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Fire protection — Automatic sprinkler system —

Part 9: Requirements and test methods for water mist nozzles

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

Partie 9: Prescriptions et méthodes d'essai des ajutages (brouillard)

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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.

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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.

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ISO 6182-9 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 8: Requirements and test methods for pre-action dry alarm valves*

— *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*

— *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 components for automatic sprinkler systems.

They are included in a series of ISO Standards planned to cover the following:

a) carbon dioxide systems,

b) explosion suppression systems,

c) foam systems.

Fire protection — Automatic sprinkler system —

Part 9:
Requirements and test methods for water mist nozzles

1 Scope

This part of ISO 6182 specifies performance requirements, test methods and marking requirements for water mist nozzles.

2 Normative references

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

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

ISO 5660-1, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)*

ANSI/UL 723:2003, *Test for surface burning characteristics of building materials*

ASTM E11:2004, *Standard specification for wire cloth and sieves for testing purposes*

ASTM E799:2003, *Standard practice for determining data criteria and processing for liquid drop size analysis*

IMO Resolution A.653(16), *Recommendation on improved fire test procedures for surface flammability of bulkhead, ceiling and deck finish materials*

3 Terms and definitions

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

3.1
assembly load
force exerted on the nozzle body at 0 MPa [0 bar[1)]] hydraulic pressure at the inlet

3.2
conductivity factor
C
measure of the conductance between the nozzle's heat-responsive element and the fitting

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

3.3
control spaces
shipboard areas such as the bridge, radio room and emergency power room

3.4
corrosion-resistant material
material of bronze, brass, copper-and-nickel-base alloy, stainless steel or plastic

3.5
design load
force exerted on the release element at the service load of the nozzle

3.6
fire control
limiting the growth of a fire and controlling ceiling gas temperatures to prevent structural damage

3.7
fire suppression
sharply reducing the rate of heat release of a fire and preventing its regrowth

3.8
fire extinguishment
zero rate of heat release, definite stoppage of flames and no re-ignition

3.9
flame spread index
FSI
fire-spread characteristic measured in accordance with ANSI/UL 723

3.10
fuel package
combustible materials in which the fire is ignited and the combustible materials covering the walls and ceiling

3.11
low hazard area
area where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected

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1) 1 bar = $10^5 N/m^2$ = 0,1 MPa.

3.12
shipboard machinery spaces
engine rooms and cargo pump rooms containing combustible or flammable liquids having fire characteristics no more severe than that of light diesel oil

3.13 Nozzles

3.13.1
automatic nozzle
thermosensitive device designed to react at a predetermined temperature by automatically releasing water mist into a designated area and volume having a response time index (RTI) of not more than 50 $(m \cdot s)^{1/2}$ and a conductivity factor (C) not more than 1,0 $(m/s)^{1/2}$

3.13.2
coated nozzle
nozzle that has a factory applied coating for corrosion protection

3.13.3
fast response nozzle
automatic nozzle having a response time index (RTI) not more than 50 $(m \cdot s)^{1/2}$ and a conductivity factor (C) not more than 1,0 $(m/s)^{1/2}$

3.13.4
fusible element nozzle
nozzle that opens under the influence of heat by the melting of a component

3.13.5
glass bulb nozzle
nozzle that opens under the influence of heat by the bursting of the glass (frangible) bulb through pressure resulting from expansion of the enclosed fluid

3.13.6
multiple orifice nozzle
nozzle having two or more outlet orifices arranged to distribute the water discharge in a specified pattern and quantity for a definite protection area

3.13.7
open nozzle
nozzle without a thermosensitive element

3.13.8
pendent nozzle
nozzle that is arranged in such a way that the water mist is directed initially downward by striking a distribution plate or by nozzle orientation

3.13.9
upright nozzle
nozzle that is arranged in such a way that the water mist is initially directed upwards against a distribution plate

3.14
operating pressure
service pressure at which a nozzle is intended to operate

3.15
rated working pressure
maximum service pressure at which a nozzle is intended to operate, but no less than 1,2 MPa (12 bar)

3.16
protective cap
device attached to the nozzle for the purpose of protecting the nozzle throughout transport and installation but mainly for the protection of the nozzle while in service

3.17
response time index
RTI
measure of automatic nozzle sensitivity

$$\text{RTI} = \tau u^{1/2}$$

where

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

u is the gas velocity, expressed in meters per second

NOTE 1 RTI is expressed in units of $(\text{m}\cdot\text{s})^{1/2}$.

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

3.18
service load
combined force exerted on the nozzle body by the assembly load of the nozzle and the equivalent force of the rated working pressure applied at the inlet

3.19
shipboard passenger cabin
area with sleeping facilities that are assigned to passengers for their private use

3.20
shipboard public space
area where people may gather such as restaurants, dining rooms, lounges, corridors and offices

3.21
shipping cap
device attached to the nozzle for the purpose of protecting the nozzle only during transport and installation

NOTE Shipping caps are not intended to remain on the nozzle after the installation is complete.

