INTERNATIONAL STANDARD

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Fire protection — Automatic sprinkler systems —

Part 7:
Requirements and test methods for early suppression fast response (ESFR) sprinklers

Protection contre l'incendie — Systèmes d'extinction automatiques du type sprinkler —

Partie 7: Prescriptions et méthodes d'essai des sprinklers de type «extinction précoce/réaction rapide»

Reference number
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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 6182-7 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 5, *Fixed firefighting systems using water*.

ISO 6182 consists of the following parts, under the general title *Fire protection — Automatic sprinkler systems*:

— *Part 1: Requirements and test methods for sprinklers*

— *Part 2: Requirements and test methods for wet alarm valves, retard chambers and water motor alarms*

— *Part 3: Requirements and test methods for dry pipe valves*

— *Part 4: Requirements and test methods for quick-opening devices*

— *Part 5: Requirements and test methods for deluge valves*

— *Part 6: Requirements and test methods for check valves*

— *Part 7: Requirements and test methods for early suppression fast response (ESFR) sprinklers*

— *Part 9: Requirements and test methods for water mist nozzles*

— *Part 10: Requirements and test methods for domestic sprinklers*

— *Part 11: Requirements and test methods for pipe hangers*

The following parts are under preparation:

— *Part 8: Requirements and test methods for pre-action dry alarm valves*

— *Part 12: Requirements and test methods for grooved end pipe couplings*

— *Part 13: Requirements and test methods for extended coverage sprinklers*

Introduction

This part of ISO 6182 is one of a number of ISO Standards prepared by ISO/TC 21 covering requirements and test methods for early suppression fast response (ESFR) sprinklers.

Fire protection — Automatic sprinkler systems —

Part 7:
Requirements and test methods for early suppression fast response (ESFR) sprinklers

1 Scope

This part of ISO 6182 specifies performance requirements, test methods and marking requirements for fusible element and glass-bulb early suppression fast response (ESFR) sprinklers. It is applicable to ESFR sprinklers with flow constants of 202 ± 8.

NOTE 1 Requirements for ESFR sprinklers with flow constants other than 202 ± 8 are in preparation.

NOTE 2 All pressure data in this part of ISO 6182 are also given as gauge pressure in bar. The correct SI unit for pressure is the pascal (Pa) (1 bar = 10^5 N/m^2 = 0,1 MPa).

2 Normative reference

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 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

3 Terms and definitions

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

3.1 General

3.1.1
sprinkler
thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and quantity over a designated area

3.1.2
conductivity factor
C
measure of the conductance between the sprinkler's heat responsive element and the fitting

NOTE The conductivity factor is expressed in units of $(m/s)^{0,5}$.

3.1.3
response time index
RTI
measure of sprinkler sensitivity

$$\text{RTI} = \tau\sqrt{u}$$

where

τ is equal to the time constant, expressed in seconds, of the heat-responsive element;

u is the gas velocity, expressed in meters per second

NOTE 1 The response time index is expressed in units of $(\text{m·s})^{0,5}$.

NOTE 2 RTI can be used in combination with the conductivity factor (C) to predict the response of a sprinkler in fire environments defined in terms of gas temperature and velocity versus time.

3.1.4
orientation A
orientation with the airflow perpendicular to both the waterway axis and the plane of the frame arms and with the heat responsive element upstream of the frame arms

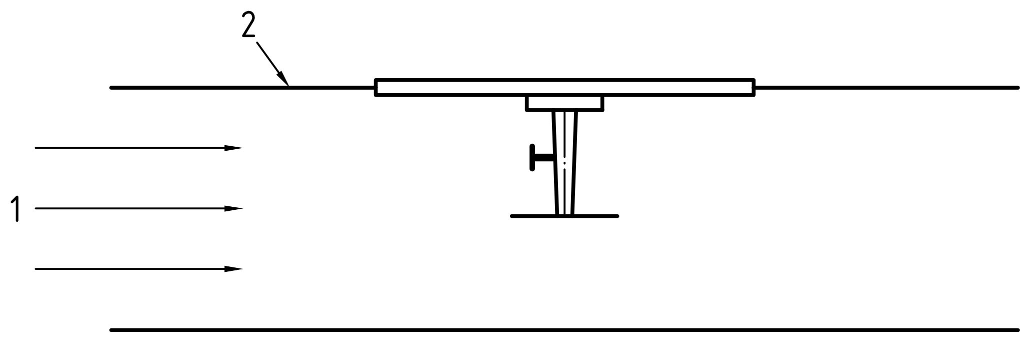
See Figure 1.

