



RULES

PUBLICATION 89/P

LINES FOR DESIGN, INSTALLATION AND TYPE TESTING OF FIXED FIRE-EXTINGUISHING SYSTEMS USED ONBOARD SHIPS

July
2023

Publications P (Additional Rule Requirements) issued by Polski Rejestr Statków complete or extend the Rules and are mandatory where applicable.

GDAŃSK

A decorative graphic at the bottom of the page consists of several overlapping, wavy blue lines that create a sense of movement and depth, extending across the width of the page.

Publication 89/P – Guidelines for Design, Installation and Type Testing of Fixed Fire-extinguishing Systems Used Onboard Ships – July 2023, was approved by the PRS S.A. Board on 19 June 2023 and enters into force on 1 July 2023.

The *Publication* is completed by final documents (resolutions and circulars) of IMO/MSC Committee referred to in particular chapters, available on webpage www.imo.org , as well as national/international standards.

© Copyright by Polish Register of Shipping*, 2023

* *Polish Register of Shipping* means *Polski Rejestr Statków S.A.*, seated in Gdańsk, al. gen. Józefa Hallera 126, 80-416 Gdańsk, Poland, registered in the Register of Entrepreneurs of the National Court Register, under entry number 0000019880. Polish Register of Shipping, its affiliates and subsidiaries, their respective officers, employees or agents are, individually and collectively, referred to as Polish Register of Shipping or as PRS for short.

CONTENTS

	Page
1 General	5
1.1 Application	5
2 Automatic Sprinkler Systems	5
2.1 High-pressure Equivalent Sprinkler System (Water Mist System)	5
3 Water Spraying Systems	9
3.1 Water-based Fire-fighting System for Ro-ro Spaces and Special Category Spaces	9
3.2 Fixed Pressure Deluge System and Equivalent Water Mist System for Machinery Spaces and Cargo Pump Rooms	17
3.3 Fixed Water-based Local Application Fire-fighting System for Machinery Spaces of Category A	20
3.4 Water-spraying System and Water-based Fire-extinguishing System for Cabin Balconies	23
4 Gas Fire-Extinguishing Systems	25
4.1 Gas Equivalent Fire-extinguishing System for Machinery Spaces and Cargo Pump Rooms	25
4.2 Fixed Aerosol Fire-extinguishing System for Machinery Spaces	30
5 Dry Chemical Powder Fire-extinguishing System For Gas Carriers	35
5.1 Application	35
5.2 Definitions	35
5.3 Requirements for the System	36
5.4 Type Tests	37
5.5 On Board Testing	37

1 GENERAL

1.1 Application

1.1.1 This *Publication* specifies guidelines for designing, installation and performance of type tests of the fixed fire-extinguishing systems used onboard ships, required by the *Rules for the Classification and Construction of Sea-going Ships, Part V – Fire Protection*.

1.1.2 The guidelines have been developed on the basis of the applicable final documents (resolutions/circulars) of the IMO MSC Committee.

1.1.3 The systems, after meeting the requirements of the product type approval procedure and passing type tests with a positive result, may obtain the *Product Type Approval Certificate*.

2 AUTOMATIC SPRINKLER SYSTEMS

2.1 High-pressure Equivalent Sprinkler System (Water Mist System)

2.1.1 Application

The system is intended for the protection of accommodation spaces, service spaces and control stations onboard ships.

2.1.2 Definitions

- .1 *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.
- .2 *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 under pressure.
- .3 *Sprinkler system with a supplemented detection system (preaction 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.
- .4 *Antifreeze system* – a wet pipe sprinkler system employing automatic sprinklers attached to a piping system containing an antifreeze solution and connected to a water supply. The antifreeze solution is discharged, followed by water, immediately upon operation of sprinklers opened by heat from a fire.
- .5 *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.
- .6 *Water-based extinguishing medium* – fresh water or sea water with or without additives (e.g. a foam concentrate) mixed to enhance fire-extinguishing capability.

2.1.3 Requirements for the System

2.1.3.1 The system should be automatic in operation, with no human action necessary to set it in operation.

2.1.3.2 The system should be capable of both detecting the fire and acting to control or suppress the fire with a water-based extinguishing medium.

2.1.3.3 The sprinkler system should be capable of continuously supplying the water-based extinguishing medium for a minimum of 30 min. A pressure tank or other device should be provided to meet the functional requirement stipulated below:

- .1 standing charge of fresh water in the tank should be equivalent to the amount of water which should be discharged in 1 min by the sea water pump;
- .2 the pressure tank should have a volume equal to at least twice that of the charge of water specified above;
- .3 an air pressure should be maintained in the tank such as to ensure that where the standing charge of fresh water in the tank has been used, the pressure will be not less than the working pressure of the sprinkler, plus the pressure exerted by a head of water measured from the bottom of the tank to the highest sprinkler in the system;
- .4 suitable means of replenishing the air under pressure and of replenishing the fresh water charge in the tank, as well as non-return valves to prevent sea water passage to the tank, should be provided;
- .5 A glass gauge and a device should be provided to indicate the lowering of water level and pressure in the tank below the required minimum, in continuously manned part of machinery compartment.

The system should be so designed that the working pressure may be achieved at the most remote sprinkler in each section within not more than 60 seconds from the system operation.

Interpretations on the selection of pump capacity and pressure vessel volume are contained in MSC.1/Circ.1556.

2.1.3.4 The system should be of the wet pipe type but small exposed sections may be of the dry pipe, preaction, deluge, antifreeze or other type, where this is necessary.

2.1.3.5 The system should be capable of fire control or suppression under a wide variety of fire loading, flammable materials arrangement, room geometry and ventilation operation.

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

2.1.3.7 The system and its components should be designed and installed in accordance with international standards acceptable to IMO¹⁾ and manufactured and tested in accordance with the requirements given in Appendices 1 and 2 to IMO Res. A800(19) as amended by MSC.265(84).

2.1.3.8 There should be not less than two sources of power for the system. Where the sources of power for the pump are electrical, these should be a main generator and an emergency source of power. One supply for the pump should be taken from the main switchboard, and one from the emergency switchboard by separate feeders reserved solely for that purpose.

¹⁾ Pending the development of international standards acceptable to IMO, national standards should be applied.

The feeders should be so arranged as to avoid galleys, machinery spaces and other enclosed spaces of high fire risk except in so far as it is necessary to reach the appropriate switchboards, and should be run to an automatic changeover switch situated near the sprinkler supply pump. This switch should permit the supply of power from the main switchboard so long as a supply is available therefrom, and be so designed that upon failure of that supply it will automatically change over to the supply from the emergency switchboard.

The switches on the main switchboard and the emergency switchboard should be clearly labelled and normally kept closed. No other switch should be permitted in the feeders concerned.

One of the sources of power supply for the system should be an emergency source. Where one of the sources of power for the pump is an internal combustion engine, it should be sufficiently remote of the category A machinery space, should not be located in any space required to be protected by a sprinkler system and be so situated that a fire in any protected space will not affect the air supply to the machinery.

Pump sets consisting of two diesel engines each supplying at least 50% of the required water capacity are considered acceptable if the fuel supply is adequate to operate the pumps at full capacity for a period of 36 h on passenger ships and 18 h on cargo ships.

The room containing the pumping arrangement should be labeled with appropriate plate placed on entry doors, with a symbol taken from *Fire Control Plan*.

2.1.3.9 The system should be provided with a redundant means of pumping, including drivers, or otherwise supplying a water-based extinguishing medium to the sprinkler system. The capacity of the redundant means should be sufficient to compensate for the loss of any single supply pump or alternative source.

Failure of any one component in the power and control system should not result in a reduction of the automatic release capability or reduction of sprinkler pump capacity by more than 50%. Hydraulic calculations should be conducted to assure that sufficient flow and pressure are delivered to the hydraulically most remote area of 140 m² in the event of the failure of any one component.

2.1.3.10 The system should be fitted with a permanent sea inlet and be capable of continuous operation using seawater.

2.1.3.11 The piping system should be sized in accordance with an hydraulic calculation technique, e.g. by Hazen-Williams method, with the purpose to gain required flow and pressure rate for proper operation of the system.

2.1.3.12 Sprinklers should be grouped into separate sections. Any section should not serve more than two decks of one main vertical zone.

2.1.3.13 Each section of sprinklers should be capable of being isolated by one stop valve only. The stop-valve in each section should be readily accessible in a location outside of the associated section or in cabinets within stairway enclosures.

The stop (section) valves location should be clearly and permanently indicated. Means should be provided to prevent the operation of the stop-valves by an unauthorized person. Isolation valves used for service, maintenance or for refilling of antifreeze solutions may be installed in the sprinkler piping in addition to the section stop valves, if provided with a means for giving a visual and audible alarm as required by paragraph 2.1.3.17. Valves on the pump unit may be accepted without such alarms if they are locked in the correct position.

2.1.3.14 Sprinkler piping should not be used for any other purpose.

2.1.3.15 The sprinkler system water supply components should be located outside category A machinery spaces and should not be situated in any space required to be protected by the sprinkler system.

2.1.3.16 A means should be provided for testing the automatic operation of the system and for assuring the required pressure and flow.

2.1.3.17 Each sprinkler section should be provided with a means for giving an automatic visual and audible alarm at a continuously manned central control station/ship safety centre within one minute of activating one or more sprinklers, a check valve, pressure gauge, and a test connection with a means of drainage.

2.1.3.18 A sprinkler system control plan should be displayed at each continuously manned control station/ship safety centre.

2.1.3.19 Installation plans and operating manuals for the sprinkler system should be readily available on board. The installation plan should show the spaces covered and the location of the zone in respect of each section. Instructions for testing and maintenance should also be available on board. The maintenance instructions should include provisions for a flow test of each section at least annually to check for possible clogging or deterioration in the discharge piping.

2.1.3.20 Sprinklers should have fast response characteristics as defined in ISO standard 6182-1.

2.1.3.21 In accommodation and service spaces, the sprinklers should have a nominal temperature rating of 68°C to 79°C, except that in locations such as drying rooms, where high ambient temperatures might be expected, the nominal temperature may be increased by not more than 30°C above the maximum deckhead temperature.

2.1.3.22 Pumps and alternative supply components should be capable of supplying the required flow rate and pressure for the space with the greatest hydraulic demand. For the purposes of this calculation, the design area used to calculate the required flow and pressure should be the deck area of the most hydraulically demanding space, separated from adjacent spaces by A-class divisions. The design area need not exceed 280 m². For application to a small ship with a total protected area of less than 280 m², the appropriate area for sizing of pumps and alternative supply components may be specified.

2.1.3.23 The nozzle location, type, and characteristics should be within the tested limits determined by the fire test procedures in Appendix 2 to Res. A.800(19), as amended by Res. MSC.265(84), to provide fire control or suppression.

