INTERNATIONAL STANDARD

ISO 7076-5

First edition
2014-05-01

Fire protection — Foam fire extinguishing systems —

Part 5: Fixed compressed air foam equipment

Protection contre l'incendie — Installations fixes d'extinction par mousse physique —

Partie 5: Équipement fixe pour mousse physique à air comprimé

Reference number
ISO 7076-5:2014(E)

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Published in Switzerland

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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).

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

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

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 5: Fixed compressed air foam equipment*

The following parts are under preparation:

— *Part 3: Medium expansion foam equipment*

— *Part 4: High expansion foam equipment*

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

Introduction

This part of ISO 7076 is prepared by ISO/TC 21/SC 6, and is based on FM Global Class 5130 Approval Standard on Foam Extinguishing Systems.

Fixed compressed air foam equipment is required to function satisfactorily not only in the event of fire, but also during and after exposure to conditions it is likely to meet in practice, including corrosion, vibration, direct impact, and indirect shock. Specific tests are intended to assess the performance of the equipment under such conditions.

The aim of using such systems is to improve the fire suppression effectiveness of the fire extinguishing agent on the burning materials for both Class A and Class B fires, by producing uniform and more stable bubbles, which improves the cooling effect of the applied media.

This part of ISO 7076 is not intended to place any other restrictions on the design and construction of fixed compressed air foam equipment.

Fire protection — Foam fire extinguishing systems —

Part 5:
Fixed compressed air foam equipment

1 Scope

This part of ISO 7076 specifies requirements, test and assessment methods, and performance criteria for fixed compressed air foam equipment of fixed foam extinguishing systems for indoor or outdoor utilization, or both.

Technical safety requirements concerning the design and manufacturing of drives, auxiliary equipment, sources of energy, or pumps are outside the scope of this part of ISO 7076.

Special hazards arising from the particular conditions under which these systems are used are outside the scope of this part of ISO 7076.

Hazards relating to any kind of mechanical, electrical, hydraulic, pneumatic, and other equipment dealt with by the respective standards for such equipment are outside the scope of this part of ISO 7076.

Hazards arising from the noise of systems are outside the scope of this part of ISO 7076.

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.

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

ASTM B117, *Standard practice for operating salt spray (fog) apparatus*

NFPA 11-2010, *Standard for Low-, Medium-, and High-Expansion Foam*

3 Terms and definitions

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

3.1
air delivery rate
volume of air, in normal condition, that is fed into a fixed compressed air foam system per unit of time

Note 1 to entry: While inside the system, the air volume will be compressed according to the pressure applied. Once it leaves the system from the nozzle to the atmosphere, the air will expand to its normal volume again.

3.2
air/foam solution volume ratio
ratio stating how many parts of air (at normal condition) are mixed with one part of the foam solution in a fixed compressed air foam system

Note 1 to entry: The ratio is expressed as the pair of values one part foam solution to x parts air (1:x).

3.3
approved
acceptable to the authority having jurisdiction

3.4
authority having jurisdiction
AHJ
organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure

3.5
compressed air foam
CAF
homogenous foam produced by the combination of water, foam concentrate, and air or nitrogen under pressure

3.6
compressed air foam generating method
method of generating compressed air foam recognized in this part of ISO 7076 using a mixing chamber to combine air or nitrogen under pressure, water, and foam concentrate in the correct proportions

Note 1 to entry: The resulting compressed air foam flows through piping to the hazard being protected.

3.7
compressed air foam discharge device
device specifically designed to discharge compressed air foam in a predetermined pattern

3.8
fixed compressed air foam system
fixed CAFS
system employing compressed air foam discharge devices attached to a piping system through which foam is transported from a mixing chamber

Note 1 to entry: Discharge of fixed CAFS begins with automatic actuation of a detection system, or manual actuation that opens valves permitting compressed air foam, generated in the mixing chamber, to flow through a piping system and discharged over the area served by the discharge devices.

3.9
drainage time 25 %
time taken for 25 % of the foam to collapse into solution

3.10
wet foam
foam produced by a fixed compressed air foam system and which has a foam solution/air volume ratio of between 1:3 to 1:10

3.11
dry foam
foam produced by a fixed compressed air foam system and which has a foam solution/air volume ratio of more than 1:10

3.12
foam expansion ratio
ratio of the volume of expanded foam and its solution

3.13
foam solution
mixture of water and foam concentrate

3.14
(foam solution) delivery rate
Q_W
volume (of water plus foam concentrate) delivered per unit of time by a system

Note 1 to entry: At proportioning ratios of up to 1 %, the difference between water delivery rate and foam solution delivery rate can be neglected.

