature	±5 % of value	
Time	$^{+5}_{0}$	seconds
	$^{+0,1}_{0}$	minutes
	$^{+0,1}_{0}$	hours
	$^{+0,25}_{0}$	days

Bibliography

[1] ISO 6447, *Rubber seals — Joint rings used for gas supply pipes and fittings — Specification for material*

[2] ISO 6448, *Rubber seals — Joint rings used for petroleum product supply pipes and fittings — Specification for material*

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