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F-12
AUTOMATIC SPRINKLER SYSTEM

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Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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Automatic Sprinkler System

1 Scope of Application

1.1 The Guideline is applicable to the type test and product inspection of automatic sprinkler system as required in Article 10 of Chapter II-2 of SOLAS Convention.

1.2 The Guideline is applicable to wetted pressure pipe system with an independently opened (automatic) nozzle, and the extinguishing medium is water without extinguishing additive.

1.3 The Guideline is applicable to the type approval of pendant nozzle installed on ceiling or sidewall nozzle installed on the bulkhead below the ceiling.

2 Normative References

2.1 *Regulations 10, Chapter II-2 of International Convention for the Safety of Life at Sea, 1974, as Amended.*

3.2 Chapter 8 of *International Code for Fire Safety Systems* (FSS Code)

2.3 *Revised Guideline for Approval of Sprinkler Systems Equivalent to That Referred to in SOLAS Regulation II-2/12* (A.800 (19)) and its amendments MSC.265 (84) and MSC.284 (86)

3 Terms and Definitions

3.1 The Guideline uses the following terms and definitions given in A.800 (19), MSC.265 (84) and GB5135.

(1) Deluge system: A sprinkler system employing open sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto

(2) Wet pipe system: A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

(3) Dry pipe system: A sprinkler system employing automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve. The water then flows into the piping system and out of the opened sprinklers.

(4) Pre-action system: A sprinkler system employing automatic sprinklers attached to a piping system containing air that may or may not be under pressure, with a supplemental detection system installed in the same area as the sprinklers. Actuation of the detection system opens a valve that permits water to flow into the sprinkler piping system and to be discharged from any sprinklers that may be open.

(5) Flame suppression: Reduce flame heat release and cover the inflamer surface directly with enough water to prevent refiring.

(6) Fire control: Spray water to limit the fire intensity to achieve the purpose of reducing flame heat release and prewetting adjacent flammable substances, as well as control ceiling air temperature to avoid structural damages.

(7) Fire source refers to combustible materials that may easily cause a fire and are covered on the wall and ceiling.

(8) Fire accelerant refers to a good that may be ignited.

(9) Nozzle: The nozzles for automatic sprinkler system fall into two type, sprinkler and water mist nozzle respectively.

(10) Sprinkler nozzle refers to a spray device that is started up automatically within the range of predetermined temperature under thermal action effect or by a control equipment according to fire signal and sprays water according to the designed shape and flow.

(11) Water mist nozzle refers to a nozzle that decomposes water current into droplets with the diameter of less than 1mm in a set area and then sprays them in a designed shape under a certain pressure.

4 Drawings and Documents

4.1 For product approval, the following drawings and documents shall be submitted to CCS for review:

(1) General layout of product;

(2) System principle diagram;

(3) Drawings of main spare parts & components;

(4) Main performance & specification sheets of product;

(5) Instruction book for design calculation;

(6) Technical conditions for delivery acceptance;

(7) Type test outline.

4.2 For product approval, the following drawings and documents shall be submitted to CCS for future reference:

(1) Product instruction sample

(2) Maintenance instruction sample

4.3 Type approval data shall generally include the following contents:

(1) Factory profile: factory name, address, production history, production capacity, technique and inspection personnel, major products, relationships, production brand, etc.;

(2) Details of products applying for approval;

(3) List of main manufacturing equipment;

(4) List of main testing equipment;

(5) Brief production process flow of products applying for approval;

(6) Quality management document or quality system certificate;

(7) Business registration certificate and business license.

(8) Qualification and/or production permission, if applicable;

(9) Product quality certificate sample;

(10) Quality control plan, if applicable;

(11) List of raw materials and qualified suppliers of main spare part & components;

(12) Asbestos-free announcement.

4.4 Other relevant type approval data that are deemed as necessary by CCS.

5 Raw Materials and Main Spare Parts & Components

5.1 Raw materials and main spare parts & components shall be controlled according to relevant requirements of current specification of the Society.

6 Technical Requirements for Design

6.1 The system can run automatically.

6.2 The system shall have fire detection function and water-based extinguishing media control or extinguishing function.

6.3 The sprinkler system should be capable of continuously supplying the water-based extinguishing medium for a minimum of 30 min.To meet the function requirements as specified in 2.3.2.1 of Chapter 8 of FSS Code, one pressure tank shall be provided or other measures shall be taken to ensure the farthest nozzle in each zone can reach pressure as required by the system within 60s after system action; the pressure tank shall be arranged to have the tank under a certain air pressure, so as to ensure regularly filled fresh water in tank is used. Pressure in the cabinet is not lower than operating pressure of sprinkler plus head pressure from the tank bottom to the highest point in the system. Appropriate facilities supplementing air and fresh water for cabinet under pressure shall be available. The pressure tank shall have a glass water gauge to indicate correct water level in the tank.

