PART II RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF SHIPS IDENTIFIED BY THEIR MISSIONS

TITLE 15 ROLL ON ROLL OFF CARGO SHIPS

SECTION 6 PIPING

CHAPTERS

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A1. APPLICATION

100. Piping systems

101. The present Title contains additional requirements for fixed water fire systems and drainage of vehicle spaces in Roll on/Roll off vessels.

200. List of documents

201. In addition to the documents required in Part II, Title 11, Section 3, in special Chapter E, Subchapter E14, the following are to be submitted for RBNA approval:

a. Fixed water spray system arrangement and specifications

b. Diagram for the drainage of fire fightin water from closed whicle and roll on/roll off spaces and special catergory spaces.

CHAPTER F
HULL PIPING SYSTEM

CHAPTER CONTENTS

F1. DRAINAGE OF FIRE-FIGHTING WATER FROM CLOSED VEHICLE AND ROLL ON / ROLL OFF SPACES AND SPECIAL CATEGORY SPACES OF PASSENGER AND CARGO SHIPS [IMO MSC.1/Circ.1320]

100. Purpose

101. When fixed water-based fire-extinguishing systems are provided for the protection of closed vehicle and Roll on / roll off spaces and special category spaces, adequate drainage facilities, as required by SOLAS regulation II-2/20.6.1.4, should be provided to prevent the accumulation of significant quantities of water on decks and the build-up of free surfaces. In addition, SOLAS

regulation II-2/20.6.1.5 requires effective measures to be taken to ensure that floating debris does not cause blockage of the drains.

102. When the direct overboard discharge provisions or the bilge system required by SOLAS regulation II-1/35-1 have a capacity sufficient for the additional flow from the fixed fire-extinguishing system and the required number of fire hoses, as determined by this Section, additional drainage facilities are not required.

103. Scuppers, freeing ports, discharges and bilge systems should be installed in accordance with SOLAS regulation II-1/35-1, the relevant regulations of the International Convention on Load Lines, 1966 (ICLL 66), and these Section.

104. *In lieu* of the above, RBNA, after having given consideration to the ship's arrangement and equipment, may accept other fixed installations if they afford equivalent protection. Any equivalent protection should demonstrate the capability to rapidly drain fire-fighting water from the affected decks and prevent the build-up of free surfaces under expected conditions of trim and list, for as long as the fire-extinguishing system is in operation.

105. **Application**: this Section applies to the design of drainage systems in closed vehicle and Roll on / roll off spaces and special category spaces required by SOLAS regulation II-2/20.6.1.4, and to the protection of drain openings required by SOLAS regulation II-2/20.6.1.5.

200. Definitions

201. **Bilge wells** are recessed areas where water accumulates before entering the bilges.

202. **Bulkhead deck** in a passenger ship means the uppermost deck at any point in the subdivision length (L_s) to which the main bulkheads and the ship's shell are carried watertight and the lowermost deck from which passenger and crew evacuation will not be impeded by water in any stage of flooding for damage cases defined in regulation 8 and in part B-2 of SOLAS chapter II-1. The bulkhead deck may be a stepped deck. In a cargo ship the freeboard deck may be taken as the bulkhead deck.

203. **Drains**, as used in these Section, refer to either scupper wells and scuppers, freeing ports, or bilge wells and drain pipes.

204. **Freeing ports** are openings in the bulwarks on the open deck to allow water to drain directly overboard.

205. **Scuppers** are a system of gravity deck drains and connected piping leading from scupper wells to the sideshell of the ship or to the bilge system.

206. **Scupper wells** are recessed areas in the deck where water accumulates before entering the scuppers.