3.22
standard hazard area
area where the quantity and combustibility of contents is moderate, stockpiles of combustibles do not exceed 1,5 m and fires with moderate rates of heat release are expected

3.23
standard orientation
orientation where the airflow is perpendicular to both the axis of the nozzle's inlet and the plane of the frame arms, if provided, that produces the shortest response time

3.24
worst-case orientation
orientation that produces the longest response time with the axis of the nozzle inlet perpendicular to the airflow

4 Product consistency

It shall be the responsibility of the manufacturer to implement a quality control program to ensure that production continuously meets the requirements in the same manner as the originally tested samples. Before testing, nozzles shall be examined with respect to marking, conformity to manufacturer's drawings and obvious defects.

Every automatic water mist nozzle shall pass a leak resistance test equivalent to a hydrostatic pressure of at least 2,5 times the rated working pressure, but no less than 3,0 MPa (30,0 bar), applied for at least 2 s.

5 General requirements

5.1 Materials

5.1.1 All water mist nozzles shall be made from corrosion-resistant materials.

5.1.2 A water mist nozzle shall be constructed to effect closure of its water seat for extended periods of time without leakage and to open as intended and release all parts from the minimum operating pressure up to the rated working pressure. For nozzles with intended operating pressures of 1,2 MPa (12 bar) or less, the closure of the water seat 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).

5.2 Prevention of field adjustment

The load on the heat-responsive element in automatic nozzles shall be set by the manufacturer in such a manner so as to prevent field adjustment or replacement. The nozzle orifice/deflector shall be permanently attached to the nozzle so as to prevent field adjustment or replacement.

5.3 Drawing review

The requirements and tests in Clauses 7 and 8 shall be conducted for each type of nozzle. Before testing, precise drawings of parts and the assembly shall be submitted together with the appropriate specifications and a copy of the manufacturer’s design and installation instructions.

5.4 Pipe and fitting threads

5.4.1 Pipe and fitting threads shall conform to the applicable requirements of ISO 7-1.

5.4.2 If International Standards are not applicable, then National Standards are permitted to be used.

5.5 Strainers and filters

5.5.1 All nozzles shall be constructed so that a sphere of diameter 5 mm can pass through each water passage in the nozzle. Nozzle with smaller openings shall utilize an integral strainer with each nozzle.

5.5.2 Nozzle strainers or filters shall be constructed from corrosion-resistant materials. The maximum dimension of an opening in the strainer or filter shall not exceed 80 % of the smallest orifice diameter being protected.

6 Elastomeric materials

6.1 Properties

An elastomer used to provide a water seal shall be tested to determine that it has the following properties.

a) As-received materials, when tested in accordance with ISO 37, shall be of minimum tensile strength of 3,4 MPa for silicone rubber having the characteristic constituent of poly-organo-siloxane and 10,3 MPa for other elastomers.

b) When tested in accordance with ISO 188, the physical properties after oven aging at the time and temperature specified in Table 1 shall be at least 60 % of the original tensile strength and elongation values.

6.2 Test specimen

A part with an inside diameter larger than 25 mm shall be subjected in whole to the above tests. If the size of the actual part is less than 25 mm or otherwise precludes accurate testing, larger samples of similar parts or sheet material made of the same compound are to be subjected to the tests.

Table 1 — Oven ageing

Maximum service temperature °C	Oven time h	Oven temperature °C
60	70	100
75	168	100
80	168	113
90	168	121
105	168	136
115	1 440	123
125	1 440	133
135	1 440	143
145	1 440	153
150	1 440	158
155	1 440	164
165	1 440	174
175	1 440	184
185	1 440	194
195	1 440	204
200	1 440	210
210	1 440	220
220	1 440	230
230	1 440	240
240	1 440	250
250	1 440	260

7 Water mist nozzle requirements (see Clause 8)

7.1 Dimensions

Nozzles shall be provided with a 6 mm or larger nominal inlet thread. The dimensions of all threaded connections shall conform to International Standards where applied. If International Standards are not applicable, National Standards may be used.

7.2 Nominal operating temperatures

7.2.1 The nominal operating temperatures of automatic glass bulb nozzles shall be as indicated in Table 2.

7.2.2 The nominal operating temperatures of automatic fusible element nozzles shall be specified in advance by the manufacturer and verified in accordance with 7.3. They shall be determined as a result of the nominal release temperature test. See 8.6.1. Nominal operating temperatures shall be within the ranges specified in Table 2.

7.2.3 The nominal operating temperature that is to be marked on the nozzle shall be that which is determined when the nozzle is tested in accordance with 8.6.1, taking into account the specifications of 7.3.

Table 2 — Nominal release temperature

Glass bulb nozzles		Fusible element nozzles	
Nominal release temperature °C	Liquid colour code	Nominal release temperature °C	Colour code
57	orange	57 to 77	uncoloured
68	red	80 to 107	white
79	yellow	121 to 149	blue
93 to 107	green	163 to 191	red
121 to 141	blue		
163 to 182	mauve		

7.3 Operating temperatures

Automatic nozzles shall open within a temperature range of $\vartheta \pm (0{,}035\vartheta + 0{,}62)$ °C where ϑ is the nominal operating temperature.