3.15
foam quality
quality of foam based on foam expansion ratio and 25 % drainage time

3.16
nozzle
specially designed device that can discharge foam in a predetermined pattern

3.17
operation pressure of the fixed CAF system
pressure at the system input connection at which all performance and safety requirements are met and which shall be specified by the fixed compressed air foam system

3.18
operation range
range (of conditions) specified by the manufacturer of a system and within which the system can be operated without limitations while achieving the intended performance characteristics

3.19
proportioning ratio
volume of foam concentrate added to water by volume, given as a percentage of the solution

3.20
listed
equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose

4 Abbreviated terms

CAF compressed air foam

CAFS compressed air foam system

5 Requirements

5.1 Compliance

In order to comply with this part of ISO 7076, the fixed CAF system shall meet the requirements of this clause, which shall be verified by technical inspection or engineering assessment, shall be tested as specified in Clause 6, and shall meet the requirements of the tests.

5.2 General

5.2.1 The fixed CAF system shall be designed in accordance with the requirements of Chapter 7 of NFPA 11-2010 and of this clause.

5.2.2 A fixed CAF system shall generate at least wet foam.

5.2.3 A homogeneous, finely pored foam shall be discharged at the nozzles.

5.3 Operation and control of systems

5.3.1 The operating range(s) for dry foam and wet foam shall be specified by the system manufacturer.

5.3.2 There shall be no compressed air pulses at the fixed CAF system outlet cross section when the system is switched on and off.

5.3.3 Within the operating range and at a foam solution delivery pressure of between 0,4 MPa and 1 MPa, the deviation from the set proportioning ratio shall not exceed

a) 0 to +20 % for proportioning ratios up to 1 % and

b) 0 to +30 % for proportioning ratios between 1 % and 3 %.

5.3.4 The pressure drop across the fixed CAF system when operated at the nominal delivery rate shall not exceed 0,2 MPa.

5.3.5 The CAF unit shall be equipped with an air pressure regulating system that prevents the flow of air when the liquid discharge is interrupted.

5.3.6 System controls shall be designed in accordance with 4.9 of NFPA 11-2010.

6 Tests

6.1 General

6.1.1 CAF shall demonstrate extinguishing performance in Class B fire tests. Fires shall be extinguished by the end of the allowable discharge time and shall not reignite during the post-extinguishment observation period.

6.1.2 Atmospheric conditions for tests

6.1.2.1 Unless otherwise stated in a test procedure, conduct the testing after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as specified in IEC 60068-1 as follows:

— temperature: (15 to 35) °C;

— relative humidity: (25 to 75) %;

— air pressure: (86 to 106) kPa.

6.1.2.2 The temperature and humidity shall be substantially constant for each test where the standard atmospheric conditions are applied.

6.1.3 Operating conditions for tests

6.1.3.1 If a test method requires a specimen, such as nozzle or mixing chamber, to be operational, then connect the specimen to a suitable water supply and foam concentrate having the characteristics required by the manufacturer's data. Unless otherwise specified in the test method, the fixed CAF system

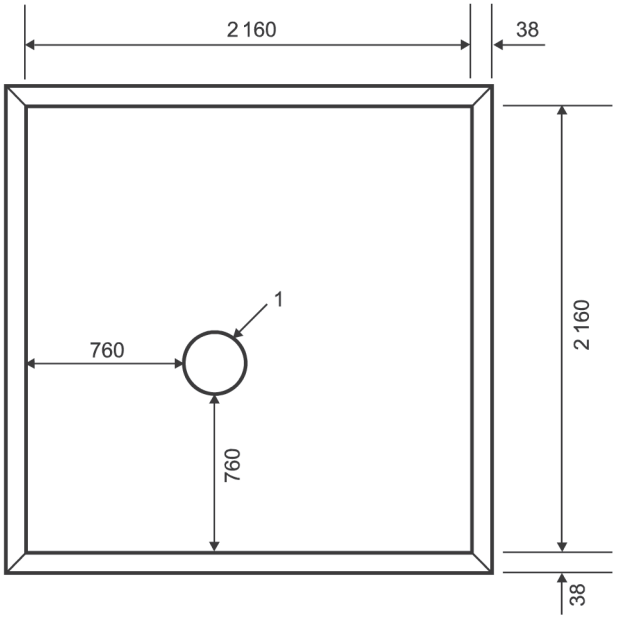
parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range.

6.1.3.2 The details of the water supply and foam concentrate used shall be given in the test report (see Clause 7).

6.2 CAF fire extinguishment tests/verification

6.2.1 The fire test pan (see Figure 1) shall be square and fabricated of steel with a minimum thickness of 4,8 mm. The inside dimensions shall be 2,16 m^2 by a minimum of 305 mm deep. All surfaces shall meet at 90° angles and shall be joined by continuous, liquid-tight welds. The upper edge of the pan shall be reinforced by an externally attached 38 mm steel angle of 4,8 mm minimum thickness. The angle shall be attached to the pan by continuously welding its outside corner to the top edge of the pan, so that the upper surface of one leg of the angle is flush with the top of the pan and the other leg of the angle is tight against the outside wall of the pan. The lower leg of the angle shall be attached to the pan by approximately 12-mm-long tack welds spaced approximately every 50 mm. The pan can be fitted with a drain connection and lifting lugs below the reinforcing angle, if desired. Other equivalent construction shall be allowed, provided that minimum section thicknesses are met or exceeded.