2.1.3.24 For atriums with intermediate level deck openings exceeding 100 m², ceiling mounted sprinklers are not required.

2.1.3.25 The system should be designed in such a way that during a fire occurrence, the level of protection provided to those spaces unaffected by fire is not reduced.

2.1.3.26 A quantity of spare nozzles should be carried for all types and ratings installed on the ship as follows:

Total number of nozzles	Required number of spares
< 300	6
300 to 1000	12
> 1000	24

The number of spare nozzles of any type need not exceed the total number of nozzles installed of that type.

2.1.3.27 Any parts of the system which may be subjected to freezing temperatures in service should be suitably protected against freezing.

2.1.4 Type Tests

2.1.4.1 Sprinklers should be manufactured and type tested in accordance with Appendix 1 to Res. A.800(19), as amended by Res. MSC.265(84).

2.1.4.2 The sprinkler system should be type tested in accordance with Appendix 2 to Res. A.800(19), as amended by Res. MSC.265(84).

2.1.5 Tests of the system after installation on board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

3 WATER SPRAYING SYSTEMS

3.1 Water-based Fire-fighting System for Ro-ro Spaces and Special Category Spaces

3.1.1 Application

3.1.1.1 The systems are intended for application in open and closed ro-ro spaces, vehicle spaces and special category spaces, defined in *Part V – Fire Protection of the Rules for the Classification and Construction of Sea-going Ships*.

3.1.1.2 The systems can be applied on open ro-ro spaces when the actual wind condition is taken into consideration, for example through the use of high velocity nozzles.

3.1.1.3 Systems using automatic sprinklers or nozzles are only permitted for closed ro-ro and special category spaces or other spaces where wind conditions are not likely to affect system performance.

3.1.1.4 All the above systems should comply with the requirements specified in 3.1.3. In addition, prescriptive-based systems should comply with section 3.1.4 and performance-based systems should comply with section 3.1.5.

3.1.2 Definitions

- .1** *Area of operation* – a design area for wet-pipe, automatic sprinkler system (to be determined for performance-based systems by the test procedure described in the Appendix to MSC.1/Circ.1430/Rev.2).
- .2** *Automatic sprinkler or nozzle* – a single or multiple orifice water discharge device that activates automatically when its heat-activated element is heated to its thermal rating or above, allowing water under pressure to discharge in a specific, directional discharge pattern.
- .3** *Automatic system* – a system utilizing either automatic sprinklers or nozzles or a system that is automatically activated by a fire detection system.
- .4** *Deluge system, automatic and manual release* – a system employing open nozzles attached to a piping system connected to a water supply through a valve that can be opened by signals from a fire detection system (automatically) and by manual operation. When this

- valve is opened, water flows into the piping system and discharges from all nozzles attached thereto.
- .5 *Deluge system, manual release* – a system employing open nozzles attached to a piping system connected to a water supply through a valve that is opened by manual operation. When this valve is opened, water flows into the piping system and discharges from all nozzles attached thereto.
 - .6 *Dry pipe system* – a system employing automatic sprinklers or nozzles attached to a piping system containing air or nitrogen under pressure, the release of which (as from the activation of a sprinkler or nozzle by heat from a fire) permits the water pressure to open a valve known as a dry pipe valve. The water then flows into the piping and discharges from the open nozzles or sprinklers.
 - .7 *Fire control* – limits the size of a fire by distribution of water so as to decrease the heat release rate, while controlling gas temperatures and pre-wetting adjacent combustibles and/or reducing heat radiation to avoid structural damage.
 - .8 *Fire suppression* – the sharp reduction of the heat release rate of a fire and the prevention of regrowth.
 - .9 *K-factor* – a sprinkler /nozzle discharge coefficient determined by testing, that is used to calculate flow rate at any given pressure through the relationship $Q = k \cdot p^{1/2}$, where Q is the flow rate in litres per minute, and p is the pressure in bars.
 - .10 *Open sprinkler or nozzle* – an open single or multiple orifice water discharge device that, when discharging water under pressure, will distribute the water in a specific, directional discharge pattern.
 - .11 *Performance based requirements* – the requirements based on the results of fire tests conducted on specific nozzle design and arrangements. The required engineering parameters for such systems are determined by the results of the fire tests.
 - .12 *Prescriptive based requirements* – specific requirements, such as minimum water flow density or maximum nozzle spacing, which are applied equally to all systems related to these guidelines.
 - .13 *Pump* – a single water pump, with its associated driver and control or an individual pump within a pump unit.
 - .14 *Pump unit* – a single water pump, or two or more pumps connected together to form a unit, with their associated driver(s) and controls.
 - .15 *Pre-action system* – a system employing automatic sprinklers or nozzles attached to a piping system containing air that may or may not be under pressure, with a supplemental fire detection system installed in the same area as the sprinklers or nozzles. Activation of the fire detection system opens a valve that permits water to flow into the system piping and to be discharged from any sprinkler or nozzle that has operated.
 - .16 *Water-based extinguishing medium* – fresh water or seawater, with or without an antifreeze solution and/or additives (foam concentrate) to enhance fire-extinguishing capability.
 - .17 *Water discharge density* – the unit rate of water flow to an area or surface expressed in mm/min (equal to $(l/min)/m^2$).
 - .18 *Wet pipe system* – a system employing automatic sprinklers or nozzles attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers or nozzles opened by heat from a fire.

3.1.3 Principal Requirements for All System Types

3.1.3.1 The system may be automatically activated, automatically activated with provisions for manual activation or manually activated.

3.1.3.2 All systems should be divided into sections. Each section should be capable of being isolated by one section control valve. The section control valves should be located outside the protected space, be readily accessible without entering the protected spaces and their locations should be clearly and permanently indicated.

The control valve locations should be indicated by a plate with the symbol used in *Fire Control Plan*.

3.1.3.2.1 It should be possible to manually open and close the section control valves either directly on the valve or via a control system routed outside of the protected spaces. Means should be provided to prevent the operation of the section control valves by an unauthorized person.

3.1.3.2.2 Control valve locations should be adequately ventilated to minimize the build-up of smoke.

3.1.3.2.3 A continuously manned control station and release station(s) for deluge systems should have remote indication of pump running and pressure in valve manifold. For deluge systems, release stations with controls for start and stop of pump(s) and operation (opening and closing) of section control valves should be provided in the valve room and in a continuously manned control station or the safety centre, if fitted. Remote indication of position of valves (open/closed) should be provided in the continuously manned control station or the safety centre, if fitted.

3.1.3.3 The piping system should be sized in accordance with a hydraulic calculation technique¹⁾, such as the Hazen-Williams hydraulic calculation technique or the Darcy-Weisbach hydraulic calculation technique, to ensure the availability of the flows and pressures required for correct performance of the system. The design of the system should ensure that full system pressure is available at the most remote sprinkler or nozzle in each section within 60 s of activation.

3.1.3.4 The system supply equipment (pumps/pump units) should be located outside the protected spaces and all power supply components (including cables) should be installed outside of the protected space. The electrical components of the pressure source for the system should have a minimum rating of IP 54.

3.1.3.5 Activation of an automatic system should give a visual and audible alarm at a continuously manned station. The alarm in the continuously manned station should indicate the specific section of the system that is activated. The system alarm requirements described within this paragraph are in addition to, and not a substitute for, the fire detection and alarm system requirements for ro-ro spaces and special category spaces contained in *Part V – Fire Protection of the Rules for the Classification and Construction of Sea-going Ships*.

¹⁾ Where the Hazen-Williams Method is used, the following values of the friction factor C for different pipe types which may be considered should apply:

Pipe type	C
Black or galvanized mild steel	100
Copper and copper alloys	150
Stainless steel	150.

3.1.3.6 Wet pipe systems on board vessels that can operate in areas where temperatures below 0°C can be expected, should be protected from freezing either by maintaining positive temperature in the space, heating coils on pipes, antifreeze agents or other equivalent measures.

3.1.3.7 The capacity of the system water supply should be sufficient for the total simultaneous coverage of the minimum coverage area as given in tables 3.1.4-1 to 3.1.4-3 and 3.1.5.4 and the vertically applicable area as defined in paragraph 3.1.3.22.

3.1.3.8 The system should be provided with a redundant means of pumping or otherwise supplying a water-based extinguishing medium to the system. The capacity of the redundant means should be sufficient to compensate for the loss of any single supply pump or alternative source. Failure of any one component in the power and control system should not result in a reduction of required pump capacity of deluge systems. In the case of wet pipe, dry pipe and pre-action systems, failure of any one component in the power and control system should not result in a reduction of the automatic release capability or reduction of required pump capacity by more than 50 %. However, systems requiring an external power source need only be supplied by the main power source. Hydraulic calculations should be conducted to assure that sufficient flow and pressure are delivered to the hydraulically most demanding section (the highest flow friction) both in normal operation and in the event of the failure of any one component of the system.

3.1.3.9 The system should be fitted with a permanent sea inlet and be capable of continuous operation during a fire using sea water.

3.1.3.10 The system and its components should be designed to withstand ambient temperatures, vibration, humidity, shock, impact, clogging and corrosion normally encountered. Piping, pipe fittings and related components except gaskets inside the protected spaces should be designed to withstand 925°C. Distribution piping should be constructed of galvanized steel, stainless steel, or equivalent. Sprinklers and nozzles should comply with paragraph 3.1.3.11.

3.1.3.11 The system and its components should be designed and installed based on international standards acceptable to IMO.¹⁾ The nozzles should be manufactured and tested based on the relevant sections of Appendix A to circular MSC/Circ.1165 (Revised Guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump rooms).

3.1.3.12 A means for testing the automatic operation of the system and for checking the required pressure and flow should be provided.

3.1.3.13 If the system is pre-primed with water containing a fire suppression enhancing additive and/or an antifreeze agent, possibility of periodic inspection and testing, as specified by the manufacturer, should be provided to assure that their effectiveness is being maintained. Fire suppression enhancing additives should be approved for fire protection service by an independent authority. The approval should consider possible adverse health effects to exposed personnel, including inhalation toxicity.

3.1.3.14 Operating instructions for the system should be displayed at each operating position.

3.1.3.15 Installation plans and operating manuals should be supplied to the ship and be readily available on board. A list or plan should be displayed showing spaces covered and the location of

¹⁾ Pending the development of international standards acceptable to IMO, national standards should be applied.

each section zones. Instructions for the system periodical testing and maintenance should be available on board.

3.1.3.16 Spare parts should be provided onboard as recommended by the manufacturer. In the case of automatic sprinkler systems, the total number of spare sprinkler heads for each type of sprinklers shall be 6 for the first 300 and 12 for the first 1,000.

3.1.3.17 Where automatic systems are installed, a warning notice should be displayed outside each entry to the protected space stating the type of medium used (i.e. water) and the possibility of automatic release.