7.4 Water flow and distribution and droplet size

7.4.1 Flow constant (see 8.10)

7.4.1.1 The flow constant K for nozzles shall be calculated by the following formula:

$$K = \frac{q}{p^{0,5}}$$

where

p is the pressure, in bars;

q is the flow rate, in l/min.

7.4.1.2 The value of the flow constant K published in the manufacturer's design and installation instructions shall be verified using the test method of 8.10. The average flow constant K shall be within ± 5 % of the manufacturer's value.

7.4.2 Water distribution [see 8.11.1 and 10.2 g)]

The discharge characteristics of the nozzle shall be determined in accordance with 8.11.1.

7.4.3 Water droplet size and velocity [see 8.11.2 and 10.2 g)]

The water droplet size distribution and droplet velocity distribution of the nozzle shall be determined in accordance with 8.11.2.

7.5 Function (see 8.5)

7.5.1 When tested in accordance with 8.5.1 to 8.5.4, an open nozzle fitted with a protective device for the outlet shall release within 10 s after the application of pressure. An automatic nozzle shall open and, within 5 s after the release of the heat responsive element, shall operate satisfactorily by complying with the requirements of 7.4.1. Any lodgement of released parts shall be cleared within 10 s of release or the nozzle shall then comply with the requirements of 7.4.2 and 7.4.3.

7.5.2 A nozzle shall not sustain damage as a result of the functional test specified in 8.5.5 and shall have the same flow constant range and water droplet size and velocity within 5 % of values as previously determined in 7.4.1 and 7.4.3.

7.6 Strength of body (see 8.3)

An automatic nozzle shall not show permanent elongation of more than 0,2 % between the load-bearing points after being subjected to two times the average service load as determined using the method of 8.3.

7.7 Strength of release element

7.7.1 Glass bulb (see 8.9.1)

When tested in accordance with 8.9.1, glass bulb elements shall

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

b) have a design strength lower tolerance limit ($L_{tol,1}$) on the strength distribution curve of at least two times the upper tolerance limit ($L_{tol,2}$) of the service load distribution curve based on calculations with a degree of confidence (Γ) of 0,99 for 99 % of the samples (P). Calculations will be based on Normal or Gaussian distribution except where other distribution can be shown to be more applicable due to manufacturing of design factors.

7.7.2 Fusible elements

Fusible heat-responsive elements in the ordinary temperature range shall be designed to

a) sustain a load of 15 times its design load corresponding to the maximum service load measured in 8.3 for a period of 100 h when tested in accordance with 8.9.2 or

b) demonstrate the ability to sustain the design load when tested in accordance with 8.9.2.

7.8 Leak resistance and hydrostatic strength

7.8.1 An automatic nozzle shall not show any sign of leakage when tested by the method specified in 8.4.1.

7.8.2 A nozzle shall not rupture, operate or release any parts when tested by the method specified in 8.4.2.

7.9 Heat exposure

7.9.1 Glass bulb nozzles

There shall be no damage to the glass bulb element when the nozzle is tested by the method specified in 8.7.1.

7.9.2 Uncoated automatic nozzles

Uncoated automatic nozzles shall withstand exposure to increased ambient temperature without evidence of leakage, weakness or failure when tested by the method specified in 8.7.2.

7.10 Thermal shock for glass bulb nozzles

Glass bulb nozzles shall not be damaged when tested by the method specified in 8.8. Proper operation shall not be considered as damage.

7.11 Corrosion

7.11.1 Stress corrosion

When tested in accordance with 8.12.1, brass nozzles or parts shall show no cracking, delamination or failure that could affect their ability to function as intended.

When tested in accordance with 8.12.2, stainless steel nozzles or parts shall show no cracking, delamination or failure that could affect their ability to function as intended.

7.11.2 Sulfur dioxide corrosion

Nozzles shall be resistant to sulfur dioxide saturated with water vapour when conditioned in accordance with 8.12.3. Following exposure, the water flow rate of the open nozzles at their minimum operating pressure shall be within 5 % of the value specified in the manufacturer's design and installation instructions. For automatic nozzles, five nozzles shall operate when functionally tested at their minimum flowing pressure (see 7.5.1 and 7.5.2) and the remaining five samples shall meet the dynamic heating requirements of 7.14.2.

7.11.3 Salt spray corrosion

Coated and uncoated nozzles shall be resistant to salt spray when conditioned in accordance with 8.12.4. Following exposure, the water flow rate of the open nozzles at their minimum operating pressure shall be within 5 % of the value specified in the manufacturer's design and installation instructions. For automatic nozzles, the samples shall meet the dynamic heating requirements of 7.14.2.

7.11.4 Moist air exposure

Nozzles shall be resistant to moist air exposure when tested in accordance with 8.12.5. Following exposure, the nozzles shall be functionally tested at their minimum flowing pressure in accordance with 7.5.1 and meet the dynamic heating requirements of 7.14.2.