Dimensions in millimetres



Key

1 typical location for stovepipe insertion

Figure 1 — Low expansion fire test pan

6.2.2 The fire test shall be conducted with the pan resting on a flat surface or elevated no more than 305 mm above that surface. If the pan is to be so elevated, then a continuous skirt shall be used to prevent air circulation below the pan during the test.

6.2.3 At minimum, the concentrate shall be tested with commercial grade heptane for the test fuel. After the pan has been levelled, heptane shall be added to a minimum depth of 50 mm. Then water shall be added to raise the heptane level to provide a minimum freeboard of 203 mm. For water-miscible fuels, water cannot be used to adjust the fuel level in the pan. Therefore, a shallower pan can be used if the manufacturer does not wish to test with a freeboard greater than 203 mm.

6.2.4 Tests shall be conducted inside or outside under conditions of calm air and no precipitation, and at ambient air, premix, and fuel temperatures between 10 °C and 32 °C.

6.2.5 Foam solution shall be prepared by mixing the specified amount of concentrate with water, either in a premixed solution or continuously by use of suitable proportioning equipment. Volume measuring, weighing, or flow measuring equipment shall be of sufficient accuracy to ensure that concentration is within ±5 % of the specified value. If conductivity measurements are to be used as a proxy for direct measurements of volume, weight, or flow to determine concentration, the procedure of Annex A shall be used to validate the correlation of conductivity to concentration.

6.2.6 The discharge device and application rate to be used in test shall be selected by the manufacturer. The application rate used shall define the minimum rate for the concentrate, unless an additional successful test is conducted at a lower application rate. Authorities having jurisdiction can mandate higher application rates for specific hazards.

6.2.7 CAF fire extinguishment tests shall be conducted using four nozzles installed on the manufacturer's maximum specified square spacing and at the manufacturer's minimum recommended foam application rate. Nozzle height shall be the manufacturer's specified minimum. A second set of tests shall be conducted using the manufacturer's maximum area of coverage asymmetry, if other than square spacing is specified for the system. After review of the test results, the worst performing combinations of concentrates, hardware, and installation geometries shall also be tested at the manufacturer's maximum recommended installation height. Tests shall be conducted with each concentrate and at the manufacturer's specified concentration(s).

6.2.8 For non-water-miscible fuels, including commercial grade heptanes, the test fuel shall be ignited and allowed to burn for the preburn time indicated in Annex B prior to the application of foam. CAF discharge duration shall be 5 min with 5 min of subsequent water discharge. Since CAF discharge devices are typically not sprinklers, this will require overlaying of the CAF piping grid with a second sprinkler grid. The sprinkler grid shall be with a minimum water application rate of 0,3 gal/min/ft^2 (12,2 mm/min). A maximum water application rate for foam breakdown as specified by the manufacturer shall be tested. The maximum water application rate can be selected by the manufacturer from 0,3 gal/min/ft^2 to 1,0 gal/min/ft^2 (12,2 mm/min to 40,8 mm/min) at even 0,1 gal/min/ft^2 (4,1 mm/min) steps. The timing for reignition attempts and the burn-back resistance evaluation shall be as specified for foam-water sprinklers and the type of concentrate, as shown in Annex B.

For water-miscible fuels, the test method is the same, except CAF discharge duration shall be 5 min with no subsequent water discharge. The timing for reignition attempts and the burn-back resistance evaluation shall be as specified for foam-water sprinklers and the type of concentrate, as shown in Annex B. If a premixed solution is not used, concentration shall be verified by appropriate instrumentation to measure water and concentrate flow rates or weight or volume changes.

6.2.9 The pan surface shall be completely covered by the foam blanket and the fire completely extinguished by the end of foam discharge. If the discharge device is a foam-water sprinkler, or a device which can be installed under a fire protection sprinkler system, then water-only discharge shall continue for an additional 5 min to verify that the foam blanket cannot be easily degraded by subsequent water discharge. The water application rate shall be the same as used for the foam for a foam-water sprinkler with a minimum 0,2 gal/min/ft^2 (8,1 mm/min) rate. A subsequent maximum water application rate for foam breakdown, as specified by the manufacturer, shall be tested. This maximum application rate can be selected by the manufacturer from 0,3 gal/min/ft^2 to 1,0 gal/min/ft^2 (12,2 mm/min to 40,8 mm/min) at even steps of 0,1 gal/min/ft^2 (4,1 mm/min). If the test fuel is water miscible, the water-only discharge will not be used for that fuel, because the mixing of water with the fuel will prejudice the reignition and sealing evaluations. All concentrates and concentrations submitted for use on water-miscible fuels shall also be tested on heptane fuel with subsequent water-only discharge.