3.1.3.18 All installation, operation and maintenance instructions/plans for the system should be in the working language of the ship. If the working language of the ship is not English, French or Spanish, a translation into one of these languages should be included.

3.1.3.19 Any foam concentrates used as system fire suppression enhancing additives should be of an approved type in conformity with the Appendix to MSC.1/Circ.1312 and Corr.1.

3.1.3.20 Means for flushing of systems with fresh water should be provided.

3.1.3.21 The presence of obstructions shielding the water spray should be evaluated to ensure that the system performance is not affected. Supplementary sprinklers or nozzles should be installed beneath obstructions where water discharge may be obstructed. Nozzles or sprinklers should be located to protect spaces above and below intermediate decks, hoistable decks and ramps. Nozzles below hoistable decks should be capable of protecting the space at all applicable heights.

3.1.3.22 Vertically applicable area of all decks, including hoistable decks or other intermediate decks, between gas-tight steel decks, should be included for simultaneous coverage (example: for the space with one hoistable deck, both the layer above and below this deck with a dimensioning area complying with tables 3.1.4-1 to 3.1.4-3 or 3.1.5.4 should be included in the water supply calculations). Decks with ramps are accepted as gas-tight decks assuming that the ramps are always in their closed position at sea and the ramps and the decks which these ramps are part of are gas-tight.

3.1.3.23 The length of a deluge section (along the lanes) should not be less than 20 m and the width of the section should not be less than 14 m. Further, the sections need not be longer or wider than the distance between gas-tight steel bulkheads (or equivalent materials). The maximum size of a section on any single deck should be 48 m multiplied by the width of cargo space (measured as a distance between tight steel divisions). Vertically one section can cover up to three decks.

3.1.4 Additional Prescriptive-based System Design Requirements

In addition to the requirements in section 3.1.3, systems designed with this approach should comply with paragraphs of this subchapter.

3.1.4.1 Wet pipe, dry pipe and pre-action systems should be designed for simultaneous coverage of the hydraulically most demanding area (the highest flow friction) at the minimum water discharge density given in tables 3.1.4-1 to 3.1.4-3. The minimum operating pressure of any sprinkler/nozzle should be 0.05 MPa.

3.1.4.2 Deluge systems should be designed for the simultaneous activation of the 2 adjacent deluge sections with the greatest hydraulic demand (the highest flow friction) at the minimum

water discharge density given in tables 3.1.4-1 to 3.1.4-3. The minimum operating pressure of any sprinkler should be 0.12 MPa.

Table 3.1.4-1
Minimum required water discharge density and area of coverage for decks
having a free height equal to or less than 2.5 m

Type of system	Minimum required water discharge density (mm/min)	Minimum coverage area
Wet pipe system	6.5	280 m ²
Dry pipe or pre-action system	6.5	280 m ²
Deluge system	5	2 × 20 m × B ¹⁾

Table 3.1.4-2
Minimum required water discharge density and area of coverage for decks
having a free height in excess of 2.5 m but equal to or less than 6.5 m

Type of system	Minimum required water discharge density (mm/min)	Minimum coverage area
Wet pipe system	15	280 m ²
Dry pipe or pre-action system	15	365 m ²
Deluge system	10	2 × 20 m × B ¹⁾

Table 3.1.4-3
Minimum required water discharge density and area of coverage for decks
having a free height in excess of 6.5 m but less than 10.0 m

Type of system	Minimum required water discharge density (mm/min)	Minimum coverage area
Wet pipe system	20	280 m ²
Dry pipe or pre-action system	20	365 m ²
Deluge system	15	2 × 20 m × B ¹⁾

¹⁾ B – full breadth of the protected space [m].

3.1.4.3 Automatic sprinklers or nozzles intended for decks with a free height equal to or less than 2.5 m should have a nominal operating temperature range between 57°C and 79°C and standard response characteristics. If required by ambient conditions, higher temperature ratings may be acceptable.

3.1.4.4 Automatic sprinklers or nozzles intended for decks with a free height in excess of 2.5 m and hoistable decks that can be raised above 2.5 m should have a nominal operating temperature range between 121°C and 149°C and standard response characteristics.

3.1.4.5 Sprinklers or nozzles should be positioned in such a way that:

- .1** they are not exposed to damage by cargo;
- .2** undisturbed spray is ensured; and
- .3** water is distributed over and between all vehicles or cargo in the area being protected.

Automatic sprinklers or nozzles should be positioned and located so as to provide satisfactory performance with respect to both activation time and water distribution.

3.1.4.6 Only upright sprinklers or nozzles are allowed for dry pipe or pre-action systems.

3.1.4.7 For wet pipe and dry pipe sprinkler systems, fire alarm and detection systems should be installed in accordance with the requirements of 6.2.2.1, *Part V – Fire Protection*.

3.1.4.8 For manual deluge systems, automatic deluge systems and pre-action systems, fire alarm and detection systems should be provided complying with subchapter 4.1, *Part V – Fire Protection* and the following additional requirements:

- .1 the detection system should consist of flame, smoke or heat detectors of approved types. The flame detectors should be installed under fixed continuous decks according to the limitation and application defined by the maker and the approval certificate. The smoke and heat detectors shall comply with subchapter 4.1, *Part V– Fire Protection*. Smoke detectors with a spacing not exceeding 11 m or heat detectors with a spacing not exceeding 9 m should be installed under hoistable ramps;
- .2 the detection system should ensure rapid operation while consideration should also be given to preventing accidental release. The area of coverage of the detection system sections should correspond to the area of coverage of the extinguishing system sections. The following arrangements are acceptable:
 - .1 set-up of flame detectors and smoke detectors or heat detectors; or
 - .2 set-up of smoke detectors and heat detectors.

Other arrangements can be accepted upon individual consideration at documentation approval;

- .3 for automatic deluge systems and pre-action systems, the discharge of water should be controlled by the detection system. The detection system should provide an alarm upon activation of any single detector and discharge if two or more detectors activate. Other arrangements may be accepted; and
- .4 automatically released systems should also be capable of manual operation (both opening and closing) of the section valves. Means should be provided to prevent the simultaneous release of multiple sections that result in water-flow demand in excess of the pumping system design capacity. The automatic release may be disconnected during vehicle on- and off-loading operations, provided that this function is automatically reconnected after a pre-set time being appropriate for the operations in question.

3.1.4.9 Where beams project more than 100 mm below the deck, the spacing of spot-type heat detectors at right angles to the direction of the beam travel should not be more than 2/3 of the spacing permitted under 4.1.5.2, *Part V – Fire Protection*.

3.1.4.10 Where beams project more than 460 mm below the deck and are more than 2.4 m on centre, detectors should be installed in each bay formed by the beams.

3.1.5 Additional Performance-based System Design Requirements

In addition to the requirements in 3.1.3, systems designed with this approach should comply with the requirements of this subchapter.

3.1.5.1 The system should be capable of suppression and control of test fires defined in Appendix to MSC.1/Circ.1430/Rev.2.

3.1.5.2 With the purpose of fire suppression and control in accordance with 3.1.5.1, the nozzle location, type and characteristics should be within the limits, determined during system type tests.

3.1.5.3 With the purpose of fire suppression and control in accordance with 3.1.5.1, system designs should be limited to the use of the maximum and minimum temperature ratings of the thermally sensitive fire detection devices tested.

3.1.5.4 The capacity of the system water supply should be sufficient for the total simultaneous coverage of the minimum coverage area of table 3.1.5.4 and the vertically applicable area as defined in paragraph 3.22, and the requirements of paragraph 3.1.5.5.

Table 3.1.5.4
Minimum coverage area per type of system

Type of system (Definition number)	Minimum coverage area
A Wet pipe, automatic sprinkler heads (3.1.2.18)	280 m ² or area of operation as defined in the fire tests – whichever is larger
B Deluge system, automatic ¹⁾ and manual release (3.1.2.4)	280 m ² and the overlapping or adjacent section as defined by paragraph 3.1.5.5 ²⁾
C Deluge system, manual release (3.1.2.5)	2 sections each of min 20 m x B ^{2), 3)}
D Other systems (3.1.2.6 and 3.1.2.15)	Equivalent to the above systems and to the satisfaction of PRS

Notes:

¹⁾ The automatic release should comply with the requirements of paragraph 3.1.5.6.

²⁾ The pump should be sized to cover the largest section for type B systems and the two largest horizontally adjacent sections for type C systems.

³⁾ B – full breadth of the protected space.

3.1.5.5 The section arrangement for a deluge system with automatic and manual release (system B) should be such that a fire in any location of the border zone between two or more sections would be completely surrounded by activated spray heads, either by activating more than one section or by overlapping sections (whereby two or more sections cover the same area in the vicinity of the border between sections). In case of overlapping sections, such overlap should be a minimum of two times the required spray head spacing of the section in question or 5 metres, whichever is larger. These overlapping sections need not comply with the minimum width and length requirements of paragraph 3.1.3.23.

3.1.5.6 For systems of type B (see table 3.1.5.4) an efficient fire detection and fire confirmation system covering all parts of the ro-ro or special category spaces should be provided as follows:

- .1 the fire detection system shall consist of flame detectors and smoke detectors of approved types. The flame detectors shall be installed under fixed continuous decks according to the limitation and application defined by the maker and the approval certificate. The smoke detector arrangement shall comply with subchapter 4.1, *Part V – Fire Protection* of the *Rules for the Classification and Construction of Sea-going Ships*. Additional smoke detectors with a spacing not exceeding 11 m shall be installed under hoistable ramps;
- .2 a colour TV monitoring system should cover all parts of the ro-ro or special category spaces. Cameras need not be installed below hoistable decks if the camera arrangement can identify smoke (confirm fire) based on positions under a fixed continuous deck. The monitors for the colour TV monitoring system should be located in the continuously manned control station having the controls for section control valves and start/stop control of pumps addressed under 3.1.3.2.2; and

- .3 the relevant section of the deluge system should be automatically released when two detectors covering this area activate. Systems being released when only one detector activates may also be accepted. Automatically released systems should also be capable of manual operation (both opening and closing) of the section valves. The automatic release may be disconnected during on- and off-loading operations, provided that this function is automatically reconnected after a preset time being appropriate for the operations in question.

3.1.6 Type Tests

3.1.6.1 Nozzles and sprinklers should be installed and tested in accordance with the provisions of Appendix A to MSC/Circ.1165, as amended by MSC.1/Circ.1269.

3.1.6.2 The performance-based systems are subject to type testing in accordance with the provisions of the Appendix to MSC.1/Circ.1430/Rev.2.

3.1.7 Tests of the System After Installation on Board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

3.2 Fixed Pressure Deluge System and Equivalent Water Mist System for Machinery Spaces and Cargo Pump Rooms

3.2.1 Application

The system, considered as “total flooding” is intended for the protection of machinery spaces of category A and cargo pump rooms.