3.1.5
orientation B
orientation with the airflow perpendicular to both the waterway axis and the plane of the frame arms and with the heat responsive element downstream of the frame arms

See Figure 1.

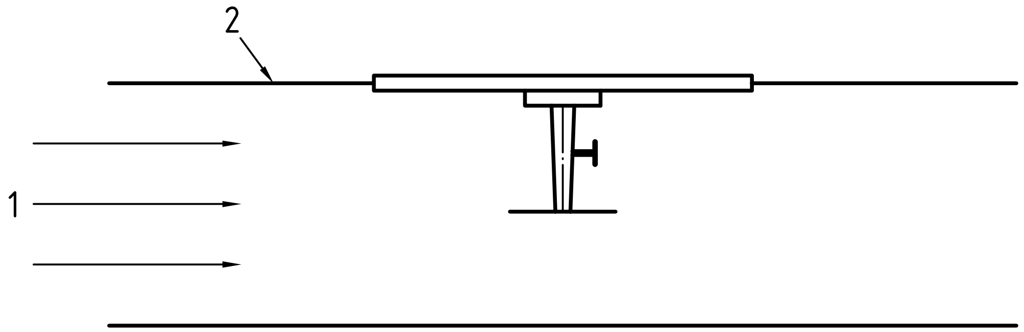
3.1.6
orientation C
⟨head on⟩ orientation with the axis of the sprinkler inlet parallel to the airflow and the deflector perpendicular to the airflow

See Figure 1.

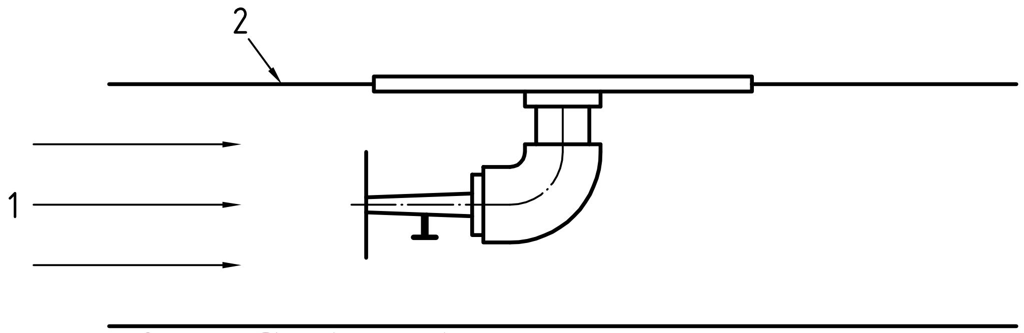


a) Orientation A

Figure 1 — Orientations A, B and C



b) Orientation B



c) Orientation C

Key

1 air flow

2 tunnel test section (elevation view)

NOTE If the sprinkler has a symmetrical heat responsive element and frame, Orientation A would be the same as Orientation B. Testing in both positions is not required.

Figure 1 (*continued*)

3.1.7
actual delivered density
ADD
rate at which water is deposited from an operating sprinkler onto the top horizontal surface of a simulated burning combustible array

3.1.8
early suppression
sprinkler system performance whereby the first few sprinklers, which operate, are able to provide sufficient water to the fire early enough so as to reduce the fire to an acceptable level, if not extinguished

3.1.9
early suppression fast response automatic sprinkler
ESFR
thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and density over a designated area so as to provide early suppression of a fire when installed on the appropriate sprinkler piping

3.1.10
assembly load
force exerted on the sprinkler at 0 MPa (0 bar) hydraulic pressure at the inlet

3.1.11
design load
force exerted on the sprinkler at the service load of the sprinkler

3.1.12
service load
combined force exerted on the sprinkler body by the assembly load of the sprinkler and the equivalent force of a 1,2 MPa (12 bar) hydraulic pressure of the inlet

3.1.13
average design strength
〈axial〉 glass-bulb suppliers specified and assured lowest average design strength of any batch of 50 bulbs

3.2 Sprinklers classified according to type of heat responsive element

3.2.1
fusible element sprinkler
sprinkler that opens under the influence of heat by the melting of a component

3.2.2
glass-bulb sprinkler
sprinkler that opens under the influence of heat by the bursting of the glass bulb caused by the increased pressure resulting from expansion of the fluid enclosed therein

3.3 Sprinklers classified according to position

3.3.1
pendent sprinkler
P
sprinkler that is arranged in such a way that the water stream is directed downwards against the distribution plate

3.3.2
upright sprinkler
U
sprinkler that is arranged in such a way that the water stream is directed upwards against the distribution plate

4 Product consistency

It shall be the responsibility of the manufacturer to implement a quality control programme to ensure that production continuously meets the requirements of this part of ISO 6182 in the same manner as the originally tested samples.