6.4 Means shall be provided to prevent the passage of sea water into the tank.

6.5 The system should be capable of fire control or suppression under a wide variety of fire loading, fuel arrangement, room geometry and ventilation conditions.

6.6 The system and equipment shall be suitably designed to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in ships.

6.7 One set of independent power pump shall be provided solely for the purpose of continuing automatically the discharge of water from the sprinklers. The pump shall be brought into action automatically by the pressure drop in the system before the standing fresh water charge in the pressure tank is completely exhausted.

6.8 The pump shall have fitted on the delivery side a test valve with a short open-ended discharge pipe. The effective area through the valve and pipe shall be adequate to permit the release of the required pump output while maintaining the pressure in the system specified in paragraph6.3.

6.9 The system shall at least have two sets of power sources. If the power sources of pump are electricity, the one power source is main generator and the other one is emergency power supply. The pump shall be powered by special independent feeder lines, one of which comes from the main distribution panel, while the other one comes from the emergency distribution panel. Except for the necessity for access to corresponding distribution panels, the feeder line shall be avoided to pass through the kitchen, machinery space and other enclosed space with high fire risk and shall be connected to 1 automatic changeover switch installed close to the sprinkler pump. In normal power supply conditions, such switch shall always be powered by the main distribution panel and designed to be powered by the emergency distribution panel through automatic changeover in case of any power supply failure. The switches for both main distribution panel and emergency distribution panel shall have clear markers and shall be kept closed in normal conditions. Other switches are not allowed to be installed on above feeder line. The one channel of power supply among the system power sources shall be emergency power supply. If one of pump power sources is diesel engine, in addition to compliance with the provisions of 2.4.3 of Chapter 8 of FSS Code, the pump shall be installed not to affect air supply of diesel engine in case any protected space catches a fire. If

fuel supply is enough to ensure all pumps on the passenger vessel run for 36h with full displacement and all pumps on the freight vessel run for 18h with full displacement, the pump set consisting of two diesel engine sets may be considered acceptable and each pump in each pump set can at least supply 50% of required displacement.

6.10 The system shall be equipped with standby pumping devices, including driver or shall use other means to supply water-based extinguishing media to the water spray system. The displacement of standby devices shall be sufficient to compensate for the loss of any independent supply pump or alternative source. The failure occurred on any device of power and control systems shall not reduce 50% of automatic release and sprinkler pump displacement. Hydraulic calculation shall be performed to ensure enough flow and pressure can be transmitted to the farthest 140m^2 area in case of any device failure. ”

6.11 The system shall have a fixed seawater inlet and can run continuously by seawater.

6.12 The system piping size shall be determined by hydraulic calculation or as per the national standard approved by relevant authority. If Hazen-Williams method is used, the calculation formulas is

$$h = \frac{10.667l}{C^{1.852}d^{4.87}}q^{1.852}$$

Where: d – pipe diameter (m)

q – flow (m^3/s)

l — length of pipe section (m)

h – head loss (m)

For different types of pipe, the friction coefficient C may select following values:

Table 6.14 Value of friction coefficient C

Pipe	C value
Clack steel pipe or galvanized mild steel pipe	120
Copper and copper alloy pipes	150
Stainless steel pipe	150
Plastic pipe	150

6.13 The sprinkler shall be grouped into several zones, each of which shall contain not more than 200 sprinklers. In passenger ships any section of sprinklers shall not serve more than two decks and shall not be situated in more than one main vertical zone. However, the Administration may permit such a section of sprinklers to serve more than two decks or be situated in more than one main vertical zone, if it is satisfied that the protection of the ship against fire will not thereby be reduced.

6.14 Each sprinkler zone can only use 1 stop valve for separation. Such stop valve in each sprinkler zone shall be located outside its service zone or at a place that is accessible from the cell in stairway enclosure. Clear fixed signs shall be provided at the valve. Measures shall be provided to prevent any unauthorized person from operating such stop valve. If visual and auditory alarm devices as required in 6.19 are equipped, except stop valve in zone, isolation valves for operation, maintenance or antifreeze supplement may be installed on the sprinkler piping. If the valve lock on the pump set is located in correct position, such alarm may not be provided.

6.15 The sprinkler system shall have one connection from the fire main by way of a lockable screw-down non-return valve at the connection which will prevent a backflow from the sprinkler system to the fire main.