3.2.2 Definitions

- .1 *Antifreeze system* – a wet pipe system containing an antifreeze solution and connected to a water supply. The antifreeze solution is discharged, followed by water, immediately upon operation of nozzles.
- .2 *Deluge system* – a system employing open nozzles attached to a piping system connected to a water supply through a valve that is opened automatically by the operation of a detection system installed in the same areas as the nozzles or opened manually. When this valve opens, water flows into the piping system and discharges from all nozzles attached thereto.
- .3 *Wet pipe system* – a system employing nozzles attached to a piping system containing water and connected to a water supply so that water discharges immediately from the nozzles upon system activation.
- .4 *Dry pipe system* – a system employing nozzles attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a nozzle) 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 nozzle.
- .5 *Preaction system* – a system employing automatic nozzles 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 nozzles. Actuation of the detection system opens a valve that permits water to flow into the piping system and to be discharged from any nozzles that may be open.
- .6 *Bilge area* – the space between the engine room floor plates (perforated or non-perforated) or gratings and the bottom of the engine room.

- .7 *Fire extinction* – a reduction of the heat release from the fire and a total elimination of all flames and glowing parts by means of direct and sufficient application of extinguishing media.
- .8 *Water-based extinguishing medium* – fresh water or seawater with or without additives (e.g. foam concentrate) mixed to enhance fire-extinguishing capability.

3.2.3 Principal Requirements for the System

3.2.3.1 The system should be capable of manual release.

3.2.3.2 The system should be capable of test fire extinction in accordance with Appendix B to MSC/Circ.1165, as amended.

3.2.3.3 The system should be available for immediate use and capable of continuously supplying water for at least 30 min in order to prevent re-ignition or fire spread within that period of time. Systems which operate at a reduced discharge rate after the initial extinguishing period should have a second full fire-extinguishing capability available within a 5-minute period of initial activation.

3.2.3.4 The system and its components should be so designed and manufactured to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in machinery spaces or cargo pump rooms in ships. Components within the protected spaces should be designed to withstand the elevated temperatures which could occur during a fire.

3.2.3.5 The system and its components should be designed and installed based on international standards acceptable to IMO.¹⁾ and manufactured and tested based on the relevant sections of Appendix A and B to circular MSC/Circ.1165 as amended.

3.2.3.6 The nozzle location, type of nozzle and nozzle characteristics should be within the limits defined during fire extinguishing tests of the system to provide fire extinction as referred to in 3.2.3.2.

3.2.3.7 The electrical components of the pressure source for the system (pump) should have a minimum rating of IP 54. The system should be supplied by both main and emergency sources of power and should be provided with an automatic change-over switch. The emergency power supply should be provided from outside the protected machinery space.

3.2.3.8 The system should be provided with a redundant means of pumping. The capacity of the redundant means should be sufficient to compensate for the loss of any supply pump or any single pump if the system is supplied by the pump unit. Failure of any one component in the power and control system should not result in a reduction of required pump capacity. Primary pump starting equipment may be manual or automatic. Switch over to redundant means of pumping may also be manual or automatic. The system should be fitted with a permanent sea water inlet and be capable of continuous operation using sea water.

¹⁾ Pending the development of international standards acceptable to IMO, national standards should be applied.

3.2.3.9 The piping system should be sized in accordance with an hydraulic calculation technique¹⁾, such as Hazen-Williams method, to ensure the availability of the flows and pressures required for correct performance of the system.

3.2.3.10 Systems capable of supplying water at the full discharge rate for 30 min may be grouped into separate nozzle sections to cover individual areas of machinery space. The sectioning of the system within such spaces should be approved by PRS in each case.

The section valve locations should be indicated by a plate with the symbol used in *Fire Control Plan*.

Nozzles should be arranged within the entire area of the machinery compartment including casing or pump room and in the bilge area.

3.2.3.11 The capacity and design of the system should be based on the complete protection of the space demanding the greatest volume of water.

3.2.3.12 The system operation controls should be available at easily accessible positions outside the spaces to be protected and should not be liable to be cut off by a fire in the protected spaces.

The system operation control position should be indicated with appropriate plate with a symbol included in the *Fire Control Plan*.

3.2.3.13 Pressure source components (pumps) of the system should be located outside the protected spaces.

3.2.3.14 A means for testing the operation of the system for assuring the required pressure and flow should be provided.

3.2.3.15 Activation of any system section valve should give a visual and audible alarm at a continuously manned central control station/ship safety centre. The alarm should indicate the specific valve activated.

3.2.3.16 Operating instructions for the system should be displayed at each operating position. The operating instructions should be in the working language of the ship. If the language is neither English, nor French, nor Spanish, a translation into one of these languages should be included.

3.2.3.17 Spare parts and operating and maintenance instructions for the system should be provided, as recommended by the manufacturer.

3.2.3.18 The additives enhancing fire-extinguishing capability should not be used for the protection of normally occupied spaces unless they have been approved for fire protection service by an authorized body. The approval should consider possible adverse health effects to exposed personnel, including inhalation toxicity.

¹⁾ Where the Hazen-Williams Method is used, the following values of the friction factor C for different pipe types which may be considered should apply:

Pipe type	C
Black or galvanized mild steel	100
Copper and copper alloys	150
Stainless steel	150

3.2.3.19 For all machinery spaces with bilges (including bilge area, as per definition in 3.2.2.6), the system should be provided with bilge nozzles.

3.2.4 Type Tests

3.2.4.1 Overhead nozzles and bilge nozzles should be manufactured and type tested in accordance with Appendix A to MSC/Circ.1165, as amended by MSC.1/Circ.1269.

3.2.4.2 The system is subject to type tests in accordance with Appendix B to MSC/Circ.1165, as amended by MSC.1/Circ.1237, MSC.1/Circ.1269 and MSC.1/ Circ.1386, taking into account Appendix to MSC.1/Circ.1385. During the tests, IACS Interpretations SC218, [Rev.1](#) and SC219, [Rev.1](#), shall be considered.

3.2.5 Tests of the System after Installation on Board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

3.3 Fixed Water-based Local Application Fire-fighting System for Machinery Spaces of Category A

3.3.1 Application

Fixed water-based local application fire-fighting system should provide localized fire suppression in areas of fire hazard for category A machinery spaces, without the necessity of engine shut-down, personnel evacuation, shutting down of forced ventilation fans, or sealing of the space.

3.3.2 Definitions

- .1 *Protected space* – a machinery space where a local application fire-fighting system is installed.
- .2 *Protected area* – an area within a protected space which is required to be protected by the local application fire-fighting system¹⁾.
- .3 *Fire suppression* – a reduction in heat output from the fire and control of the fire to restrict its spread from its seat and reduce the flame area.
- .4 *Water based extinguishing medium* – freshwater or seawater with or without additives (such as foam concentrate) mixed to enhance fire-extinguishing capability.

3.3.3 Requirements for the System

3.3.3.1 The system should comply with the requirements given in subchapter 3.4.6, *Part V* of the *Rules for the Classification and Construction of Sea-going Ships*, and additionally with the guidelines of this subchapter.

¹⁾ For internal combustion machinery, typical protected areas are hot surfaces such as exhaust pipes without insulation, or with insulation, of temperature > 220°C, that is likely to be removed frequently for maintenance, and high-pressure fuel oil systems installed near hot surfaces.

For typical diesel engines, such areas would include the area on top of the engine, the fuel injection pumps and turbochargers, unless the fuel injection pumps are installed in a sheltered location beneath the steel platform.

For boiler fronts and oil-fired inert gas generators, typical protected areas are hot surfaces around the burners without insulation, or with insulation of temperature > 220°C, that is likely to be removed frequently for maintenance. Boiler fronts should be interpreted as the boiler burner location irrespective of the boiler design.

For incinerators, typical protected areas are hot surfaces around the burners without insulation, or with insulation of temperature > 220°C, that is likely to be removed frequently for maintenance.

3.3.3.2 The activation of the system should not require engine shutdown, closing fuel oil tank outlet valves, evacuation of personnel or sealing of the space, which could lead to loss of electrical power or reduction of manoeuvrability. This is not intended to place additional requirements on the electrical equipment in the protected area when the system is discharging freshwater.

3.3.3.3 The operation controls should be located at easily accessible positions inside and outside the protected space. The controls inside the space should not be liable to be cut off by a fire in the protected areas.

The operation controls locations should be indicated with appropriate plate with a symbol included in the *Fire Control Plan*.

3.3.3.4 Pressure source components (water supply pumps) of the system should be located outside the protected areas.

3.3.3.5 Automatically operated fire-fighting systems should fulfil the below requirements:

- .1 a warning notice should be displayed outside each entry stating the type of medium used and the possibility of automatic release;
- .2 the alarm and detection system should ensure rapid operation while consideration should also be given to preventing accidental release. The area of coverage of the detection system sections should correspond to the area of coverage of the extinguishing system sections. The following arrangements are acceptable:
 - .1 set-up of two approved flame detectors; or
 - .2 set-up of one approved flame detector and one approved smoke detector.

Other arrangements can be accepted. However, use of heat detectors should be avoided for these systems;

- .3 the discharge of water should be controlled by the detection system. The detection system should provide an alarm upon activation of any single detector and discharge if two or more detectors activate. Other arrangements may also be accepted;
- .4 visual and audible indication of the activated local application fire-fighting system should be provided. The alarm indicating activation of the given section should be provided in the protected space, the engine control room and the continuously manned central control station/ship safety centre. Audible alarms may use a single tone.

3.3.3.6 Operating instructions for the system should be displayed at each operating position.

3.3.3.7 Appropriate operational measures or interlocks should be provided if the engine room is fitted with a fixed high-expansion foam or aerosol fire-fighting system, to prevent the local application system from interfering with the effectiveness of these systems.

3.3.4 Arrangement of Nozzles and Water Supply

3.3.4.1 The system should be capable of fire suppression based on testing conducted in accordance with the Appendix to MSC.1/Circ.1387/Corr.1. Any installation of nozzles on board should reflect the arrangement successfully tested. If a specific arrangement of the nozzles is foreseen on board, deviating from the one tested, e.g. nozzles fitted at angle, it can be accepted provided such arrangement additionally passes fire tests based on the scenarios of the Appendix to the above Circular.

3.3.4.2 The location, type and characteristics of the nozzles should be within the limits defined during system fire-extinguishing testing. Nozzle positioning should take into account obstructions to the spray of the fire-fighting system. The use of a single row of nozzles or single nozzles may be

accepted for installation where this gives adequate protection according to paragraph 3.4.2.4 of the Appendix to MSC.1/Circ.1387/Corr.1.