Every manufactured sprinkler shall pass a leak resistance test equivalent to a hydrostatic pressure of at least 3,4 MPa (34 bar) for at least 2 s.

5 Product assembly

All sprinklers shall be designed and manufactured in such a way that they cannot be readily adjusted, dismantled or reassembled.

6 Requirements

6.1 Dimensions

6.1.1 Sprinklers shall have a nominal thread size of R 3/4.

6.1.2 Nominal thread sizes shall be suitable for fittings threaded in accordance with ISO 7-1.

The dimensions of all threaded connections should conform to International Standards where applied. National standards may be used if International Standards are not applicable.

6.1.3 All sprinklers shall be constructed so that a sphere of diameter 8 mm can pass through each water passage in the sprinkler.

6.2 Nominal operating temperatures (see 7.7)

The nominal operating temperature of ESFR sprinklers shall be as indicated in Table 1.

The nominal operating temperatures of all sprinklers shall be specified in advance by the manufacturer and verified in accordance with 6.3. They shall be determined as a result of the operating temperature test (see 7.7.1). Nominal operating temperatures shall be within the ranges specified in Table 1.

The nominal operating temperature that is to be marked on the sprinkler shall be that determined when the sprinkler is tested in accordance with 7.7.1, taking into account the specifications of 6.3.

Table 1 — Nominal operating temperature and colour coding

Values in degrees Celsius

Glass-bulb sprinklers		Fusible element sprinklers	
Nominal operating temperature	**Liquid colour code**	**Nominal operating temperature**	**Yoke arm colour code**
68 to 74	red	68 to 74	uncoloured
93 to 104	green	93 to 104	white

6.3 Operating temperatures (see 7.7.1)

Sprinklers shall open within a temperature range of

$$T \pm (0{,}035T + 0{,}62) \quad (1)$$

where T is the nominal operating temperature, expressed in degrees Celsius.

6.4 Water flow and distribution

6.4.1 Flow constant (see 7.11)

The flow constant, K, for sprinklers is given by the formula

$$K = \frac{q_V}{\sqrt{p}} \quad (2)$$

where

p is the pressure, expressed in bars;

q_V is the flow rate, expressed in litres per minute (l/min).

The flow constant for ESFR sprinklers shall have values of 202 ± 8 when determined by the test method of 7.11. All values tested shall be within the acceptable range and the standard deviation divided by the average value of the flow constant shall be less than 2 %.

6.4.2 Water distribution (see 7.12)

6.4.2.1 To demonstrate the required coverage of the protected area allotted to it, the sprinkler shall be subjected to the tests specified in 7.12.

6.4.2.2 Ten collection pans, as specified in 7.12.1, shall be utilized on a rotating table to measure the distribution from a single sprinkler. All pan collection rate values shall be recorded. The tenth pan shall have a collection rate not exceeding 0,80 mm/min.

6.4.2.3 Three samples, or sets of samples, shall be tested to the requirements of Table 2 in accordance with 7.12.2.

Table 2 — Sprinkler water distribution measurements

Number of sprinklers under the water-collection system	Sprinkler spacing m	Pipe spacing m	Ceiling clearance to water-collection pans m	Pressure [a, b] MPa (bar)	Minimum 16-pan average density[c] mm/min	Minimum flue space (4 pans) average[c] mm/min	Minimum 20-pan average density[c] mm/min	Minimum non-flue 10-pan average density[c,d] mm/min	Minimum single non-flue pan density[c] mm/min
1	0	0	3,04	0,34 (3,4)	21,22	40,80	NR	NR	NR
1	0	0	4,42	0,34 (3,4)	19,58	36,31	NR	NR	NR
1	0	0	4,42	0,51 (5,1)	NR	69,36	37,13	20,40	10,61
2	3,04	0	1,27	0,34 (3,4)	24,48	NR	NR	NR	NR
2	3,04	0	3,04	0,34 (3,4)	22,03	NR	NR	NR	NR
2	0	3,04	1,27	0,34 (3,4)	23,66	NR	NR	NR	NR
2	0	3,04	3,04	0,34 (3,4)	23,26	NR	NR	NR	NR
2	3,66	0	1,27	0,34 (3,4)	17,95	NR	NR	NR	NR
2	0	3,66	1,27	0,34 (3,4)	18,36	NR	NR	NR	NR
2	3,04	0	1,27	0,51 (5,1)	NR	NR	31,42	24,48	8,16
2	0	3,04	1,27	0,51 (5,1)	NR	NR	31,42	24,48	8,16
4	3,04	3,04	1,27	0,34 (3,4)	27,74	NR	NR	NR	NR
4	3,04	3,04	3,04	0,34 (3,4)	35,09	NR	NR	NR	NR
4	2,44	3,6	1,27	0,34 (3,4)	26,93	NR	NR	NR	NR
4	3,04	3,04	1,27	0,51 (5,1)	NR	NR	28,97	24,48	15,10

