INTERNATIONAL STANDARD

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Second edition
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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"

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 5, *Fixed firefighting systems using water*.

This second edition cancels and replaces the first edition (ISO 6182-7:2004), which has been technically revised.

The main changes compared to the previous edition are as follows:

— added requirements and test methods for K242 pendent ESFR sprinklers.

A list of all parts in the ISO 6182 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Early Suppression-Fast Response (ESFR) sprinklers are a unique type of sprinkler primarily intended to provide sprinkler protection for storage facilities. Other types of sprinklers are addressed in separate documents in the ISO 6182 series. These sprinklers are specifically designed to discharge water at a location near the ceiling of a structure in a manner that effectively attacks a fast-growing fire that can occur in a storage facility.

These sprinklers characteristically discharge water in a mostly downward trajectory with relatively large water droplets and incorporate a fast-response type heat responsive element intended to allow the discharge of water at an early stage of the fire growth. Due to the relatively quick operation and effective nature of the sprinkler discharge, these sprinklers can be used to provide ceiling-only sprinkler protection for taller storage facilities compared to other types of sprinklers. The performance of ESFR sprinklers is sensitive to obstructions to the sprinkler discharge. ESFR sprinkler installation guidelines need to account for this obstruction sensitivity by limiting the size of obstructions as well as specifying sprinkler installation locations that minimize the impact of these obstructions.

Fire protection — Automatic sprinkler systems —

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

1 Scope

This document specifies performance requirements, test methods and marking requirements for pendent early suppression fast response (ESFR) sprinklers.

NOTE This document currently provides requirements for K202 and K242 ESFR pendent sprinklers.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7-1, *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.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General

3.1.1
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

3.1.2
assembly load
force exerted on the sprinkler body excluding hydrostatic pressure

3.1.3
average design strength
glass bulb supplier's specified and assured lowest average axial design strength of any batch of 50 bulbs

3.1.4
design load
force exerted on the release element at the service load (3.1.10) of the sprinkler

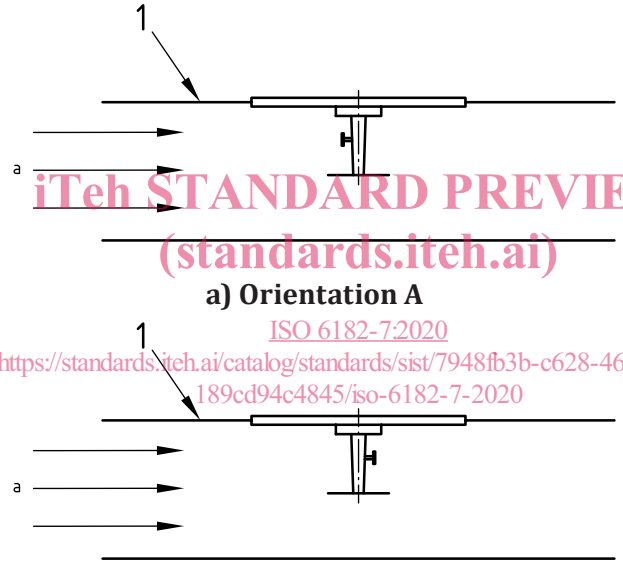
3.1.5
early suppression fast response automatic sprinkler
ESFR
sprinkler that is intended to provide early suppression of a fire when installed on the appropriate sprinkler piping

3.1.6
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

Note 1 to entry: See Figure 1.

3.1.7
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

Note 1 to entry: See Figure 1.



a) Orientation A

b) Orientation B

Key

1 tunnel test section (elevation view)

a Airflow.

Figure 1 — Orientations A and B

3.1.8
protective covers
protective caps or straps intended to provide temporary protection for sprinklers during shipping, handling and installation

3.1.9
response time index
RTI
measure of sprinkler sensitivity

$$RTI = t\sqrt{u}$$

where

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

u is the gas velocity, expressed in metres per second.

Note 1 to entry: The RTI is expressed in units of $(m \cdot s)^{0,5}$.

3.1.10
service load
combined force exerted on the sprinkler body by the assembly load (3.1.2) of the sprinkler and the equivalent force of the rated pressure on the inlet

3.1.11
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

Note 1 to entry: For the purposes of this document, "sprinkler" is intended to refer to ESFR (3.1.5) sprinklers.

3.2 Types of sprinklers 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 through pressure resulting from expansion of the fluid enclosed therein

3.3 Sprinklers classified according to position

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

4 Product consistency

4.1 Quality control program

It shall be the responsibility of the manufacturer to implement a quality control program to ensure that production continuously meets the requirements of this document.

4.2 Leak resistance testing

Every manufactured sprinkler shall pass a leak resistance test equivalent to a hydrostatic pressure of at least twice the rated pressure for at least 2 s.

4.3 Glass bulb integrity test

Each glass bulb sprinkler assembly shall be evaluated for glass bulb cracking, breaking, or other damage as indicated by the loss of fluid. The test shall be conducted after the leakage test.

The bubble in each glass bulb shall be examined at room ambient temperature. The sprinkler shall then be heated in a circulating air oven or liquid bath to 5 °C below the minimum operating temperature range of the sprinkler. The bubble shall then be examined to determine the bubble size has been reduced

in accordance with the glass bulb manufacturer's specifications. After cooling, the bubble size shall again be examined to determine the bubble returned to the original size within the tolerance allowed by the glass bulb manufacturer.

5 Product assembly

5.1 General

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

5.2 Dynamic O-ring seals

The closure of the waterway shall not be achieved by the use of a dynamic O-ring or similar seal. (An O-ring or similar seal that moves during operation or is in contact with a component that moves during operation.)