6.16 The sprinkler piping shall not be used for other purposes.

6.17 The water supply device of sprinkler system shall be arranged outside Class A machine but shall not be located in any space protected by such sprinkler system .

6.18 To ensure the system has pressure and flow required, one set of test device that enables automatic operation of system shall be provided.

6.19 Each water spray zone shall have one set of audible/visual alarm device sending audible/visual alarm signal to the manned centralized control station within 1min upon spraying water from one or several sprinklers, one check valve, pressure gauge and one connector with release device. The visual/auditory alarm device can automatically send signal to one or several indicating devices when any one sprinkler acts. This alarm system shall be capable of indicating any failure occurred in such system. This device shall be capable of indicating fire occurred inside such system service zone and shall be arranged in a centralized manner in the driving cab or continuously manned central control station. In addition, audible/visual alarm facilities of such device shall be located beyond above spaces to ensure the crew can receive fire signal immediately.

6.20 One sprinkler control drawing shall be posted in each manned centralized control station.

6.21 The installation layout and operation manual shall be available on the vessel and put in a place that is easy for use. The drawing or table shall be posted at each system indicating device to show space where such device is located and each relevant zone location. The instructions for test and maintenance shall be available on the vessel. The instruction for maintenance shall cover the provisions for flow test to be carried out at least once per year for each zone to eliminate possible blockage or damage in pipe during inspection.

6.22 The sprinkler shall be capable of resisting marine atmospheric corrosion. The acting temperature of sprinkler shall be within the range of 57℃ - 77℃ in accommodation and service spaces, except potential high-temperature spaces. In such spaces, the acting temperature of sprinkler may be increased to a temperature less than cabin top temperature plus 30℃.

6.23 The pump and alternative water supply device shall be capable of providing flow and pressure required for the spaces with maximum hydraulic demand. For calculation, the designed area for required flow and pressure calculation shall be the deck area, namely the space with maximum hydraulic demand and is separated from adjacent spaces by Class A fire compartment. The designed area must not exceed $280m^2$. For small vessel with total protected area of less than $280m^2$, the authority may specify appropriate protected area to determine the displacement of pump and alternative water supply device.

6.24 The nozzle location, mode and features shall be compliant with test limits determined by extinguishing performance test in 8.3 for fie control or suppression as described in 6.2.

6.25 For vestibule with an area of more than 100m^2 and middle deck opening, the sprinkler shall not be installed on the ceiling.

6.26 The system shall be designed not to reduce the level of protection provided for spaces unaffected by fire in case of a fire.

6.27 The standby nozzles shall all types and specifications of nozzles installed on the vessel, and their quantities are as follows:

Total number of nozzles	**Number of spares parts required**
<300	6
300～1000	12
>1000	24

The number of standby nozzle of any type must not exceed the number of nozzles installed on the vessel.

6.28 At any part in system, proper anti-freezing measures shall be available in case of possible freezing temperature during use.

6.29 The sprinklers shall be provided at the top of protected space and at a proper interval to ensure average water flow of not less than 5l/m^2.min for rated area protected by the sprinkler. For this, the rated area shall be the total horizontal projection area of protected area. But, the authority may also allow using sprinklers that are distributed properly but have different flows, if their efficiencies are not lower than those required above and satisfy the authority.

6.30 After the automatic sprinkler system with a water mist nozzle shall undergo extinguishing test as per the requirements in 8.3 of the Guideline, its average water flow shall be determined.

7 Selection of Typical Samples

7.1 For type approval, the systems of each model shall be subject to type test. If there are different modes of nozzles, each nozzle shall subject to type test. For different modes of nozzles made of the same material, only one model may be selected for corrosion test.

7.2 The test samples provided by the manufacturer shall be taken randomly to conduct extinguishing test.

8 Type Test

8.1 For nozzle type test, see Table 8.1 for test items and requirements.

Table 8.1Nozzle type test items

S/N	Test items	Test requirements Corresponding clauses in A.800(19) Annex 1	Test methods Corresponding clauses in A.800(19) Annex 1
1	Overall dimension inspection	4.1	5.2
2	Operating temperature	4.3	5.6.1
3	Water flow and water distribution	4.4	5.10/5.11
4	Function test	4.5	5.5
5	Strength of body	4.6	5.3
6	Strength of release element	4.7	5.9
7	Tightness and hydrostatic pressure strength	4.8	5.4
8	Heat exposure	4.9	5.7
9	Thermal shock of glass bulb nozzle	4.10	5.8
10	Corrosion	4.11	5.12
11	Integrity of nozzle coatings	4.12	5.13
12	Water hammer	4.13	5.15
13	Dynamic heating test	4.14	5.6.2
14	Heat resistance	4.15	5.14
15	Vibration resistance	4.16	5.16
16	Impact test	4.17	5.17
17	Transverse discharge	4.18	5.18
18	30-day leakage test	4.19	5.19
19	Vacuum resistance	4.20	5.20
20	Clogging	4.22	5.21
21	Nozzle mark	6	6