3.3.4.3 The piping system should be sized in accordance with a hydraulic calculation technique¹⁾ such as the Hazen-Williams hydraulic calculation technique and the Darcy-Weisbach hydraulic calculation technique, to ensure availability of flows and pressures required for correct performance of the system.

3.3.4.4 The system may be grouped into separate sections within a protected space. The capacity of the system should be based on the section demanding the greatest volume of water. In any case the minimum capacity should be adequate for a single section protecting the largest single engine, diesel generator or piece of machinery. In multi-engine installations, at least two sections should be arranged.

3.3.4.5 Nozzles and piping should not prevent access to engine or machinery for routine maintenance and inspections. In ships fitted with overhead hoists or other moving equipment, nozzles and piping should not be located to prevent operation of such equipment.

3.3.5 Requirements for System Components

3.3.5.1 The system supplied with fresh-water should have permanently available reserve of water to be capable of continuously supplying water-based medium for at least 20 min to one section with the greatest rate. The fresh water tank shall be fitted with liquid level indicator with a low level alarm.

3.3.5.2 The system and its components should be suitably designed and manufactured to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in machinery spaces. Components within the protected spaces should be designed to withstand the elevated temperatures which could occur during a fire.

3.3.5.3 The system and its components should be designed and installed based on international standards acceptable to IMO.²⁾ and manufactured and tested based on the relevant sections of Appendix A to circular MSC/Circ.1387/Corr.1.

3.3.5.4 The electrical components of the pressure source (supply water pump) for the system should have a minimum rating of IPX4³⁾ if located in the protected space. Systems requiring an external power source may only be supplied by the main power source.

3.3.5.5 The water supply for local application systems may be fed from the supply to a water-based main deluge system, providing that adequate water quantity and pressure are available to operate both systems for the required period of time. Local application systems may form a section(s) of a water-based main deluge system, provided that all requirements for main deluge

¹⁾ Where the Hazen-Williams Method is used, the following values of the friction factor C for different pipe types which may be considered should apply:

Pipe type	C
Black or galvanized mild steel	100
Copper and copper alloys	150
Stainless steel	150.

²⁾ Pending the development of international standards acceptable to IMO, national standards should be applied

³⁾ X means the characteristic numeral used to mark the degree of protection against access to hazardous parts and ingress of solid foreign objects, which could be 0.1 to 6

system given in subchapter 3.2 are met, and the systems are capable of being isolated from the other sections of the main system.

3.3.5.6 A means for testing the operation of the system and for checking the required pressure and flow after activating the supply pump should be provided.

A stub pipe with test valve of diameter permitting water flow with the greatest rate at the required pressure should be fitted on the piping at the suction side of the pump, for the purpose of checking the flow rate.

3.3.5.7 Spare parts and operating and maintenance instructions for the system should be provided as recommended by the manufacturer.

3.3.5.8 The additives enhancing fire-extinguishing capability should not be used for the protection of normally occupied spaces unless they have been approved for fire protection service by an authorized body. The approval should consider possible adverse health effects to exposed personnel, including inhalation toxicity.

3.3.6 Type Tests

3.3.6.1 Nozzles should be manufactured and type tested in accordance with Appendix A to MSC/Circ.1165, as amended by MSC.1/Circ.1269, taking into account Appendix to MSC.1/Circ.1387/Corr.1, paragraph 3.3.2.

3.3.6.2 The system is subject to type testing in accordance with Appendix to MSC.1/Circ.1387/Corr.1, [taking into account interpretation of IACS UI SC217/ Corr.2](#).

3.3.7 Tests of the System after Installation on Board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

3.4 Water-spraying System and Water-based Fire-extinguishing System for Cabin Balconies

3.4.1 Application

The systems are intended for fire protection of cabin balconies of fire risk on passenger ships.

3.4.2 Definitions

- .1** *Automatic system* – a system with automatic nozzles. Each nozzle should be individually activated by heat from the fire before water will be discharged.
- .2** *Manually released system* – a pipework system with open nozzles, controlled by section valves. When a section valve is opened, all of the connected nozzles will discharge water simultaneously.

3.4.3 Requirements for the System

3.4.3.1 The system should either be automatic or capable of manual release from a location remote from the protected area.

3.4.3.2 The system should be capable of fire suppression based on testing conducted in accordance with the Appendix to MSC.1/Circ.1268.

3.4.3.3 The system should be capable of fire suppression on open deck areas with expected wind conditions while the vessel is underway. The fire test does not require the use of actual wind velocities; instead, a nominal wind speed is included to account for variables in balcony geometry and equipment arrangement. Although the test ventilation conditions are intended to provide a safety factor, it is recognized that in an actual fire, the master and crew are expected to take appropriate actions to manoeuvre the ship to assist the suppression system, by shielding the ship side with burning balconies against the wind.

3.4.3.4 The system should be available for immediate use and capable of continuously operating for at least 30 min.

3.4.3.5 The system and its components should be suitably designed and manufactured to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered on open deck areas.

3.4.3.6 The location, type and characteristics of the nozzles should be within the limits tested during the system type tests. Nozzle positioning should take into account obstructions to the spray of the fire-fighting system. Automatic nozzles (sprinklers) should have fast response characteristics as defined in ISO standard 6182-1:2014.

3.4.3.7 The piping system should be sized in accordance with a hydraulic calculation technique such as the Hazen-Williams hydraulic calculation technique and the Darcy-Weisbach hydraulic calculation technique, to ensure availability of flows and pressures required for correct performance of the system.

3.4.3.8 The minimum capacity of the supply system for a manually released system should be based on the complete protection of the most hydraulically demanding section. The minimum capacity of the supply system for an automatic system should be based on the complete protection of the eight most hydraulically remote balconies, but not exceeding 50 m².

3.4.3.9 The water supply for cabin balcony systems may be fed from an independent supply, or they may be fed from the supply to another water-based fire-fighting system, providing that adequate water quantity and pressure are available as indicated below:

- .1** Manually released systems: The water supply should be capable of supplying the largest balcony section and, if supplied by the sprinkler system, the capacity should be adequate to supply 8 adjacent cabins. If supplied by the fire main, the system should be capable of supplying the largest balcony section plus the two jets of water required by *Part V – Fire Protection of the Rules for the Classification and Construction of Sea-going Ships*;
- .2** Automatic systems: The water supply should be capable of supplying the 8 most hydraulically demanding balconies, but not exceeding 50 m². If combined with the sprinkler system, the design area in total need not exceed 280 m².

3.4.3.10 The system should be grouped into sections. A manually released section should not serve cabin balconies on both sides of the ship, except that the same section may serve balconies located on one side of the ship and balconies in the fore or aft end of the ship.

3.4.3.11 The system section valves and operation controls should be located at easily accessible positions outside the protected space, not likely to be cut off by a fire in the cabin balconies.

3.4.3.12 A means for testing the operation of the system for assuring the required pressure and flow should be provided.

3.4.3.13 Activation of any water supply pump should give a visual and audible alarm at a continuously manned central control station or ship safety centre.

3.4.3.14 Any parts of the system which may be subjected to freezing temperatures in service should be suitably protected against freezing.

3.4.3.15 The system should be provided with a redundant means of pumping or otherwise supplying the discharge nozzles. The capacity of the redundant means should be sufficient to compensate for the loss of any single pump or supply source. The system should be fitted with a permanent sea inlet and be capable of continuous operation using seawater.

3.4.3.16 Operating instructions for the system should be displayed at each operating position.

3.4.3.17 Spare parts and operating and maintenance instructions for the system should be provided as recommended by the manufacturer.

3.4.3.18 Dry pipe systems should be designed such that water will discharge from the farthest sprinkler within 60 s of actuation of the sprinkler.

3.4.4 Type Tests

3.4.4.1 Open type nozzles should be manufactured and type tested in accordance with Appendix A to MSC/Circ.1165, as amended by MSC.1/Circ.1269.

3.4.4.2 Automatic nozzles (sprinklers) should be manufactured and type tested in accordance with Appendix 1 to Res. A.800(19), as amended by Res. MSC.265(84).

3.4.4.3 The system is subject to type tests in accordance with Appendix to MSC.1/Circ.1268.

3.4.5 Tests of the system after installation on board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

4 GAS FIRE-EXTINGUISHING SYSTEMS

4.1 Gas Equivalent Fire-extinguishing System for Machinery Spaces and Cargo Pump Rooms

4.1.1 Application

The system is intended for the protection of machinery spaces and cargo pump rooms onboard ships.

4.1.2 Definitions

4.1.2.1 *Adverse physiological or toxicological effects* are considered to be evidence of cardiac sensitization, for the purposes of approving halocarbon fire-extinguishing agents in accordance with MSC/Circ.848 and MSC.1/Circ.1267.

4.1.2.2 *Halocarbon agent* is a fire-extinguishing medium consisting of one or more carbon atoms linked to one or more Halogen atoms from the elements bromine, chlorine, fluorine and iodine.

4.1.2.3 *NOAEL* is the highest concentration at which no adverse physiological or toxicological effect has been observed.

4.1.2.4 *LOAEL* is the lowest concentration at which an adverse physiological or toxicological effect has been observed.

4.1.3 Requirements for the System

4.1.3.1 The system should comply with applicable general requirements for fixed gas fire-extinguishing systems, as specified in subchapter 3.6, *Part V – Fire Protection* of the *Rules for the Classification and Construction of Sea-going Ships* and additionally the guidelines of this subchapter.

4.1.3.2 The minimum extinguishing agent concentration should be determined in accordance with international standard ISO 14520, considering the type of extinguished material. The design concentration should be at least 30% above the minimum extinguishing concentration. These concentrations should be verified by full-scale fire testing described in the test method, as set out in the Appendix to MSC/Circ.848, as amended by MSC.1/Circ.1267.

4.1.3.3 For systems using halocarbon “clean” agents, i.e. chemical compositions from the group of halogen derivatives of hydrocarbons, 95% of the design concentration should be discharged in 10 s or less. For inert gas systems, the discharge time should not exceed 120 s for 85% of the design concentration.

4.1.3.4 The quantity of extinguishing agent for the protected space should be calculated at the minimum expected ambient temperature using the design concentration based on the net volume of the protected space, including the casing.

4.1.3.5 The net volume of a protected space is that part of the gross volume of the space which is accessible to the free extinguishing agent gas, after releasing the agent to the space.

4.1.3.6 When calculating the net volume of a protected space, the net volume should include the volume of the bilge, the volume of the casing to the space and the volume of free air contained in air receivers that in the event of a fire is released into the protected space.

4.1.3.7 The machinery and equipment that occupy volume in the protected space, such as main engines and auxiliary machinery, boilers, condensers, evaporators, reduction gears, tanks and transit ventilation ducts, should be subtracted from the gross volume of the space.