6.2.10 As for reignition resistance, after the completion of discharge, the foam blanket shall remain undisturbed for an observation period, as indicated in Annex C. During this time, the fuel shall not reignite when a lighted torch is passed within 25 mm of the surface of the foam blanket. Reignition attempts shall

be made within 1 min after the end of discharge and within 1 min before the end of the observation period. Reignition attempts shall be 1 min in duration, during which time the entire surface of the blanket shall be probed, including the corners. The torch shall consist of an approximately 100-mm-diameter by 100-mm-long tightly wrapped roll of heptane-soaked cotton cloth at the end of a steel rod approximately 1,2 m long. Alternatively, a propane torch can be used for this purpose if provided with a non-air-aspirating tip at the end of a minimum length 1,2 m wand and adjusted to produce a yellow flame a minimum of 100 mm long. The propane container shall be at the operator end of the wand and shall not be extended over the pan surface.

6.2.11 As for burn-back resistance, at the end of the observation period, the foam blanket shall be deliberately broken and the fuel shall be reignited in the rift. The rift shall be created by placing a vertical pipe in the pan, removing the foam blanket from within the pipe, reigniting the fuel within the pipe, and slowly removing the pipe. The pipe shall be fabricated from steel sheet of 0,38 mm to 1,23 mm thickness and a minimum of 305 mm inside diameter and approximately 355 mm long. The pipe shall be placed with its outer surface approximately 0,76 m from both walls of the pan in the corner where the foam blanket appears to be weakest. The foam blanket captured within the pipe shall be removed as thoroughly as possible without agitating the surface of the fuel. The fire within the pipe shall be allowed to burn for 1 min prior to removing the pipe. Subsequently, the burning rift shall either reclose or not enlarge beyond 0,9 m^2 over a 5 min observation period.

6.2.12 Annex C provides a tabular chronology of the schedule of events for this test.

6.2.13 A foam sample shall be captured under the same discharge conditions as used for this test. Quality measurements shall be taken from this sample. These values shall be used to verify that discharge devices can produce foam sufficiently similar to that used in the successful fire tests. Accurate foam quality measurements cannot be possible with extremely low expansion ratios and rapid drainage times, such as is frequently the case with conventional sprinklers used for foam water service. When there is no quality data obtained in an extinguishment test, that test cannot be used to qualify equipment other than that actually used in the test.

6.3 CAF foam quality measurements

6.3.1 The expansion ratio and 25 % drainage time for foam produced from a concentrate at a specified concentration ratio that has been successfully fire tested shall be measured to establish benchmark values for use in evaluation of the effectiveness of any discharge devices proposed for use with that foam.

6.3.2 A foam slider shall be used to collect foam samples for determining foam quality. A typical "slider" is illustrated in Figure 2 and consists of a sheet of smooth metal, plastic, or wood held on a frame at an angle of 45° to the floor. Foam reaching the "slider" surface shall be guided into a foam sample container placed at the bottom of the sheet. Excessive overflowing of foam solution shall be avoided to prevent foam agitation in the container.

6.3.3 Two collection containers shall be used. The containers shall be graduate cylinders of 1 600 ml to 2 000 ml capacity. Each container shall be weighed prior to the test to the nearest gram and these tare weights shall be recorded. The specific size of the containers used is not critical, as long as the volume is accurately measured and the gradations are a maximum of 0,1 times the liquid volume for 25 % drainage.

6.3.4 The foam discharge shall be stabilized at the desired concentration and flow rate. The foam shall be running freely down the slider, presenting a uniform, steady-state appearance at the time of sample collection.

6.3.5 Each container shall be filled with foam from the sample collector. Timers shall be started at the completion of filling.

6.3.6 Observations of the liquid level at the bottom of each container shall be recorded at 15 s intervals. Data recording shall continue for a minimum of 30 s after the liquid quantity exceeds 1/10 of the graduate cylinder's volume, or all foam has been liquefied, whichever first occurs. Data recording intervals can be increased to 30 s if the 25 % drainage times exceed 5 min.