8.2 Wet-type & deluge alarm valve test

S/N	Test items	Test requirements	Test methods
1	Strength test	The valve body shall be free from damages such as macroscopic deformation and leakage.	Kept for 5min under 4 times rated operating pressure (but no less than 4.8 MPa)
2	Leakage and deformation	There shall be no leakage and permanent deformation, etc.	Kept for 5min under 2 times rated operating pressure
3	Alarm function of wet-type alarm valve	Refer to the requirements of 4.10 in GB5135.2-2003.	Refer to the requirements of 5.8.1-5.8.4 in GB5135.2-2003.
4	Alarm function of deluge alarm valve	Refer to the requirements of 4.12 in GB5135.5-2003.	Refer to the requirements of 5.9 in GB5135.5-2003.
Note: 1. Proper alarm valves shall be selected according to different water spray modes of system. 2. For test items in items 3 and 4 in table, it is acceptable to substitute national standards by ISO standards (if available).			

8.3 Extinguishing test

8.3.1 Test purpose

(1) Evaluate the effectiveness of water mist systems that are installed in accommodation and service spaces and equivalent to the provisions of Chapter 8 of FSS Code. The test is only limited to evaluate extinguishing effects of system, rather than testing of design parameters and quality of system components.

(2) Determine the manufacturer's design and installation standards.

8.3.2 Classification of various spaces and extinguishing tests

To determine different fire levels, the relationships between extinguishing tests and various manned spaces defined in Articles Ⅱ-2/9.2.2.3 and Ⅱ-2/9.2.2.4 of SOLAS Convention are shown in Table 8.3.2.

Table 8.3.2 Relationships between various manned spaces and extinguishing tests

Classification	Corresponding extinguishing tests			
	Section 5 Living cabin	Section 5 Corridor	Section 6 Public space	Section 6 Storeroom
(1) Control station			X	
(2) Stairway		X[1]		
(3) Corridor		X[1]		
(6) Accommodation space with minor fire risk	X[2]		X[3]	
(7) Accommodation space with moderate fire risk	X[2]		X[3 4]	
(8) Accommodation space with large fire risk			X[3 4]	
(9) Toilet and similar space	X[2]		X[3]	
(11) Refrigerating chamber			X	
(12) Main kitchen and its auxiliary room			X	
(13) Storeroom, workshop and diet preparation room, etc.				X
(14) Other spaces for flammable liquid storage				X

Notes: 1 For corridor and stairway with the width of more than 1.5m, the extinguishing test for corridor may be substituted by an extinguishing test for public space in Section 6.

2 Space with the area up to that of living cabin used in Section 5.

3 Space with the area exceeding that of living cabin used in Section 5.

4 Refer to Guideline 6.25.

8.3.3 General requirements for extinguishing test

(1) Nozzle arrangement

The testing agency shall ensure that the nozzle for each test shall be installed in accordance with the manufacturer's design and installation manuals. The test shall be performed with maximum interval, installation height and distance between ceilings as specified. If the testing agency considers it necessary, the test may be performed with minimum interval, installation height and distance between ceilings as specified. If two types of nozzles are installed in the same area, the test shall be at least performed at 1/2 of maximum nozzle spacing by crossed spraying methods with different nozzles.

(2) Test pressure and flow

The testing agency shall ensure all extinguishing tests are performed under operating pressure and flow as specified by the manufacturer. The systems undergoing extinguishing test shall be one of the followings:

① Withstand pressure as per min. operating pressure as specified by the manufacturer. When the first nozzle is opened, the flowing pressure shall be kept under min. operating pressure of system.

② Withstand pressure as per min. standby pressure as specified by the manufacturer. When the first nozzle is opened, the flowing pressure shall be gradually increased to min. operating pressure of system. The delay time for reaching min. operating pressure of system shall be at least 15s and recorded in the test report.

(3) Temperature measurement

Throughout the test, continuous temperature measurement shall be performed by chromium-aluminum thermocouple with a diameter of no more than 0.5mm at least once every 2s.

(4) Extinguishing laboratory and its environment conditions

The extinguishing test shall be performed in a fireproof laboratory with good ventilation conditions and ambient temperature of 20±5℃. There shall have no ponding on floor and the ceiling shall be kept dry.