4.1.3.8 Subsequent modifications to the protected space that may alter the net volume of the space shall require the quantity of extinguishing agent to be adjusted to meet the requirements of 4.1.2.9 to 4.1.2.12.

4.1.3.9 All systems should be designed to allow evacuation of the protected spaces prior to discharge of extinguishing medium. Means should also be provided for automatically giving audible and visual warning of the release of fire-extinguishing medium into any space in which personnel normally work or to which they have access. The alarm should operate for the period of time necessary to evacuate the space, but not less than 20 s before the medium is released. Unnecessary exposure, even at concentrations below an adverse effect level, should be avoided.

4.1.3.10 Even at concentrations below an adverse effect level, exposure to gaseous fire extinguishing agents should not exceed 5 min. Halocarbon agents may be used up to the No Observed Adverse Effect Level (NOAEL) calculated on the net volume of the protected space at the

maximum expected ambient temperature without additional safety measures. If a halocarbon agent is to be used above its NOAEL, means should be provided to limit exposure to no longer than the time specified according to a scientifically accepted physiologically based pharmacokinetic¹⁾ (PBPK) model or its equivalent which clearly establishes safe exposure limits both in terms of extinguishing media concentration and human exposure time.

4.1.3.11 For inert gas systems, means should be provided to limit exposure to no longer than 5 min for inert gas systems designed to concentrations below 43% (corresponding to an oxygen concentration of 12%) or to limit exposure to no longer than 3 min for inert gas systems designed to concentrations between 43% and 52% (corresponding to between 12% and 10% oxygen) calculated on the net volume of the protected space at the maximum expected ambient temperature.

4.1.3.12 In no case should a halocarbon agent be used at concentrations above the Lowest Observed Adverse Effect Level (LOAEL) nor the Approximate Lethal Concentration (ALC) nor should an inert gas be used at gas concentrations above 52% calculated on the net volume of the protected space at the maximum expected ambient temperature.

4.1.3.12.1 The NOAEL and LOAEL values for halocarbon agents listed in the National Fire Protection Association Standard (NFPA) 2001 are acceptable as meeting these Guidelines without further testing. For halocarbon agents not listed in NFPA 2001, cardiac sensitization testing in accordance with section 4 of the Annex to MSC.1/Circ.1316 should be performed to determine the NOAEL and LOAEL values.

4.1.3.13 The system and its components should be so designed and manufactured to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging, and corrosion normally encountered in machinery spaces or cargo pump rooms in ships.

4.1.3.14 The system and its components should be designed, manufactured and acceptance tested onboard in accordance with international standards, e.g. PN-EN 15004 or equivalent. As a minimum, the design and installation standards should cover the following elements:

- .1 safety, within the scope of:
 - .1.1 toxicity,
 - .1.2 noise due to gas discharge through nozzles,
 - .1.3 extinguishing agent decomposition products;
- .2 storage container design and arrangement:
 - .2.1 strength requirements,
 - .2.2 maximum/minimum fill density, operating temperature range,
 - .2.3 pressure and weight indicators,
 - .2.4 pressure relief;
 - .2.5 agent identification and lethal warning requirements;
- .3 agent supply, quantity, quality standards;
- .4 pipings and fittings:
 - .4.1 strength, material properties, fire resistance;
 - .4.2 cleaning requirements;
- .5 valves:
 - .5.1 testing requirements,
 - .5.2 corrosion resistance;

¹⁾ Refer to document FP 44/INF.2 – Physiologically based pharmacokinetic model to establish safe exposure criteria for halocarbon fire extinguishing agents.

- .5.3 elastomer compatibility;
- .6 nozzles:
 - .6.1 height and area testing requirements;
 - .6.2 corrosion and elevated temperature resistance;
- .7 actuation and control systems:
 - .7.1 testing requirements;
 - .7.2 backup power requirements;
- .8 alarms and indicators:
 - .8.1 predischage alarm, agent discharge alarms as time delays,
 - .8.2 abort switches,
 - .8.3 supervisory circuit requirements;
 - .8.4 warning signs and audible and visual alarms should be located outside each entry to the relevant space as appropriate;
- .9 agent flow calculation:
 - .9.1 approval and testing of design calculation method;
 - .9.2 fitting pressure losses and/or determination of equivalent length;
- .10 protected space enclosure integrity and leakage requirements:
 - .10.1 enclosure leakage,
 - .10.2 enclosure openings;
 - .10.3 mechanical ventilation interlocks;
- .11 design concentration requirements, total flooding quantity of agent;
- .12 discharge time;
- .13 inspection, maintenance, and service and testing requirements.

4.1.3.15 The nozzle type and such parameters as maximum nozzle spacing, maximum height and minimum nozzle pressure should be within limits tested during fire tests of the system.

4.1.3.16 Provisions should be made to ensure that escape routes which are exposed to vapours leakage from the protected space are not rendered hazardous during or after discharge of the agent in the event of a fire. In particular, hydrogen fluoride (HF) vapour can be produced in fires as a breakdown product of the fluorocarbon fire extinguishing agents and cause health effects such as upper respiratory tract and eye irritation to the point of impairing escape. Control stations and other locations that require manning during a fire should have provisions (such as mechanical exhaust ventilation) to keep HF and HCl below 5 ppm at that location. The concentrations of other products should be kept below concentrations considered hazardous for the required duration of exposure.

4.1.3.17 Where agent cylinders are stored within a protected space, the containers/container groups should be evenly distributed throughout the space, in at least 6 separate spots, and meet the following provisions:

- .1 a manually initiated power release, located outside the protected space, should be provided. Duplicate sources of power should be provided for this release and should be located outside the protected space, and be immediately available;
- .2 electric power circuits connecting the containers should be monitored for fault conditions and loss of power. Visual and audible alarms should be provided to indicate this;
- .3 electric, pneumatic or hydraulic power circuits connecting the containers should be duplicated and widely separated and ensure simultaneous actuation of all cylinders. The remotely controlled pilot cylinders, pneumatic or hydraulic sources of pressure, should be monitored for loss of pressure. Visual and audible alarms should be provided to indicate pressure drop;

- .4 within the protected space, electrical circuits essential for the release of the system should be fire resistant according to standard IEC 60331 or other equivalent standards. Piping systems essential for the release of systems designed to be operated hydraulically or pneumatically should be of steel or other equivalent heat-resisting material;
- .5 each pressure container should be fitted with an automatic overpressure release device which, in the event of the container being exposed to the effects of fire and the system not operating, will safely vent the contents of the container into the protected space. Each pressure container should be provided with a gauge to check the pressure inside the container;
- .6 the arrangement of extinguishing agent containers and the electrical circuits and piping essential for the release of any system should be such that in the event of damage to any one power release line or container valve through mechanical damage, fire or explosion in a protected space, i.e. a single fault concept, at least the amount of agent needed to achieve the minimum extinguishing concentration can still be discharged having regard to the requirement for uniform distribution of medium throughout the space, however, not less than 5/6 of its amount; and;
- .7 the containers should be monitored for decrease in pressure due to leakage and discharge. Visual and audible alarms in the protected area and on the navigation bridge or in the space where the fire control equipment is centralized should be provided to indicate this condition;
- .8 for systems that need less than 6 cylinders (using the smallest bottles available), the total amount of extinguishing gas in the cylinders shall be such that in the event of a single failure to one of the release lines (including cylinder valve), 5/6 of the fire extinguishing gas can still be discharged. This may be achieved by for instance using more extinguishing gas than required so that if one cylinder has been discharged due to a single fault, the remaining cylinders will discharge the minimum 5/6 of the required amount of gas. This can be achieved with a minimum of 2 cylinders. However, NOAEL values calculated at the highest expected engine room temperature are not to be exceeded when discharging the total amount of extinguishing gas simultaneously.
- .9 locations of extinguishing agent cylinders should be indicated by appropriate plate with the symbol used in the *Fire Control Plan*.

4.1.3.18 If the system extinguishing agent is stored in one cylinder, the cylinder should be placed outside the protected space, in fire-extinguishing station complying with the requirements of 3.6.2, *Part V* of the *Rules for the Classification and Construction of Sea-going Ships*.

4.1.3.19 A minimum extinguishing agent hold time of 15 min should be ensured for the protected space.

4.1.3.20 The release of an extinguishing agent may produce significant over and under pressurization in the protected space. Appropriate valves/air release flaps should be provided to limit the induced pressures to acceptable limits and to prevent damage to space structure, after releasing the agent.

4.1.3.21 For all ships, the fire-extinguishing system design manual should be prepared and should address recommended procedures for the removal of gases being the products of agent decomposition, including HF vapour generated from fluorocarbon extinguishing agents which could impair evacuation. Longer exposure of the agent to high temperatures would produce greater concentrations of these types of gases. The type and sensitivity of detection system, coupled with the rate of discharge, should be selected to minimize the exposure time of the agent

to the elevated temperature. The performance of fire-extinguishing arrangements on passenger ships should not present health hazards from decomposed extinguishing agents, for example on passenger ships, the decomposition products should not be discharged in the vicinity of muster (assembly) stations. Other mitigating steps including evacuation, and donning masks, should be provided.

4.1.4 Type Tests

The system is subject to type testing in accordance with Appendix to MSC/Circ.848, as amended by MSC.1/Circ.1267.

4.1.5 Tests of the system after installation on board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

4.2 Fixed Aerosol Fire-extinguishing System for Machinery Spaces

4.2.1 Application

The aerosol system is intended for the protection of machinery spaces and cargo pump rooms onboard ships.

4.2.2 General

4.2.2.1 Aerosol fire-extinguishing systems involve the release of a chemical agent to extinguish a fire by interruption of the process of the fire.

4.2.2.2 There are two methods considered for applying the aerosol agent to the protected space:

- .1 condensed aerosols are created in pyrotechnical generators through the combustion of the agent charge;
- .2 dispersed aerosols that are not pyrotechnically generated but are stored in containers with carrier agents such as inert gases or halocarbon agents, with the aerosol released in the space through pipings with valves and nozzles.

4.2.3 Definitions

- .1 *Aerosol* – a fire-extinguishing medium consisting of finely divided solid particles of chemicals released into a protected space as either condensed aerosol or dispersed aerosol.
- .2 *Generator* – a device for creating a fire-extinguishing medium by pyrotechnical means.
- .3 *Design application density* – the mass of an aerosol forming composition per m³ of the space volume, required to extinguish a specific type of fire, including a safety factor of 1.3 times the test (extinguishing) density, g/m³.
- .4 *Efficiency coefficient* – the percentage (%) of aerosol forming composition actually discharged from a specific aerosol generator. It is determined by comparing the mass loss of a generator after discharge to its beginning mass.

4.2.4 Requirements for the System

4.2.4.1 The design application density of aerosol should be determined and verified by the full-scale testing described in the Appendix 1 to MSC.1/ Circ.1270/Corr.1.