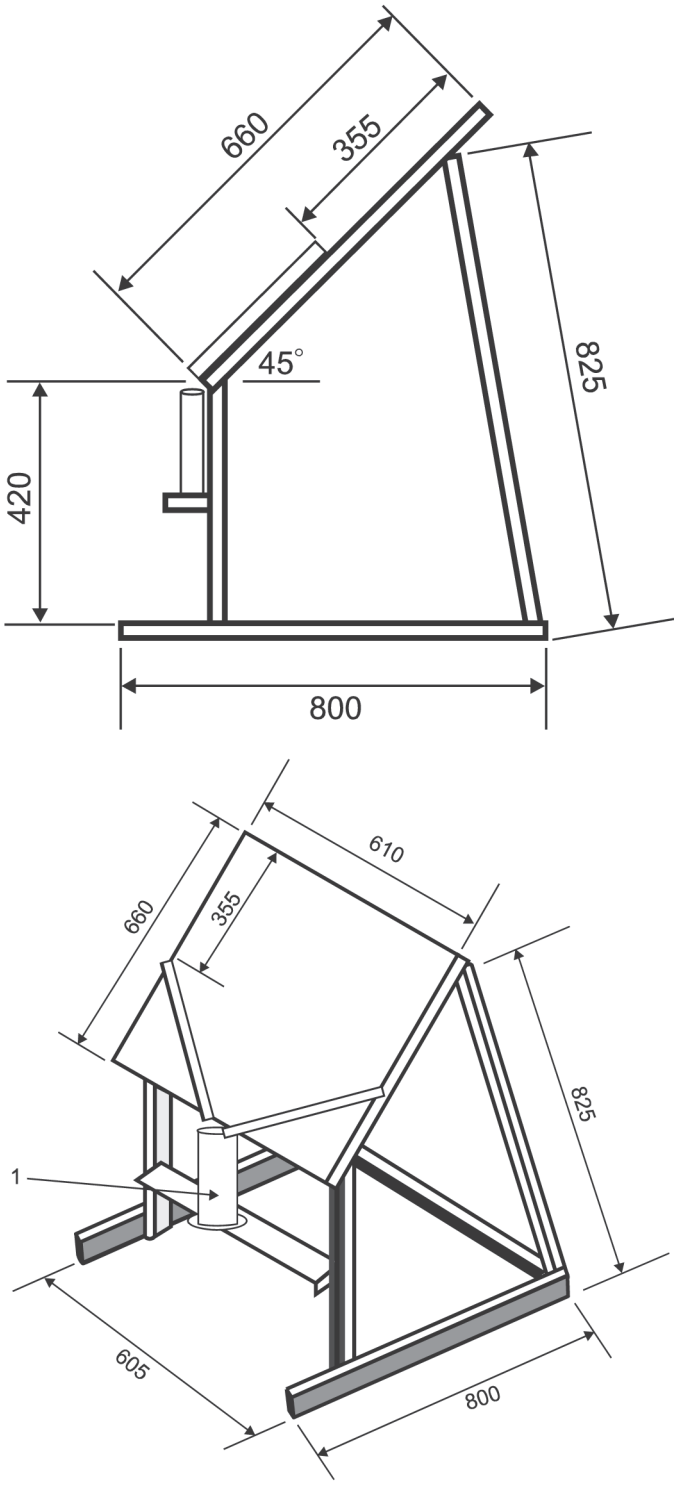
6.3.7 The foam container external surfaces shall be thoroughly wiped off and each container reweighed. Net weights shall be calculated for each container by subtracting its tare weight from the final weight.

6.3.8 Each container shall be thoroughly rinsed out with water and refilled with foam solution, at the same concentration as used to generate the foam samples. The refilled containers shall be reweighed and the net weights of the solution shall then be calculated by subtracting the tare weights. Alternatively, the weight of foam solution can be calculated from the specific gravity of the solution and the container volume, if the solution specific gravity has been determined to a level of acceptable accuracy.

6.3.9 Expansion ratio shall be calculated by dividing the total of the net weights of the solution from both containers by the total of the net weights of the foam samples from each.

6.3.10 25 % drainage time shall be determined by fitting the best line to the time versus collection data for each container and calculating the time for drainage of 25 % of the container volume. This process can be automated using an electronic spreadsheet program. The data for the time of collection (in seconds) shall be plotted as a function of the volume of solution collected (in grams) using the spreadsheet software. The spreadsheet shall also be used to fit the best line to the data and obtain the equation of that line, as well as its R^2 correlation coefficient. If the correlation coefficient is 0,95 or higher, then the equation for that line shall be used to calculate the time to collect liquid solution equivalent to 0,25 of the graduate cylinder's foam weight. This shall be termed the "25 % drainage time" for the sample. If the correlation coefficient is less than 0,95, the test shall be repeated until data are obtained which will generate a curve fit of acceptable accuracy. The value for the two containers shall be averaged and recorded. This shall determine the 25 % drainage time to be used for future comparisons.

Dimensions in millimetres



Key
1 collection container

Figure 2 — Typical foam slider

6.4 CAF foam discharge devices

6.4.1 A discharge device shall either be used to create foam used in a successful fire test, as described in 6.2, or shall produce foam of approximately equivalent quality to that undergoing a successful fire test, when tested using a solution of the same concentrate at the same concentration ratio.

6.4.2 Testing of discharge devices shall be conducted as described in 6.2 to demonstrate their ability to produce foam capable of extinguishing the Class B pan fire.

6.4.3 Fire extinguishment testing can be waived if the discharge device is of the same type as one used in a successful fire extinguishment test and demonstrates the ability to produce foam of essentially equivalent quality, when tested as described in 6.3.

6.5 CAF generation and proportioning

6.5.1 Generation rates

Generation rates shall be measured for all sizes of mixing devices, with each specified concentrate, and at minimum and maximum specified water pressures. When the mixing devices also perform the proportioning function, all sizes shall be tested to verify accuracy of proportioning of all concentrates over the manufacturer's specified range of supply pressures. Tests shall be repeated using concentrate supplies at the manufacturer's minimum specified temperature, but no higher than 1,7 °C. The foam generation rates measured in these tests shall meet or exceed the manufacturer's specified capacities for each size of mixing device.

