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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 automatique du type sprinkler —

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

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Contents

Page

Foreword	v
Introduction.....	v
1 Scope	1
2 NORMATIVE REFERENCES	8
3 TERMS AND DEFINITIONS	9
4 PRODUCT CONSISTENCY	14
5 GENERAL REQUIREMENTS.....	14
6 ELASTOMERIC MATERIALS	15
7 WATER MIST NOZZLE REQUIREMENTS	17
8 TEST METHODS.....	33
9 WATER MIST NOZZLE MARKING	83
10 DESIGN, INSTALLATION AND MAINTENANCE INSTRUCTIONS	85
ANNEX A: TOLERANCE LIMIT CALCULATION METHODS (MANDATORY)	99
ANNEX B: ANALYSIS OF THE STRENGTH TEST FOR FUSIBLE ELEMENTS (INFORMATIONAL)	102
ANNEX C: NOZZLE RESPONSE SAMPLE CALCULATIONS (INFORMATIONAL)	104
ANNEX D: TOLERANCES (MANDATORY)	106
FIGURES	
FIGURE 1 — IMPACT TEST APPARATUS	86
FIGURE 2 — ENGINE MOCK-UP DETAIL	87
FIGURE 3 — ENGINE MOCK-UP DETAIL	88
FIGURE 4 — ENGINE MOCK-UP DETAIL	89
FIGURE 5 — 12M CABIN AND CORRIDOR DETAILS	90
FIGURE 6 — BUNK BED ARRANGEMENT	91
FIGURE 7 — CORRIDOR FIRE FUEL PACKAGE	92

FIGURE 8 — LOCATION OF THERMOCOUPLES IN THE CABIN/CORRIDOR AND AREAS RESTRICTED FOR

LOCATION OF NOZZLES.....	93
FIGURE 9 — 24 M ² AND LARGER CABIN FIRE TEST ARRANGEMENT	94
FIGURE 10 — CABIN FIRE TEST CRIB AND SIMULATED FURNITURE FUEL PACKAGE.....	95
FIGURE 11 — PUBLIC SPACE FIRE TEST ARRANGEMENT	96
FIGURE 12 — PUBLIC SPACE CORNER FIRE TEST ARRANGEMENT.....	97
FIGURE 13 — PUBLIC SPACE ORDINARY HAZARD TEST ARRANGEMENT	98

TABLES

TABLE 1 — OVEN AGING	16
TABLE 2 — NOMINAL RELEASE TEMPERATURE.....	18
TABLE 3 — CLASSIFICATION OF CATEGORY A ENGINE ROOMS.....	29
TABLE 4 — PERFORMANCE CRITERIA FOR 12 M ² CABIN/CORRIDOR FIRE TEST	31
TABLE 5 — PLUNGE OVEN TEST CONDITIONS	39
TABLE 6 — PLUNGE OVEN TEST CONDITIONS FOR CONDUCTIVITY DETERMINATION	41
TABLE 7 — TEST TEMPERATURES FOR COATED AND UNCOATED AUTOMATIC NOZZLES.....	46
TABLE 8 — CONTAMINANT FOR CONTAMINATED WATER TEST.....	60
TABLE 9 — MACHINERY SPACE FIRE TEST SCENARIOS	63
TABLE 10 — OIL SPRAY FIRE TEST PARAMETERS.....	65
TABLE A.1 — TABLE FOR K, FACTORS FOR ONE-SIDED TOLERANCE LIMITS FOR NORMAL DISTRIBUTIONS	100
TABLE A.2 — TOLERANCE LIMIT WORKSHEET FOR STRENGTH OF HEAT-RESPONSIVE ELEMENT TEST FOR FRANGIBLE BULB TYPES.....	101

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.

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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, *Sprinkler and water spray extinguishing systems*.

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*

All pressure data in this ISO Standard are given as gauge pressure in bar¹ (1 bar = 0,1 MPa).