4.2.4.2 The delivered density for each type of generator should be determined and verified by the test method set out in Appendix 2 to MSC.1/Circ.1270/Corr.1.

4.2.4.3 The system discharge time should not exceed 120 s.

4.2.4.4 The quantity of extinguishing agent for the protected space should be calculated at the minimum expected ambient temperature using the design density based on the net volume of the protected space, including the casing.

4.2.4.5 The net volume of a protected space is that part of the gross volume of the space, which is accessible to the fire-extinguishing agent.

4.2.4.6 When calculating the net volume of a protected space, the net volume should include the volume of the bilge, the volume of the casing to the space and the volume of free air contained in air receivers that in the event of a fire may be released into the protected space.

4.2.4.7 The machinery and equipment that occupy volume in the protected space, such as main engines and auxiliary machinery, boilers, condensers, evaporators, reduction gears, tanks and transit ventilation ducts, should be subtracted from the gross volume of the space.

4.2.4.8 Subsequent modifications to the protected space that alter the net volume of the space should require the quantity of extinguishing agent to be adjusted to maintain the required fire-extinguishing concentration.

4.2.4.9 No fire suppression system should be used which is carcinogenic, mutagenic or teratogenic at application densities expected during use. The discharge of aerosol systems to extinguish a fire could create a hazard to personnel from the natural form of the aerosol, or from certain products of aerosol generation (including combustion products and trace gases from condensed aerosols). Other potential hazards that should be considered for individual systems are the following: noise from discharge, turbulence, low temperature of vaporizing liquid, reduced visibility, potential toxicity, thermal hazard and potential toxicity from the aerosol generators, and eye irritation from direct contact with aerosol particles. Unnecessary exposure to aerosol media, even at concentrations below an adverse effect level, and to their decomposition products should be avoided. All aerosols used in fire-extinguishing systems should have non-ozone-depleting characteristics.

4.2.4.10 All systems should be designed to allow evacuation of the protected spaces prior to discharge through the use of two separate controls for releasing the extinguishing medium. Means should also be provided for automatically giving visual and audible warning of the release of fire-extinguishing medium into any space in which personnel normally work or to which they have access. The alarms should operate for the period of time necessary to evacuate the space, but not less than 20 s before the medium is released.

4.2.4.11 Condensed aerosol systems for spaces that are normally occupied should be permitted in concentrations where the aerosol particulate density does not exceed the adverse effect level as determined by a scientifically accepted technique¹⁾ and any combustion products and trace gases produced by the aerosol generating reaction do not exceed the mean concentration for the critical toxic effect as determined in acute inhalation toxicity tests.

¹⁾ Reference to the EPA regional dose ratio program deposited in the United States "Methods for Determining Reference Inhalation Concentrations and Using Inhalation Dosimetry" EPA / 600 8-90 / 066F. October 1994.

4.2.4.12 Dispersed aerosol systems for spaces that are normally occupied should be permitted in concentrations where the aerosol particulate density does not exceed the adverse effect level as determined by a scientifically accepted technique. Even at concentrations below an adverse affect level, exposure to extinguishing agents should not exceed 5 min. If the carrier gas is a halocarbon, it may be used up to its No Observed Adverse Effect Level (NOAEL) calculated on the net volume of the protected space at the maximum expected ambient temperature, without additional safety measures. If a halocarbon carrier gas is to be used above its NOAEL, means should be provided to limit exposure to no longer than the corresponding maximum permitted human exposure time specified according to a scientifically accepted physiologically based pharmacokinetic (PBPK) model¹⁾ or its equivalent which clearly establishes safe exposure limits both in terms of extinguishing media concentration and human exposure time.

4.2.4.13 If the carrier is an inert gas, appropriate means should be provided to limit exposure to no longer than 5 min for inert gas systems designed to concentrations below 43% (corresponding to an oxygen concentration of 12%) or to limit exposure to no longer than 3 min for inert gas systems designed to concentrations between 43% and 52% (corresponding to between 12% and 10% oxygen) calculated on the net volume of the protected space at the maximum expected ambient temperature.

4.2.4.14 In no case should a dispersed aerosol system be used with halocarbon carrier gas concentrations at concentration above the Lowest Observed Adverse Effect Level (LOAEL) nor the Approximate Lethal Concentration (ALC) nor should a dispersed aerosol system be used with an inert gas carrier at gas concentrations above 52% calculated on the net volume of the protected space at the maximum expected ambient temperature.

4.2.4.14.1 The NOAEL and LOAEL values for halocarbon agents listed in the National Fire Protection Association Standard (NFPA) 2001 are acceptable as meeting these Guidelines without further testing. For halocarbon agents not listed in NFPA 2001, cardiac sensitization testing in accordance with section 4 of the Annex to MSC.1/Circ.1316 should be performed to determine the NOAEL and LOAEL values.

4.2.4.15 The system and its components should be suitably designed to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging, electromagnetic incompatibility and corrosion normally encountered in machinery spaces. Generators in condensed aerosol systems should be designed to prevent self-activation at a temperature below 250°C.

4.2.4.16 The system and its components should be designed in accordance with requirements of international standards. As a minimum, the design and installation standards should cover the following elements:

- .1** safety, within the scope of:
 - .1.1** toxicity,
 - .1.2** noise during generator/nozzle discharge,
 - .1.3** extinguishing agent decomposition products,
 - .1.4** obscuration;
 - .1.5** minimum safe distance required between generators and escape routes and combustible materials;
- .2** extinguishing agent storage container design and arrangement:
 - .2.1** strength requirements,

¹⁾ Reference to FP 44/INF.2 – Physiological-pharmacokinetic model to establish criteria for safe exposure to halogenated fire extinguishing agents.

- .2.2 maximum/minimum fill density, operating temperature range,
- .2.3 pressure and weight indication,
- .2.4 pressure relief;
- .2.5 agent identification, production date, installation date and hazard classification;
- .3 agent supply, quantity, quality standards, shelf life and service life of agent and igniter;
- .4 handling and disposal of generator after service life;
- .5 pipes and fittings:
 - .5.1 strength, material properties, fire resistance;
 - .5.2 cleaning requirements;
- .6 valves:
 - .6.1 testing requirements;
 - .6.2 elastomer compatibility;
- .7 generators/nozzles:
 - .7.1 placement height and area testing requirements,
 - .7.2 elevated temperature resistance;
 - .7.3 mounting location requirements considering safe distances to escape routes and combustible materials;
- .8 actuation and control systems:
 - .8.1 testing requirements;
 - .8.2 backup power requirements;
- .9 alarms and indicators:
 - .9.1 predischarge alarm, agent discharge alarms and time delays,
 - .9.2 supervisory circuit requirements,
 - .9.3 warning signs, audible and visual alarms;
 - .9.4 announcement of faults;
- .10 protected space enclosure integrity and leakage requirements:
 - .10.1 enclosure leakage,
 - .10.2 openings in space enclosures;
 - .10.3 mechanical ventilation interlocks;
- .11 electrical circuits for pyrotechnic generators:
 - .11.1 requirements for mounting and protection of cables;
- .12 requirements for design density and total flooding quantity;
- .13 agent flow calculation:
 - .13.1 verification and approval of design calculation method,
 - .13.2 pressure losses during passage of fitting and/or determination of equivalent length;
 - .13.3 agent discharge time;
- .14 inspection, maintenance, service and testing requirements;
- .15 handling and storage requirements for pyrotechnical components.

4.2.4.17 The types of generators/nozzles and their parameters such as maximum spacing, maximum installation height and minimum pressure should be compatible or be within limits defined during fire tests.

4.2.4.18 Installation testing should be limited to the tests at maximum volume.

4.2.4.19 Where agent containers/generators are stored within a protected space, the containers/generators should be evenly distributed throughout the space and meet the following provisions:

- .1 a manually initiated power release, located outside the protected space, should be provided. Duplicate sources of power should be provided for this release and should be

- located outside the protected space and be immediately available. The release device should be supplied from two power sources, easily accessible, situated outside the protected space;
- .2 electric power circuits connecting the containers/generators should be monitored for fault conditions and loss of power. Visual and audible alarms should be provided to indicate the faults;
 - .3 electric, pneumatic or hydraulic power circuits connecting the containers/generators should be duplicated and widely separated. The sources of pneumatic or hydraulic pressure should be monitored for loss of pressure. Visual and audible alarms should be provided to indicate the loss of pressure;
 - .4 within the protected space, electrical circuits essential for the release of the system should be fire resistant according to standard IEC 60331 or equivalent standards. Piping systems essential for the release of systems designed to be operated hydraulically or pneumatically should be of steel or other equivalent heat-resisting material;
 - .5 each dispersed aerosol pressure container should be fitted with an automatic overpressure release valve which, in the event of the container being exposed to the effects of fire and the system not being operated, will safely vent the contents of the container into the protected space;
 - .6 the arrangement of aerosol containers/generators and the electrical circuits and piping essential for the release of any system should be such that in the event of damage to any one power release line or generator through mechanical damage, fire or explosion in a protected space, i.e., a single fault concept, at least the amount of agent needed to achieve the minimum fire-extinguishing concentration can still be discharged having regard to the requirement for uniform distribution of medium throughout the space; and;
 - .7 dispersed aerosol containers should be monitored for decrease in pressure due to leakage and discharge. Visual and audible alarms in the protected area and on the navigation bridge, or in the control station should be provided to indicate the pressure drop;
 - .8 for systems that need less than 6 cylinders (using the smallest bottles available), the total amount of extinguishing gas in the cylinders shall be such that in the event of a single failure to one of the release lines (including cylinder valve), 5/6 of the fire extinguishing gas can still be discharged. This may be achieved by for instance using more extinguishing gas than required so that if one cylinder has been discharged due to a single fault, the remaining cylinders will discharge the minimum 5/6 of the required amount of gas. This can be achieved with a minimum of 2 cylinders. However, NOAEL values calculated at the highest expected engine room temperature are not to be exceeded when discharging the total amount of extinguishing gas simultaneously;
 - .9 the place of location of aerosol containers/generators should be indicated by an appropriate plate with the symbol used in the *Fire Control Plan*.

4.2.4.20 If the system extinguishing agent is stored in one cylinder, the cylinder should be placed outside the protected space, in fire-extinguishing station complying with the requirements of 3.6.2, Part V of the Rules for the Classification and Construction of Sea-going Ships.

4.2.4.21 The release of an extinguishing agent may produce significant over and under pressurization in the protected space. Structural protection measures to limit the induced pressures to acceptable limits after releasing the agent to the space may have to be provided.

4.2.4.22 For all ships, the fire-extinguishing system operation manual should be provided. The manual should address recommended procedures for the control and disposal of gases being the products of agent decomposition during fire. The performance of fire-extinguishing arrangements

on passenger ships should not present health hazards from decomposed extinguishing agents, (e.g., on passenger ships, the decomposition products should not be discharged in the vicinity of assembly stations).