(5) The following data shall be observed and recorded during the test:

① Ignition time

② Beginning time of nozzle operation

③ Water flow cutoff time

④ Degree of damage caused by fire source⑤ Temperature recording

⑥ System flow and pressure

⑦ Total number of operating nozzles

8.3.4 Test items

(1) Extinguishing test for space

Table 8.3.4(1) Items of extinguishing test for space

S/N	Main function test items	Sub-items	Corresponding clauses in amendment A800(19) prepared based on amendment MSC.265(84)
1	Performance verification test for fire source material	(1) Plywood	5.1.5

Table 8.3.4(1) (continued)

S/N	Main function test items	Sub-items	Corresponding clauses in amendment A800(19) prepared based on amendment MSC.265(84)
1	Performance verification test for fire source material	(2) Sound barrier	5.1.4
		(3) Mattress and sofa cushion	5.4.1
2	Extinguishing tests for living cabin and corridor	(1) Lower bed test	5.1~5.7
		(2) Upper bed test	
		(3) Ignition test	
		(4) Nozzle out-of-action test	
		(5) Test for lower part of single nozzle for corridor	
		(6) Test for middle parts of double nozzles for corridor	
3	Extinguishing test for public space	Test for open public space (following tests are respectively performed at 2.5m and 5m high ceilings)	6.1~6.6
		(1) Oxygen content verification test of space	
		(2) Test for lower part of one nozzle	
		(3) Test for middle parts of two nozzles	
		(4) Test for centers & middle parts of four nozzles	
		(5) Additional test: performed below the nozzle out of action at ignition source center	
		Test for public space at wall corner	
		(1) Matrix arrangement test for at least four 2*2 nozzles	
4	Extinguishing test for storeroom	(1) Test for lower part of one nozzle	7.1~7.6
		(2) Test for middle parts of two nozzles	
		(3) Test for centers & middle parts of four nozzles	

(2) System function test

Table 8.3.4(2) System function test items

System function test	(1) System integrity inspection	Manufacturer's design requirements
	(2) Water pressure tightness test of piping system	
	(3) Automatic and manual operation control tests for fresh water pump and seawater pump	
	(4) Signal butterfly valve action test	
	(5) Alarm valve device action test	
	(6) Alarm and display systems test	

8.3.5 Document requirements

The extinguishing test report shall identify key parameters in design, installation and operation manuals. The operation manual shall indicate limitations of each device and include at least following items:

（1） Detailed operation instructions for each device and all auxiliary elements, including identification of extinguishing system parts or its auxiliary elements by component or specimen codes.

（2） Design proposals and its limitation instructions of all nozzles appropriate for all tests

（3） Models and rating pressure of selected piping, pipeline and accessory

（4） Equivalent length of all accessories that water passes through and all system parts

（5） Relevant limitations for nozzle, including max. size and coverage area, min. & max. installation height limitations and allowable installation location of protected nozzle

（6） Injection capacity of each size of storage vessel

（7） Detailed instructions for correct installation of each device, including all elements

（8） Specific reference models of detection and control panels connected to equipment

（9） System operating pressure range

（10） Methods for determining piping and pipeline sizes

（11） Arrangement orientation and flow distribution of recommended T-shaped connector

（12） Max. operating pressure difference between the farthest and nearest nozzles

9 Product Inspection by Piece/Batch

9.1 The certificates for marine products of main parts and components shall be checked according to relevant requirements of our current specification.

9.2 The nozzle shall have no visible external defects. The conspicuous part of nozzle shall be attached with a permanent label showing clearly the manufacturer's trademark, model and No.

9.3 The nozzle flow test shall be performed to test nozzle flow characteristic coefficient K. 10% of nozzles (at least 2 in quantity) in the same batch shall be randomly sampled. The testing results shall be within ±5% of its manufacturer's specified value.

9.4 For nozzle function test, 3 nozzles in the same batch shall be randomly sampled to perform 15min hydraulic pressure strength test under 1.25 times rated operating pressure.

9.5 System operation test

9.5.1 Automatic and manual startup and shutdown tests of system

9.5.2 Alarm and display system tests

9.5.3 At least one protected area is selected for spay test with duration of not less than 30s, and a low-power pump is selected as an alternative for effect test.

9.6 If the nozzle is a licensed outsourced product, tests in Articles 9.3 and 9.4 of Guideline may not be carried out.

9.7 If the factory applies for our mode A for type approval, product inspection by piece and batch may be performed upon reference to the post-approval quality control plan.