6.5.2 CAF area of coverage

Areas of effective coverage for each nozzle design shall be measured by foam collection at the specified flow rate, in known size pans throughout the specified coverage area. These tests shall be conducted using both the most highly and least highly expanded foams identified in the CAF generation tests and at the minimum specified nozzle height. The minimum specified application rate shall be achieved over the entire specified areas of coverage.

6.5.3 CAF hydraulics

Because fixed CAF systems transport foam from the generator to the discharge device in a fully expanded state, the manufacturer shall demonstrate the ability to predict flow rates at the discharge device either by testing the most restrictive specified balanced piping arrangements, or by conducting tests at the specified limits of design methodology for unbalanced systems. In these tests, discharge rates and foam quality shall be measured for all discharge points and compared to the predicted rates and the quality of the foam applied in the successful extinguishment tests.

6.5.4 Suitability and durability

The system shall be exercised through all its operating modes and shall operate as specified by the manufacturer. All possible combinations of inputs shall be applied and responses shall be as specified. A minimum of three trials shall be conducted for each combination with successful results. Components shall operate normally at the maximum and minimum installation temperatures, water pressures, air pressures, and other extremes of specified operating ranges.

6.5.5 Gas pressure containing components

All components subject to gas pressure that are intended to be shipped pressurized shall meet the relevant requirements of the countries having jurisdiction (such as US Department of Transportation or Transport Canada) or equivalent relative standards for the jurisdiction of installation. Cylinder construction shall be verified to be in compliance to the standards to which they are designed. This will

require design calculations per the appropriate standards, chemical and physical data for the materials, and drawings illustrating the relevant construction details, such as wall thickness and materials. All components subject to gas pressure shall not leak at the proof test pressure and shall not be damaged when subjected to 5/3 that pressure, or twice the pressure relief setting, whichever is greater. For pressure vessels that will be transported while pressurized, permanent volume expansion resulting from a 30 s application of the proof pressure shall not exceed 10 % of the total expansion.

6.5.6 Durability

All operating devices shall not fail, leak, or significantly change their operating characteristics after being cycled 500 times at rated conditions.

6.5.7 Nozzle materials

Nozzles shall not exhibit corrosion which would compromise their hydraulic or mechanical performance after being subjected to salt fog testing per 6.6. Any nozzle incorporating moving parts showing increased resistance to motion after this test shall be retested at the lowest foam delivery pressure to ensure that it can still maintain its specified coverage area.

6.5.8 Nozzle impact resistance

Nozzles shall withstand a drop of 0,75 m onto a concrete surface in various impact orientations with no adverse effect on hydraulic or mechanical performance. Any nozzle incorporating moving parts showing increased resistance to motion after this test shall be retested at the lowest foam delivery pressure to ensure that it can still maintain its specified coverage area.

6.6 Salt fog corrosion

6.6.1 System components shall withstand a 240 h exposure to a 20 % salt in water (laboratory grade sodium chloride in demineralized water) fog without incurring damage which would impair function.

6.6.2 Test samples shall be selected to represent all material combinations and configurations. The test shall be conducted in conformance to ASTM B117. Tested samples shall remain fully functional and exhibit no corrosion, galvanic action, loss of legibility of markings, or separation of protective coatings which would impair future functionality. Superficial discoloration with no substantial attack of the underlying material shall be acceptable.

6.7 Thermal shock

6.7.1 Components such as oscillating monitors, nozzles, and other discharge devices, which are exposed to the protected space, shall remain functional if heated by a fire prior to the system discharge. Functionality shall be defined as appropriate for the specific component.

6.7.2 The component shall be connected to a 1,21 MPa water supply.

6.7.3 The component shall be placed on the edge of the fire test pan described in 6.2, arranged as it would be to protect the pan. Heptane fuel shall be provided in sufficient depth to last 6 min. Components shall be dry for the first minute of fire exposure. Then water shall be flowed for an additional 5 min.

6.7.4 After this test, the component shall exhibit normal operation. After being allowed to return to room temperature, the sample shall be inspected for damage. No damage which would impair function shall be allowed.

7 Test report

The report of tests applied to the fixed CAF system shall contain at least the following information:

a) the manufacturer's name or trademark;

b) a reference to this part of ISO 7076 (i.e. ISO 7076-5:2014);

c) the designation;

d) the operating range;

e) the date of tests;

f) the results of the tests.