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 (ISO 6183),
- b) explosion suppression systems (ISO 6184),
- c) foam systems (ISO/DIS 7076).

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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 normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6182. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6182 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Designation, Dimension and Tolerances.*

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

ISO 49, *Malleable cast iron fittings threaded to ISO 7-1.*

ISO 65, *Carbon steel tubes suitable for screwing in accordance with ISO 7-1.*

ISO 188: 1982, *Rubber, vulcanized — Accelerated ageing or heat-resistance tests.*

ISO 5660-1, *Rate of heat release from building products.*

ANSI/UL 723: 1993, *Test for surface burning characteristics of building materials.*

ASTM E 799: 1992, *Standard Practice for Determining Data Criteria and Processing for Liquid Drop Size Analysis.*

ASTM E 11: 1987, *Standard Specification for Wire - Cloth Sieves for Testing Purposes.*

IMO Resolution A.653(16).

3 Definitions

3.1 assembly load the force exerted on the nozzle body at 0 bar hydraulic pressure at the inlet.

3.2 conductivity factor (C) measure of the conductance between the nozzle's heat-responsive element and the fitting expressed in units of $(\text{m/s})^{0.5}$

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

3.4 corrosion resistant material materials of bronze, brass, monel metal, 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. a 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 the *Standard for tests for surface burning characteristics of building materials*, 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

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 $50 (\text{ms})^{1/2}$ and a conductivity factor (C) not more than $1,0 (\text{m/s})^{1/2}$.

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 $50 (\text{ms})^{1/2}$ and a conductivity factor (C) not more than $1,0 (\text{m/s})^{1/2}$

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 not less than 12bar

3.16 protective cap: a 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 expressed as $RTI = tu^{1/2}$, where t is the time constant of the heat-responsive element in units of seconds, and u is the gas velocity expressed in meters per second. RTI has units of $(ms)^{1/2}$.

NOTE 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 the 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 a device attached to the nozzle for the purpose of protecting the nozzle only during transport and installation. Shipping caps are not intended to remain on the nozzle after the installation is complete.

ISO/DIS 6182-9

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 twice the rated working pressure, but not less than 30,0 bar, applied for at least 2 sec.

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. 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 the *International Standard for Pipe Threads*, ISO 7-1:1982.

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 Each water mist nozzle shall be provided with a strainer or filter 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.

5.5.2 All nozzles shall be constructed so that a sphere of diameter 8 mm can pass through each water passage in the nozzle. Nozzle with smaller openings shall utilize an integral strainer with each nozzle.

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.

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

Table 1 — Oven Aging

6.2 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.

7 Water mist nozzle requirements (see 8. Test methods)

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.

Glass bulb nozzles		Fusible element nozzles	
Nominal release temperature	Liquid color code	Nominal release temperature	Color code
57	orange	57 – 77	uncolored
68	red	80 – 107	white
79	yellow	121 – 149	blue
93 – 107	green	163 – 191	red
121 – 141	blue		
163 – 182	mauve		

Table 2 — Nominal release temperature

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.

7.3 Operating temperatures Automatic nozzles shall open within a temperature range of $X \pm (0,035X + 0,62) ^\circ\text{C}$ where X 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 10.2g). 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 10.2g). 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 5 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 (LTL) on the strength distribution curve of at least two times the upper tolerance limit (UTL) of the service load distribution curve based on calculations with a degree of confidence (y) of 0,99 for 99 percent 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.

7.9.3 Coated automatic nozzles In addition to meeting the requirement of 7.9.2 in an uncoated version, coated automatic nozzles shall withstand exposure to ambient temperatures without evidence of leakage, weakness or failure of the coating when tested by the method specified in 8.7.3.

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 vapor 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.