300. Drainage arrangements for passenger ships

301. **Arrangements above the bulkhead deck**

a. Above the bulkhead deck, except as provided in paragraph F1.102 above, an adequate number of properly-sized drains should be provided on each deck to ensure that the combined water flow from the fixed fire-extinguishing system and the required number of fire hoses can be rapidly discharged overboard or drain to a bilge system with a reservoir tank fitted with a high water level alarm.

b. At least four drains should be located on each side of the protected space, uniformly distributed fore and aft. Freeing ports should not be installed in enclosed superstructures, as defined by regulation 3.10 of the ICLL 66.

c. The drainage system on each side of the deck should have an aggregate capacity of not less than 125% of the maximum flow rate of the fixed fire-extinguishing system water pumps plus the flow from two fire hoses (four if required by SOLAS regulation II-2/19.3.1.2). In case an automatic deep well or submersible pumping system is installed, the bilge pump capacity can be subtracted from the required drainage capacity.

d. **Minimum capacity of drains:** the minimum capacity of scuppers, freeing ports or a combination thereof should be determined in accordance with the provisions of paragraphs F1.301.d1 or F1.301.d3, respectively.

d.1 The minimum required area of scuppers and connected piping should be determined by the following formula:

$$A = \frac{Q}{0.5\sqrt{19.62\left(h - \sum h_\ell\right)}}$$

where:

A is the total required sectional area of the drains on each side of the deck in m^2;

Q is the combined waterflow from the fixed fire-extinguishing system and the required number of fire hoses in m^3/s;

h is the elevation head difference between the bottom of the scupper well or suction level and the overboard discharge opening or highest approved load line in m; and

$\sum h_l$ is the summation of head losses corresponding to scupper piping, fittings and valves in m.

In no case should the area of each individual drain be less than 0.0078 m^2 or 125 mm diameter piping.

d.2 The minimum required area of freeing ports should be determined by the following formula:

$$A = \frac{Q}{0.5\sqrt{19.62(h_1 - h_2)}}$$

where:

A is the total required sectional area of freeing ports on each side of the ship in m^2;

Q is the combined waterflow from the fixed fire-extinguishing system and the required number of fire hoses in m^3/s; and

h_1-h_2 is the depth of water on the deck determined in accordance with paragraph F1.402.

If the cross-sectional area of freeing ports required by the ICLL 66 is equal to or greater than determined above, additional freeing ports are not required.

302. **Arrangements below the bulkhead deck**

a. Below the bulkhead deck, except as provided in paragraph F1.102 above, an efficient bilge pumping system should be provided to ensure that the combined waterflow from the fixed fire-extinguishing system and the required number of fire hoses can be rapidly collected and led to suitable arrangements for discharge overboard. The bilge system capacity should be not less than that required by paragraph F1.302.c.

b. The bilge piping system should be arranged in accordance with SOLAS chapter II-1. At least four bilge wells should be located on each side of the protected space, uniformly distributed fore and aft.

c. The bilge pumping system on each side of the ship should have an aggregate capacity of not less than 125% of the maximum flow rate of the fixed fire-extinguishing system water pumps plus the flow from two fire hoses (four, if required by SOLAS regulation II-2/19.3.1.2).

d. The required area of the main and branch bilge pipes for the protected space should be adequate to ensure a maximum waterflow of 2 m/s in each section of piping in accordance with paragraphs F1.302.d.i to F1.302.d.iii.

d.1. If the drainage system is a bilge pumping system, the following three criteria should be satisfied:

$$\sum Q_{bpump} \geq 1.25Q$$

$$A_M \geq 0.625Q \;\&$$

$$\sum A_B \geq 0.625Q$$

where:

Q_{bpump} is the combined capacity of all power bilge pumps except the emergency bilge pump in m^3/s;

Q is the combined waterflow from the fixed fire-extinguishing system and the required number of fire hoses in m^3/s;

A_m is the sectional area of the main bilge pipe of the protected space in m^2;

$\sum A_B$ is the total sectional area of branched bilge pipes for each side in m^2.

d.2. If the drainage system is based on gravity drains leading to a reservoir tank, the minimum required area of drains and connected piping should be determined by paragraph F1.301.d.

d.3. If the drainage system is a combined system, the relevant dimensioning for each part of the system should be determined using paragraphs F1.302.d.1 and F1.302.d.2.

e. The required capacity of each bilge well should be at least 0.15 m^3.

f. If the system includes a reservoir tank, the tank should have adequate capacity for at least 20 min of operation at the required drainage capacity for the affected space.

400. Drainage arrangements for cargo ships

401. In cargo ships, the drainage and pumping arrangements should be such as to prevent the build-up of free surfaces in accordance with paragraph F1.301 or F1.302, as appropriate.

402. If the abovementioned pumping arrangement is not possible, the adverse affect upon stability of the added weight and free surface of water should be taken into account according to the International Code on Intact Stability, 2008, chapter 3.