8 Data

8.1 Operating instructions

Operating instructions shall be provided with the fixed CAF system. The operating instructions shall include the following:

a) general description;

b) application range and limits of use as intended (e.g. note that the system is not intended for use in potentially explosive atmospheres), including specification of all ambient conditions at the place of deployment;

c) manufacturer's name or name of their authorized representative;

d) designation, type, and size;

e) revision number and/or revision date of the operating instructions;

f) warnings to prevent foreseeable misuses, including

   1) how hazards that might cause burns or frostbite can be reduced (e.g. by wearing protective gloves for operators) and

   2) how to avoid igniting objects in the vicinity;

g) necessary personal protective equipment (e.g. the need to wear protective gloves) in accordance with ISO 11393-4;

h) ambient temperature range for system operation;

i) design, mode of operation, and system performance, including main specifications (e.g. materials, draining, maintenance items);

j) overview of permitted foam concentrates (manufacturer, product designation) and temperatures;

k) information concerning the hoses (e.g. diameter, length) and the nozzles to be used;

l) maximum operating pressure;

m) information on control and indicating equipment;

n) design, operating principle, and use of protective devices;

o) additional description of accessories;

p) cutaway or exploded view drawings of the system;

q) information on the electrical equipment;

r) commissioning instructions, including

   1) measuring points and piping diagram (e.g. piping and instrumentation flow diagram) and

   2) overview of recommended lubricants;

s) settings for control and indicating equipment, including

   1) function test and

   2) setting values;

t) instructions for putting the system into operation, including

   1) commissioning,

   2) putting system into operation after interruptions,

   3) switching the system on/number of switching cycles,

   4) operation and starting up with closed valve,

   5) operating characteristics with increased inlet pressure, and

   6) special information (e.g. readiness for operation, disturbances);

u) decommissioning instructions, including

   1) switching off the system,

   2) emptying and draining,

   3) flushing,

   4) preservation, and

   5) storage.

8.2 Service and maintenance instructions

Service and maintenance instructions recommended by the manufacturer shall be provided with the fixed CAF system. The service and maintenance instructions shall include the following:

a) maintenance intervals;

b) maintenance and inspection tasks, including

   1) consumables, including a list of replacement parts and special tools,

   2) monitoring during operation,

   3) preventive measures (e.g. for parts subject to wear, lubrication, sealing medium), and

   4) warning against risks arising from incorrectly set safety devices;

c) tightening torques for connecting elements;

d) criteria for selecting parts needing replacement;

e) durability of markings and warning notices.

8.3 Fault causes and corrective actions

Information to assist in the diagnosis of faults and the relevant corrective actions shall be provided with the fixed CAF system. The information shall include the following faults and corrective actions:

a) hydrodynamic;

b) mechanical;

c) electrical;

d) measuring instruments and their connections.

9 Marking

9.1 The following information shall be permanently marked on the fixed CAF system:

a) the registered name and address of the manufacturer;

b) the type and type test number;

c) a reference to this part of ISO 7076 (i.e. ISO 7076-5:2014) and the designation (classification) of the system;

d) the serial number of the system and year of manufacture;

e) at the operator position, a diagram showing the system operating range;

f) at the operator position, a short form of the operating instructions.

9.2 Markings of control elements and filling devices shall be durable and legible at all times.

9.3 Lubrication and servicing points, draining devices, etc. shall be identified by appropriate colours.

Annex A
(normative)

Conductivity test procedure

A.1 General

This method is based on changes in electrical conductivity as foam concentrate is added to water. A handheld conductivity meter is used to measure the conductivity of foam solutions in microsiemen units. Conductivity is a very accurate method, provided there are substantial changes in conductivity as foam concentrate is added to the water in relatively low percentages (i.e. 1 %, 3%, or 6%). Since salt or brackish water is very conductive, this method might not be suitable due to small conductivity changes as foam concentrate is added. It will be necessary to make foam and water solutions in advance to determine if adequate changes in conductivity can be detected if the water source is salty or brackish. If conductivity is not an appropriate proxy for concentration due to one of these circumstances, then direct flow rate or timed volume or weight change measurements of the water and concentrate supplies shall be used to determine concentration.

A.2 Equipment required

A base calibration curve shall be prepared using the following apparatus:

1. four 100 ml plastic bottles with caps;
2. one 10 ml measuring pipette or 10 cc syringe;
3. one 100 ml graduated cylinder;
4. a laboratory stirring device and plastic-coated magnetic stirring bars;
5. one portable temperature-compensated conductivity meter;
6. a temperature measuring device;
7. a personal computer;
8. a spreadsheet program with graphing and straight line regression capability.

A.3 Procedure

Using the water and foam concentrate from the system to be tested, a minimum of three standard solutions shall be made up using the 100 ml graduate.

At minimum, these standards shall include the nominal specified percentage of injection, the nominal percentage plus 1 % or 2 % points, and the nominal percentage minus 1 % or 2 % points.

The water shall be placed in the 100 ml graduate (leaving adequate space for the foam concentrate) and then the foam concentrate samples shall be carefully added into the water using the syringe to measure the specified amount. Care shall be taken not to pick up air in the foam concentrate samples.

Each standard foam solution shall be poured from the 100 ml graduate into a 100 ml plastic bottle. Each bottle shall be marked to indicate the percent solution it contains. A plastic stirring bar shall be added to the bottle. The bottle shall be capped, placed on the stirring device, and stirred thoroughly to mix the foam solution.

The samples shall be brought to the same temperature as the tested solution, 70 °F ± 5 °F (21 °C ± 2 °C).