5.3 Rated pressure

Sprinklers shall have a rated pressure of 1,2 MPa (12 bar).

6 Requirements

6.1 Dimensions

6.1.1 Orifice size

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

6.1.2 Nominal thread sizes

6.1.2.1 Sprinklers shall have a nominal thread size of R ¾.

6.1.2.2 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.

6.2 Temperature ratings and color codings

The marked nominal temperature rating and color coding of sprinkler shall be in accordance with Table 1.

Table 1 — Nominal temperature rating and color coding

Glass bulb sprinklers		Fusible element sprinklers	
Marked nominal temperature rating (°C)	Liquid color code	Marked nominal temperature rating (°C)	Yoke arm color code
68 to 74	red	68 to 74	uncolored
93 to 104	green	93 to 104	white

6.3 Operating temperature (see 7.3)

Sprinklers shall be verified to operate within a temperature range of

$t = x \pm (0{,}035x + 0{,}62)$ °C

where

t is the temperature range, rounded to the nearest 0,1 °C;

x is the marked nominal temperature rating (see Table 1).

6.4 Water flow constant (see 7.4)

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

$$K = \frac{q}{\sqrt{10p}}$$

where

p is the pressure, expressed in MPa;

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

The flow constant for ESFR sprinklers shall have values of 202 ± 10 or 242 ± 12 when determined by the test method of 7.4

6.5 Water distribution (see 7.5)

6.5.1 When tested in accordance with 7.5 the sprinkler shall meet the requirements of Tables 2 or 3, as applicable.

Table 2 — Sprinkler water distribution measurement K202

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)	21,2	40,8	NR	NR	NR
1	0	0	4,42	0,34 (3,4)	19,6	36,3	NR	NR	NR
1	0	0	4,42	0,51 (5,1)	NR	69,4	37,1	20,4	10,6
2	3,04	0	1,27	0,34 (3,4)	24,5	NR	NR	NR	NR
2	3,04	0	3,04	0,34 (3,4)	22,0	NR	NR	NR	NR
2	0	3,04	1,27	0,34 (3,4)	23,7	NR	NR	NR	NR

[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 5 to 9).

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

Table 2 *(continued)*

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
2	0	3,04	3,04	0,34 (3,4)	23,3	NR	NR	NR	NR
2	3,66	0	1,27	0,34 (3,4)	18,0	NR	NR	NR	NR
2	0	3,66	1,27	0,34 (3,4)	18,4	NR	NR	NR	NR
2	3,04	0	1,27	0,51 (5,1)	NR	NR	31,4	24,5	8,2
2	0	3,04	1,27	0,51 (5,1)	NR	NR	31,4	24,5	8,2
4	3,04	3,04	1,27	0,34 (3,4)	27,7	NR	NR	NR	NR
4	3,04	3,04	3,04	0,34 (3,4)	35,1	NR	NR	NR	NR
4	2,44	3,6	1,27	0,34 (3,4)	26,9	NR	NR	NR	NR
4	3,04	3,04	1,27	0,51 (5,1)	NR	NR	29,0	24,5	15,1

[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 5 to 9).

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

Table 3 — Sprinkler water distribution measurement K242

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	0,24 (2,4)	21,2	40,8	NR	NR	NR
1	0	0	4,42	0,24 (2,4)	19,6	36,3	NR	NR	NR
1	0	0	4,42	0,36 (3,6)	NR	69,4	37,1	20,4	10,6
2	3,04	0	1,27	0,24 (2,4)	24,5	NR	NR	NR	NR
2	3,04	0	3,04	0,24 (2,4)	22,0	NR	NR	NR	NR
2	0	3,04	1,27	0,24 (2,4)	23,7	NR	NR	NR	NR

[a] All 0,24 MPa (2,4 bar) tests are performed on a system fed from both directions (double feed).

[b] All 0,36 MPa (3,6 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 5 to 9).

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

Table 3 *(continued)*

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
2	0	3,04	3,04	0,24 (2,4)	23,3	NR	NR	NR	NR
2	3,66	0	1,27	0,24 (2,4)	18,0	NR	NR	NR	NR
2	0	3,66	1,27	0,24 (2,4)	18,4	NR	NR	NR	NR
2	3,04	0	1,27	0,36 (3,6)	NR	NR	31,4	24,5	8,2
2	0	3,04	1,27	0,36 (3,6)	NR	NR	31,4	24,5	8,2
4	3,04	3,04	1,27	0,36 (3,6)	27,7	NR	NR	NR	NR
4	3,04	3,04	3,04	0,24 (2,4)	35,1	NR	NR	NR	NR
4	2,44	3,6	1,27	0,24 (2,4)	26,9	NR	NR	NR	NR
4	3,04	3,04	1,27	0,36 (3,6)	NR	NR	29,0	24,5	15,1

[a] All 0,24 MPa (2,4 bar) tests are performed on a system fed from both directions (double feed).

[b] All 0,36 MPa (3,6 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 5 to 9).

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

6.6 Function (see 7.6)

6.6.1 Lodgement (see 7.6.1)

When tested in accordance with 7.6.1, the sprinkler shall open and, any lodgement of released parts shall be cleared within 10 s of release of the heat-responsive element.

6.6.2 Deflector strength (see 7.6.2)

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

If minor damage is noted, testing in accordance with 6.5.1 can be done to demonstrate compliance.

NOTE In most instances, visual examination of the sprinkler will be sufficient to establish conformance with 6.5.1.