403. For that purpose, the depth of water ($h_1 - h_2$) on each deck should be calculated by multiplying the maximum flow rate of the installed fire-extinguishing system water pumps plus the flow from two fire hoses (four if required by SOLAS regulation II-2/19.3.1.2) by an operating time of 30 min. This volume of water should be divided by the area of the affected deck.

500. Protection of drain openings

501. An easily removable grating, screen or other means should be installed over each drain opening in the protected spaces to prevent debris from blocking the drain. The total open area ratio of the grating to the attached drain pipe should be at least 6 to 1. The grating should be raised above the deck or installed at an angle to

prevent large objects from blocking the drain. No dimension of the individual openings in the grating should be more than 25 mm.

502. No grating or screen is required when a fixed mechanical system is provided to unblock the drainage system, or when other than a gravity drain system is provided with its own filter.

503. A clearly visible sign or marking should be provided not less than 1,500 mm above each drain opening stating, "Drain opening – do not cover or obstruct". The marking should be in letters at least 50 mm in height.

F10. DESIGN AND APPROVAL OF FIXED WATER-BASED FIRE-FIGHTING SYSTEMS FOR ROLL ON / ROLL OFF SPACES AND SPECIAL CATEGORY SPACES [MSC.1/Circ.1430 - 31 May 2012]

100. General

101. The present Subchapter is additional to Part II, Title 11, Section 3, Chapter E and in particular Subchapter E14.

102. This Chapter is intended for the design and approval of fixed water-based fire-fighting systems for open and closed Roll on / roll off spaces and special category spaces defined in SOLAS regulations II-2/3.12, II-2/3.13, II-2/3.35, II-2/3.36, II-2/3.46 and II-2/3.49. Deluge systems can be applied on open Roll on / roll off spaces when the actual wind condition is taken into consideration, for example through the use of high velocity nozzles. Systems using automatic sprinklers or nozzles are only permitted for closed Roll on / roll off and special category spaces or other spaces where wind conditions are not likely to affect system performance.

103. All systems should comply with F10.100, F10.200 and F10.300. In addition, prescriptive-based systems should comply with F10.400, and performance-based systems should comply with F10.500.

200. Definitions

201. **Area of operation** is a design area for wet-pipe, automatic sprinkler system (to be determined for performance-based systems by the test procedure described in Subchapter T4

202. **Automatic sprinkler or nozzle** is 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.

203. **Automatic system** is a system utilizing either automatic sprinklers or nozzles or a system that is automatically activated by a fire detection system.

204. **Deluge system, automatic and manual release** is 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 and by manual operation. When this valve is opened, water flows into the piping system and discharges from all nozzles attached thereto.

205. **Deluge system, manual release** is 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.

206. **Dry pipe system** is 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.

207. **Fire control** limits the size of a fire by distribution of water so as to decrease the heat release rate, while controlling ceiling gas temperatures and pre-wetting adjacent combustibles and/or reducing heat radiation to avoid structural damage.

208. **Fire suppression** is the sharp reduction of the heat release rate of a fire and the prevention of regrowth.

209. **K-factor** is a sprinkler nozzle discharge coefficient determined by testing, that is used to calculate flow rate at any given pressure through the relationship

$$\mathbf{Q} = \mathbf{k}\,\mathbf{P}^{1/2},$$

where **Q** is the flow rate in litres per minute, and **P** is the pressure in bars.

210. **Open sprinkler or nozzle** is 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.

211. **Performance based requirements** are 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.

212. **Prescriptive based requirements** are specific requirements, such as minimum water discharge density or maximum nozzle spacing, and are applied equally to all systems designed to this approach.

213. **Pump** means a single water pump, with its associated driver and control or an individual pump within a pump unit.

214. **Pump unit** means a single water pump, or two or more pumps connected together to form a unit, with their associated driver(s) and controls.

215. **Pre-action system** is 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.

216. **Water-based extinguishing medium** is fresh water or seawater, with or without an antifreeze solution and/or additives to enhance fire-extinguishing capability.

217. **Water discharge density** is the unit rate of water application to an area or surface expressed in mm/min (equal to (l/min)/m^2).

218. **Wet pipe system** is 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.