7.12 Integrity of nozzle coatings

7.12.1 Evaporation of wax and bitumen used for atmospheric protection of nozzles Waxes and bitumens used for coating nozzles shall not contain volatile matter in sufficient quantities to cause shrinkage, hardening, cracking or flaking of the applied coating. The loss in mass shall not exceed 5 % of that of the original sample when tested by the method detailed in 8.13.1.

7.12.2 Resistance to low temperatures All coatings used for nozzles shall not crack or flake when subjected to low temperatures by the method detailed in 8.13.2.

7.12.3 Resistance to high temperature Coated nozzles shall meet the requirements of 7.9.3.

7.13 Water hammer Automatic nozzles shall show no signs of leakage or mechanical damage when tested in accordance with 8.15 and shall operate within the parameters of 7.5.1 at the minimum operating pressure.

7.14 Dynamic heating

7.14.1 When tested in accordance with 8.6.2 in their standard orientation, automatic nozzles shall have a Response Time Index (*RTI*) not exceeding 50 (ms)^{1/2} and a Conductivity Factor (*C*) less than 1 (m/s)^{1/2}. When

tested at an angular offset of 25 degrees to the worst case orientation, the *RTI* shall not exceed 250 % of the value of *RTI* in the standard orientation.

7.14.2 After exposure to the corrosion test described in 7.11.2, 7.11.3 and 7.11.4, automatic nozzles shall be tested in the standard orientation as described in 8.6.2.1 to determine the post-exposure *RTI*. All post-exposure *RTI* values shall not exceed the limits specified in 7.14.1. In addition, the average *RTI* value shall not exceed 130 % of the pre-exposure average value. All post-exposure *RTI* values shall be calculated in accordance with 8.6.2.3 using the pre-exposure conductivity factor (C).

7.15 Resistance to heat Nozzles shall be resistant to high temperatures when tested in accordance with 8.14. After exposure, the nozzle shall not show any of the following: a) visual breakage or deformation, b) a change in flow constant *K* of more than 5 %, and c) no changes in the discharge characteristics of the water distribution test (see 7.4.2) exceeding 5 %.

7.16 Resistance to vibration Nozzles shall be able to withstand the effects of vibration without deterioration of their performance characteristics when tested in accordance with 8.16. After the vibration test of 8.16, automatic nozzles shall show no visible deterioration and shall meet the requirements of 7.5 and 7.8. Open nozzles shall not rupture when subjected to the body strength test in accordance with 8.4.2.

7.17 Resistance to impact (see 8.17) Nozzles shall have adequate strength to withstand impacts associated with handling, transport and installation without deterioration of their performance or reliability. Resistance to impact shall be determined in accordance with 8.17.

7.18 Lateral discharge Automatic nozzles shall not prevent the operation of adjacent automatic nozzles when tested in accordance with 8.18.

7.19 30-day leakage resistance Automatic nozzles shall not leak, sustain distortion or other mechanical damage when subjected to twice the rated pressure for 30 days. Following exposure, the nozzles shall satisfy the test requirements of 8.19.

7.20 Vacuum resistance Automatic nozzles shall not exhibit distortion, mechanical damage or leakage after being subjected to the test detailed in 8.20.

7.21 Clogging A water mist nozzle and strainer or filter shall show no evidence of clogging during 30 min of continuous flow at rated working pressure using water that has been contaminated in accordance with 8.21.3. Following the 30 min of flow, the water flow at rated pressure of the nozzle and strainer or filter shall be within ± 10 % of the value obtained prior to conducting the clogging test.

7.22 Fire tests

7.22.1 General

7.22.1.1 Water mist nozzles shall be tested for compliance with one or more of the fire test categories described in 7.23 through 7.25 as follows:

- a) Shipboard Class 1 Machinery Spaces
- b) Shipboard Class 2 Machinery Spaces
- c) Shipboard Class 3 Machinery Spaces
- d) Shipboard Passenger Cabins
- e) Shipboard Corridors
- f) Shipboard Luxury Passenger Cabins
- g) Shipboard Open Public Spaces and Corner Public Spaces