4.2.4.23 Spare parts and operating and operation and maintenance instructions, including operational tests for the system should be provided as recommended by the manufacturer.

4.2.4.24 The temperature profile of the discharge stream from condensed aerosol generators should be measured in accordance with Appendix 1 to MSC.1/Circ.1270/Corr.1. This data should be used to establish the minimum safe distances away from the generator where the discharge temperatures do not exceed 75°C and 200°C.

4.2.4.25 The casing temperature of condensed aerosol generators should be measured in accordance with Appendix 1 to MSC.1/Circ.1270/Corr.1. This data should be used to establish the minimum safe distances away from the generator where the discharge temperatures do not exceed 75°C and 200°C.

4.2.4.26 Generators should be separated from escape routes and other areas where personnel may be present by at least the minimum safe distances determined in paragraphs 4.2.4.23 and 4.2.4.24, to avoid exposure to temperatures above 75°C.

4.2.4.27 Generators should be separated from combustible materials by at least the minimum safe distances determined in paragraphs 4.2.4.23 and 4.2.4.24, to avoid exposure to temperatures above 200°C.

4.2.4.28 The service life of condensed aerosol generators should be determined by the manufacturer for the temperature range and other conditions likely to be encountered on board ships. Generators should be replaced before the end of their service life. Each generator should be permanently marked with the date of manufacture and the date of mandatory replacement.

4.2.5 Type Tests

The aerosol system is subject to type testing in accordance with Appendixes 1 and 2 to MSC.1/Circ.1270/Corr.1.

4.2.6 Tests of the system after installation on board

After installation on board, the system is subject to functional tests in accordance with the agreed acceptance and test program.

5 DRY CHEMICAL POWDER FIRE-EXTINGUISHING SYSTEM FOR GAS CARRIERS

5.1 Application

The system is intended for the protection of cargo areas onboard ships carrying liquefied gases in bulk, subject to *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)*, as amended..

5.2 Definitions

- .1 *Pressurizing medium* – the gas used to expel the dry chemical powder from the system, usually nitrogen.
- .2 *Powder monitor* – a fixed dry chemical powder nozzle protecting cargo loading and discharge manifold areas.

- .3 *Dry chemical powder* – an extinguishing medium consisting of very fine particles of sodium or potassium bicarbonate treated or supplemented with additional materials to prevent packing and caking (moisture absorption) and to ensure consistent flow characteristics.
- .4 *Gas point* – a defined point in the discharge of a dry chemical powder unit when the discharge of dry chemical powder ends, and is marked by a change in the nozzle stream to the discharge of primarily pressurizing gas.
- .5 *Hand hose line* – a hand-held dry chemical powder nozzle covering cargo areas not covered by a monitor.
- .6 *Packing* – a phenomenon that occurs when dry chemical powder stored in a container is subjected to vibration causing the smaller particles to move to the bottom of the container and the larger particles to travel to the top.
- .7 *Caking* – a chemical reaction between dry chemical powder and moisture that causes individual particles of the medium to bind together to form an aggregate mass.
- .8 *Dry chemical powder unit* – a complete system including dry chemical storage container(s), pressurizing gas storage container(s), controls, piping and hand hose lines.

5.3 Requirements for the System

5.3.1 The system should be capable of manual release. A manual release station should be located adjacent to each hand hose line storage area and each powder monitor. A back-up release station should be provided at the fixed dry chemical powder unit. The operation of any manual release station should initiate the pressurization of each fixed dry chemical powder unit and begin the discharge of dry chemical powder to all connected hand hose lines and powder monitors.

5.3.2 The system and its components should be designed to withstand ambient temperature changes, vibration, humidity, shock, impact and corrosion normally encountered on the open deck of ships and manufactured and tested in accordance with the criteria given in the Appendix to MSC.1/Circ.1315.

5.3.3 Systems should be designed for the discharge characteristics and flow rates of a specific dry chemical medium. The type of dry chemical powder in the system should not be changed unless positive results are submitted for testing to verify powder flow conducted by an approved laboratory. Different dry chemical media should not be mixed.

5.3.4 Only chemicals based on the salts of potassium should be used in the system. Dry chemical storage containers should comply with the requirements for pressure vessels (refer to the *Rules for the Classification and Construction of Sea-going Ships, Part VII – Machinery, Boilers and Pressure Vessels*) taking into account the maximum pressure in the system developed at 55°C.

5.3.5 A means for pressurizing the system should be inert gas, which is normally dry nitrogen, kept in high pressure cylinders. The nitrogen should be of industrial grade with a dewpoint of -50°C or lower. Pressure gauges should be provided for monitoring the contents of the cylinders. A pressure regulator should be installed to reduce the gas pressure to the required system operating pressure.

5.3.6 The quantity of expellant gas should be adequate for the system to discharge the entire charge of dry chemical powder within the required time period. If multiple gas cylinders are provided, they should be arranged with normally closed cylinder valves that are automatically opened by a pilot system when the system is actuated from the manual release station. Each cylinder should, in addition, be capable of manual operation.

5.3.7 System piping should be arranged to ensure that the required flow rates are achieved at each hand hose line and powder monitor. Flow through the piping should be based on flow calculation methods determined by the test laboratory for the specific dry chemical powder medium and equipment used.

The minimum required rate of a hand hose line should be at least 3.5 kg/s, whereas the minimum required capacity of a powder monitor – at least 10 kg/s. Length of hose line should not exceed 33 m.

5.3.8 Hand hose line nozzles, powder monitors and hose couplings should be constructed of brass or stainless steel. Piping, fittings and related components, except gaskets, should be designed to withstand 925°C.

5.3.9 Dry chemical storage container pick-up tubes and related internal structures should be shown to be resistant to corrosive effects of the dry chemical medium.

5.3.10 Dry chemical storage containers should have a fill opening of at least 100 mm to allow onboard recharging, and suitable connections to allow the dry powder charge to be fully agitated with nitrogen, in accordance with the system manufacturer's maintenance instructions.

5.3.11 Operating instructions for the system should be placed at each operating station.

5.3.12 Recharging instructions should be provided on a permanent nameplate affixed to the fixed dry chemical powder unit. As a minimum, the instructions should indicate the required type of dry chemical powder, the manufacturer of the powder and the required charge. The required pressurizing medium pressure, number of cylinders and regulator valve setting should also be provided.

5.3.13 An approved dry powder system design, installation, operation and maintenance manual should be provided to the shipowner for each type of fixed dry chemical powder unit.

5.4 Type Tests

The system is subject to type tests in accordance with Appendix to MSC.1/Circ.1315.

5.5 On Board Testing

After installation, the pipes, valves, fittings and assembled systems shall be subjected to a tightness test and functional testing of the remote and local release stations. The initial testing shall also include a discharge of sufficient amounts of dry chemical powder to verify that the system is in proper working order. All distribution piping shall be blown through with dry air to ensure that the piping is free of obstructions

Testing arrangements are to involve the discharge using dry chemical powder from all monitors and hand hose lines on board, but it is not required that there is a full discharge of the installed quantity of dry powder. This testing can also be used to satisfy the requirement that the piping is free of obstructions, in lieu of blowing through with dry air all the distribution piping. However, after the completion of this testing, the system, including all monitors and hand hose lines, are to be blown through with dry air; but only for the purpose of the system subsequently being clear from any residues of dry chemical powder.

List of IMO Documents referred to in *Publication 89/P*

1. A.800(19): Revised Guidelines for approval of sprinkler systems equivalent to that referred to in *SOLAS* Regulation II-2/12.
2. MSC.265(84): Amendments to the Revised Guidelines for approval of sprinkler systems equivalent to that referred to in *SOLAS* Regulation II-2/12 (Resolution A.800(19)).
3. MSC/Circ.848: Revised Guidelines for the approval of equivalent fixed gas fire-extinguishing systems, as referred to in *SOLAS 74*, for machinery spaces and cargo pump rooms
4. MSC/Circ.1165: Revised Guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump rooms.
5. MSC.1/Circ.1237: Amendments to the Revised Guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump rooms (MSC/Circ.1165).
6. MSC.1/Circ.1267: Amendments to the Revised Guidelines for the approval of equivalent fixed gas fire-extinguishing systems, as referred to in *SOLAS 74*, for machinery spaces and cargo pump rooms (MSC/Circ.848).
7. MSC.1/Circ.1268: Guidelines for the approval of fixed pressure water-spraying and water-based fire extinguishing systems for cabin balconies.
8. MSC.1/Circ.1269: Amendments to the Revised Guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump rooms (MSC.1/Circ.1165).
9. MSC.1/Circ.1270/Corr.1: Revised Guidelines for the approval of fixed aerosol fire-extinguishing systems equivalent to fixed gas fire-extinguishing systems, as referred to in *SOLAS 74*, for machinery spaces.
10. MSC.1/Circ.1312: Revised Guidelines for the Performance and Testing Criteria of Foam Concentrates for Fixed Fire Extinguishing Systems.
11. MSC.1/Circ.1315: Guidelines for the approval of fixed dry chemical powder fire-extinguishing systems for the protection of ships carrying liquefied gases in bulk.
12. MSC.1/Circ.1316: Guidelines on determining the *No Observed Adverse Effect Level* (NOAEL) and *Lowest Observed Adverse Effect Level* (LOAEL) values for halocarbon fire-extinguishing agents.
13. MSC.1/Circ.1385: Scientific methods on scaling of test volume for fire test on water-mist fire-extinguishing systems.
14. MSC.1/Circ.1386: Amendments to the Revised Guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump rooms (MSC/Circ.1165).
15. MSC.1/Circ.1387/Corr.1: Revised Guidelines for the approval of fixed water-based local application fire-fighting systems for use in category A machinery spaces (MSC/Circ.913).
16. MSC.1/Circ.1430/Rev.2: Revised Guidelines for the design and approval of fixed water-based fire-fighting systems for ro-ro spaces and special category spaces.
17. MSC.1/Circ.1556: Unified interpretation of Chapter 8 of the FSS Code and the Revised Guidelines for approval of sprinkler systems equivalent to that referred to in *SOLAS* regulation II-2/12 (Resolution A.800(19)), as amended by Resolution MSC.265(84)

National/International Standards

1. PN-EN 15004: Fixed firefighting system – Gas extinguishing systems.

List of amendments effective as of 1 July 2023

<i>Item</i>	<i>Title/Subject</i>	<i>Source</i>
3.2.4.2	IACS interpretation revision number has been added	IACS UI SC218/ Rev.1 and SC219/ Rev.1
3.3.6.2	Reference to IACS interpretation has been added	IACS UI SC217/ Corr.2