[a] All 0,34 MPa (3,4 bar) tests are performed on a system fed from both directions (double feed).

[b] All 0,51 MPa (5,1 bar) tests are performed on a system fed from one direction (single feed), except for the two-sprinklers, single-pipe tests which are performed on a double-feed system.

[c] NR = No requirement (see Figures 8 to 13).

[d] Average of the ten non-flue pans with the lowest water collection.

6.5 Ability to function (see 7.6)

6.5.1 When tested in accordance with 7.6.1, all operating parts shall clear the sprinkler within 10 s or shall comply with the requirements of 6.4.2.

6.5.2 The deflector and its supporting parts shall not sustain significant damage as a result of the deflector strength test specified in 7.6.2 and shall meet the requirements of 6.4.2.

NOTE In most instances, visual examination of the sprinkler is sufficient to establish conformity with the requirements of 6.5.1 and 6.5.2.

6.6 Strength of sprinkler body (see 7.4)

The sprinkler body shall not show permanent elongation of more than 0,2 % between the load-bearing points of the sprinkler body after being subjected to twice the average service load as measured in 7.4.

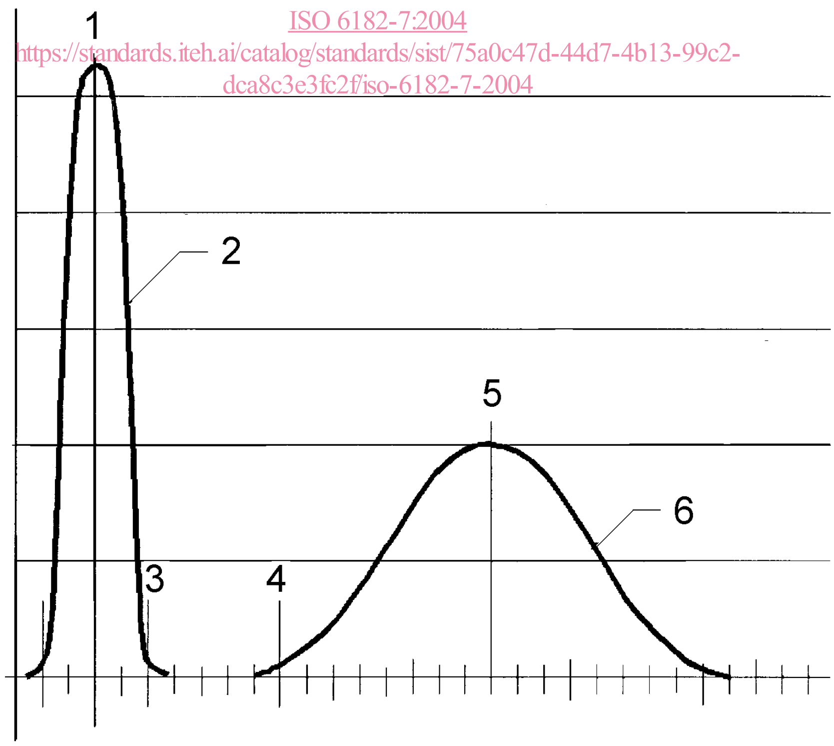
6.7 Strength of release element (see 7.10)

6.7.1 When tested in accordance with 7.10.1, the elements of glass bulbs shall

a) have an average design strength of at least six times the average service load, and

b) have a design strength lower tolerance limit (L_{TL}) on the strength distribution curve of at least two times the upper tolerance limit (U_{TL}) of the service load distribution curve based on calculations with a degree of confidence (y) of 0,99 for 99 % of samples (n).

Calculations will be based on a normal or Gaussian distribution, except where other distributions can be shown to be more applicable due to manufacturing or designing factors. See Figure 2 and Annex A.



Key

1 average service load
2 service load curve
3 U_{TL}
4 L_{TL}
5 average design strength
6 design strength curve

Figure 2 — Strength curve