300. Principal requirements for all systems

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

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

303. The piping system should be sized in accordance with a hydraulic calculation technique 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.

a. 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:

TABLE T.F10.303.1 – FRICTION FACTOR C

Pipe	*C*
Black or galvanized mild steel	100
Copper and copper alloy	150
Stainless steel	150

304. The system supply equipment 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.

305. 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 detection and fire alarm system required by SOLAS regulation II-2/20.4.

306. 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 having temperature control of the space, heating coils on pipes, antifreeze agents or other equivalent measures.

307. The capacity of the system water supply should be sufficient for the total simultaneous coverage of the minimum coverage area of tables T.F10.307.1 to T.F10.307.3 and T.F10.504.1 and the vertically applicable area as defined in paragraph F10.322.

308. 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 per cent. 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 both in normal operation and in the event of the failure of any one component.

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

310. 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 F10.311.

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

312. A means for testing the automatic operation of the system and, in addition, assuring the required pressure and flow should be provided.

313. If the system is pre-primed with water containing a fire suppression enhancing additive and/or an antifreeze agent, periodic inspection and testing, as specified by the manufacturer, should be undertaken 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.

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

315. 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 the zone in respect of each section. Instructions for testing and maintenance should be available on board.

316. Spare parts should be provided 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 six for the first 300, 12 for the first 1,000.

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

318. All installation, operation and maintenance instruction/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.

319. Any foam concentrates used as system additives should comply with the Revised Section for the performance and testing criteria and surveys of foam concentrates for fixed fire-extinguishing systems (MSC.1/Circ.1312).

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

321. The presence of obstructions and the potential for shielding of the water spray should be evaluated to ensure that the system performance is not affected. Supplementary sprinklers or nozzles should be installed beneath obstructions. In addition, nozzles should be located to protect spaces above and below intermediate decks, hoistable decks and ramps. Nozzles below hoistable decks should be capable of protecting all applicable heights.

322. Vertically the applicable area of all decks, including hoistable decks or other intermediate decks, between reasonably gas-tight steel decks (or equivalent materials), should be included for simultaneous coverage (example: with one hoistable deck, both the layer above and below this deck with a dimensioning area complying with tables T.F10.307.1 to T.F10.307.3 and T.F10.504.1 should be included in the water supply calculations). Decks with ramps are accepted as reasonably 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 reasonably gas-tight.

323. All release controls for deluge systems, monitor(s) for any CCTV system, the control panel (or an indication panel) for the fire detection system, water pressure on the discharge side of all pump units, and the position indication of all section valves should be available and grouped together in a continuously manned control station or the safety centre, if provided.

324. 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 reasonably 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 distance between tight steel divisions). Vertically one section can cover up to three decks.

TABLE T.F10.307.1 - 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 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 × 20m x B[1]

(1) B = full breadth of the protected space.

TABLE T.F10.307.2 MINIMUM REQUIRED WATER DISCHARGE DENSITY AND AREA OF COVERAGE FOR DECKS HAVING A FREE HEIGHT IN EXCESS OF 2.5 M BUT LESS THAN 6.5 M

Type of system	Minimum 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 x B[1]

(1) B = full breadth of the protected space.

TABLE T.F10.307.3 MINIMUM REQUIRED WATER DISCHARGE DENSITY AND AREA OF COVERAGE FOR DECKS HAVING A FREE HEIGHT IN EXCESS OF 6.5 M BUT LESS THAN 9.0 M

Type of system	Minimum 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 x B[1]

(1) B = full breadth of the protected space.

400. Additional prescriptive-based system design requirements

401. In addition to the requirements in section 3, systems designed with this approach should comply with paragraphs F10.401 to F10.410. Wet pipe, dry pipe and pre-action systems should be designed for simultaneous coverage of the hydraulically most demanding area at the minimum water discharge density given in tables T.F10.307.1 to T.F10307.3. The minimum operating pressure of any sprinkler should be 0.05 MPa.

402. Deluge systems should be designed for the simultaneous activation of the two adjacent deluge sections with the greatest hydraulic demand at the minimum water discharge density given in tables T.F10.307.1 to T.F10.307.3. The minimum operating pressure of any sprinkler should be 0.12 MPa.

403. 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.