The conductivity of each solution shall be measured. Reference shall be made to the instructions for the specific conductivity meter to determine proper procedures for taking readings. It will be necessary to switch the meter to the correct conductivity range setting to obtain a proper reading. Most synthetic-based foams used with freshwater will result in foam solution conductivity readings of less than 2 000 microsiemens. Protein-based foams will generally produce conductivity readings in excess of 2 000 microsiemens in freshwater solutions. Due to the temperature compensation feature of the conductivity meter, it can take a short time to obtain a consistent reading.

Once the solution samples have been measured and recorded, the bottles shall be set aside for control sample references. The standard concentrations and conductivity readings shall then be entered into a spreadsheet program and plotted with the foam solution percentage on the horizontal axis and conductivity readings on the vertical axis.

Using the spreadsheet utility, the best line shall then be fitted to the data, and the equation of that line, as well as its R^2 correlation coefficient, shall be obtained. If the correlation coefficient is 0,95 or higher, then the equation for that line shall be used to calculate the concentrations from conductivity readings, for that concentrate and water supply. If the correlation coefficient is less than 0,95, the test shall be repeated until data are obtained which will generate a curve fit of acceptable accuracy. This plot will serve as the known base (calibration) curve to be used for the test series.

A.4 Obtaining and evaluating test samples

Foam solution samples shall be collected from the proportioning system, using care to ensure the sample is taken at an adequate distance downstream from the proportioner being tested and that the flow has been well established to flush any stagnant water from the system. Using foam solution samples that are allowed to drain from expanded foam can produce misleading conductivity readings and, therefore, is not allowed.

Once one or more samples have been collected and stabilized at 70 °F ± 5 °F (21 °C ± 2 °C), their conductivity shall be read and the corresponding percentage found using the line equation of the base curve prepared from the control sample solutions.

At the conclusion of all readings, a water sample shall be obtained and a new calibration sample produced at the specified concentration to revalidate the base curve. If the measured and specified values do not match within 5 % of the specified value, then additional calibration samples shall be made and the software used to produce a new baseline equation. The test sample conductivities shall then be used to obtain new calculated concentrations and these averaged with those obtained from pretest baseline to produce the final figures to be used for evaluation of the proportioning device.

Annex B
(normative)

Low expansion foam fire test configurations

Table B.1 — Fire test configurations

Application type	**Concentrate type**	**Discharge device location relative to pan**	**Discharge device elevation above pan** ft (m)	**Manufacturer-specified application rate** gal/min/ft^2 (mm/min)	**Remarks**
Compressed air foam	P, FP, S, FFFP, AFFF, Class A, AR-FFFP, AR-AFFF	Four nozzles centred with spacing of 12 ft (3,6 m) by 12 ft (3,6 m)	Any elevation above top of pan, as required by manufacturer	0,04 (1,63)	5 min of foam discharge are to be followed by 5 min of water-only discharge at a minimum flow rate of 0,3 gal/min/ft^2 (12,2 mm/min) for tests using fuels other than polar solvents.

Annex C
(normative)

Low expansion foam fire test chronology

Table C.1 — Fire test chronology

Event	Target time from ignition min:s			
	Sprinklers and CAF nozzles[a]		Other devices	
	Hydrocarbon fuels	Polar solvent fuels	AFFF and FFFP[b]	Other foams
Ignition preburn starts	00:00	00:00	00:00	00:00
Foam application starts, preburn ends	00:15	00:15	01:00	01:00
Fire out	Record actual time[c]	Record actual time[c]	Record actual time[c]	Record actual time[c]
Foam application ends	05:15	05:15	04:00	06:00
Water application starts	05:15	Not applicable	Not applicable	Not applicable
Water application ends	10:15	Not applicable	Not applicable	Not applicable
First torch pass	11:15	06:15	05:00	07:00
Second torch pass	17:15	17:15	11:00	18:00
Stovepipe insertion	18:15	18:15	12:00	19:00
Stovepipe ignition	19:15	19:15	13:00	20:00
Stovepipe removal	20:15	20:15	14:00	21:00
Rift fire extinguished	Record actual time[d]	Record actual time[d]	Record actual time[d]	Record actual time[d]
Rift fire >10 ft^2	Record actual time[d]	Record actual time[d]	Record actual time[d]	Record actual time[d]
Final observation	25:15	25:15	19:00	26:00

NOTE 1 AFFF = aqueous film-forming foam; FFFP = film-forming fluoroprotein.

NOTE 2 At the discretion of AHJ, chronology can vary slightly from target times, as long as the foam blanket remains undisturbed for a minimum of 10 min (15 min for polar solvent fuels) after the completion of all discharge (foam or water) and the rift fire is observed for a minimum of 5 min after removal of the stovepipe.

[a] Other application devices which can be used under fire protection sprinkler systems shall also be tested with 5 min of water application subsequent to the end of foam discharge.

[b] FFFP at 1,63 mm/min application rate only.

[c] Fire shall be extinguished by the end of foam application.

[d] If the fire in the stovepipe rift is extinguished, the time of extinguishment shall be recorded. Conversely, if the rift fire spreads to an area greater than 0,93 m^2, the time for that event shall also be recorded.

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