404. 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.

405. Sprinklers or nozzles should be positioned at or within 0.6 m of the underside of the deck, in order to distribute water 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. The maximum horizontal spacing between nozzles or sprinklers should not exceed 3.2 m.

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

407. For wet pipe and dry pipe sprinkler systems, fire detection systems should be installed in accordance with the requirements of SOLAS regulation II-2/20.4.

408. For manual deluge systems, automatic deluge systems and pre-action systems, fire detection systems should be provided complying with the International Code for Fire Safety Systems (FSS Code) and the following additional requirements:

a. the detection system should consist of flame, smoke or heat detectors of approved types, arranged as described below. 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 detector arrangement shall comply with the FSS Code. 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;

b. 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:

b.1. set-up of approved flame detectors and aproved smoke detectors or heat detectors; or

b.2. set-up of approved smoke detectors and approved heat detectors; other arrangements can be accepted by the Administration;

b.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. The Administration may accept other arrangements; and

b.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 on- and off-loading operations, provided that this function is automatically reconnected after a pre-set time being appropriate for the operations in question.

409. 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 two thirds of the spacing permitted under chapter 9 of the FSS Code.

410. 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.

500. Additional performance-based system design requirements

501. In addition to the requirements in Section 3 F10.300, systems designed with this approach should comply with paragraphs F10.501 to F10.506. The system should be capable of fire suppression and control and be tested to the satisfaction of the Administration in accordance with the Subchapter F10.

502. The nozzle location, type of nozzle and nozzle characteristics should be within the limits tested to provide fire suppression and control as referred to in paragraph F10.501.

503. System designs should be limited to the use of the maximum and minimum temperature ratings of the thermally sensitive fire detection devices tested to provide fire suppression and control as referred to in paragraph F10.501.

504. The capacity of the system water supply should be sufficient for the total simultaneous coverage of the minimum coverage area of table T.F10.504.1 and the vertically applicable area as defined in paragraph F10.322, and the requirements of paragraph F10.505.

TABLE T.F10.504.1 - MINIMUM COVERAGE AREA PER TYPE OF SYSTEM

Type of system (Definition number)	**Minimum coverage area**
A. Wet pipe, automatic sprinkler heads (F10.218)	280 m^2 or area of operation as defined in the fire tests – whichever is larger
B. Deluge system, automatic[1] and manual release (F10.204)	280 m^2 and the overlapping or adjacent section as defined by paragraph 5.5 [2]
C. Deluge system, manual release (F10.205)	2 sections each of min 20 m x B [2,3]
D. Other systems (F10.206, F10.215)	Equivalent to the above systems and to the satisfaction of the Administration

[1] The automatic release should comply with the requirements of paragraph F10.506.
[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.

505. 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 five metres, whichever is larger. These overlapping sections need not

comply with the minimum width and length requirements of paragraph F10.324.

506. For systems of type B (see table T.F10.504.1) an efficient fire detection and fire confirmation system covering all parts of the Roll on / roll off or special category spaces should be provided as follows:

a. 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 the FSS Code. Additional smoke detectors with a spacing not exceeding 11 m shall be installed under hoistable ramps;

b. a colour TV monitoring system should cover all parts of the Roll on / roll off 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; and

c. 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.

CHAPTER T
TESTS

CHAPTER CONTENTS

T4. FUNCTIONAL TEST OF DRAINAGE FACILITIES ON RO-RO PASSENGER SHIPS [IMO MSC.1/Circ. 1320]

100 Scope

101. The drainage facilities on ro-ro passenger ships should be functionally tested before the ship enters service to verify that the capacity of the system is adequate. The drainage facilities on all ships should be periodically visually examined for blockage or other damage and should be flushed with fire hoses or similar means to verify that the system is functional, if obstructions are noted.

T5. TEST METHOD FOR FIXED WATER-BASED FIRE-FIGHTING SYSTEMS FOR ROLL ON / ROLL OFF SPACES AND SPECIAL CATEGORY SPACES [IMO MSC.1/Circ. 1430]

100 Scope

101. This test method is intended for evaluating the effectiveness of fixed water-based fire-fighting systems installed in Roll on / roll off spaces and special category spaces with deck heights up to and including 5 m and/or up to and including 2.5 m.

102. The test programme has two objectives:

a. establishing nozzle location, nozzle characteristics, minimum water delivery rate and minimum water pressure for systems which will provide the required level of system response time, suppression and control; and

b. establishing the minimum area of operation of the system for the purpose of determining hydraulic design requirements for wet pipe, dry pipe and preaction systems.

200 General requirements

201**. Sampling**
The nozzles and other components to be tested should be supplied by the manufacturer together with design and installation criteria, operational instructions, drawings and technical data sufficient for the identification of the components.

202. **Tolerances**

Unless otherwise stated, the following tolerances should apply:

a. length: ± 2% of value;

b. volume: ± 5% of value;

c. pressure: ± 3% of value; and

d. temperature: ± 2% of value.

203. **Observations**

The following observations should be made during and after each test:

a. time of ignition;

b. activation time of first nozzle;

c. time when water flows out through first nozzle;

d. time when water flow is shut off;

e. time when the test is terminated; and

f. total number of activated nozzles.

204. **Test hall and environmental conditions**

The test hall where the tests are conducted should have a minimum floor area of 300 m^2 and a ceiling height in excess of 8 m. The test hall may be equipped with a forced ventilation system, or be natural ventilated, in order to ensure that there is no restriction in air supply to the test fires. The test hall should have an ambient temperature of between 10 and 25°C at the start of each test.

205. **Measurement equipment**

a. Temperatures should be measured using plain K-type thermocouple wires not exceeding 0.5 mm in diameter. The thermocouple head should be protected against direct water impingement, e.g. by tin cans.

b. System water pressure should be measured by using suitable equipment. Total water flow rate should be determined by a direct measurement or indirectly by using the pressure data and "k" factor of the nozzles.

c. The measurements should be made continuously throughout the tests.

206. **System operational conditions**

The tests should simulate the conditions of an actual installed system regarding objectives such as time delays between the activation of the system and minimum system water pressure or water delivery. In addition, the use of a pre-primed fire suppression enhancing additive, if applicable, should be taken into account.

300. Determination of fire suppression and control capabilities

301. **Principle**

These test procedures test the effectiveness of a water-based fire-fighting system against two different scenarios: a cargo fire in a simulated freight truck, and a passenger vehicle fire.

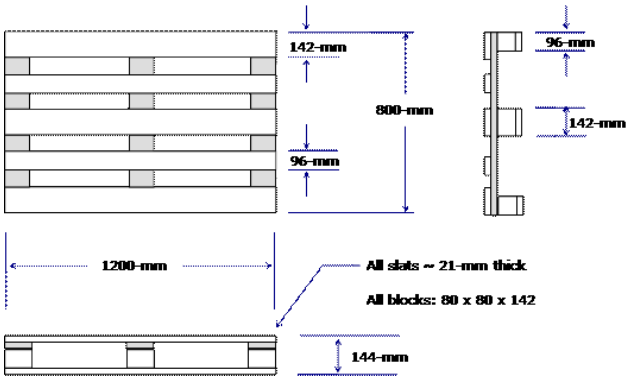
302. **Fire source**

a. The primary fire source for both scenarios consists of EUR standard wood pallets (ISO 6780:2003), stored inside with the moisture content of 14 ± 2%. Figure F.T5.302.a shows details of a EUR pallet.

b. Plywood panels made of pine or spruce are used as targets. The panels should be approximately 12 mm thick. The ignition time of the panel should not be more than 35 s and the flame spread time at 350 mm position should not be more than 100 s as measured in accordance with resolution A.653(16).

c. For ignition, commercial heptane should be applied.

FIGURE F.T5. 302.a – TYPICAL DIMENSION OF STANDARD EUR PALLET



303. **Apparatus**

a. **Test area**

The tests should be conducted in a test hall as specified in paragraph T5.204 above, under a flat, smooth, non-combustible ceiling of at least 100 m^2. There should be at least a 1 m space between the perimeters of the ceiling and any wall of the test hall.

b. **Fire scenario 1: cargo fire in a simulated freight truck** (see figures F.T5.303.1to F.T5.303.3

b.1. The primary fuel package consists of 112 wood pallets arranged in an array of 2 (wide) x 7 (high) x 8 (long) and raised up on a level of 2.8 m so that the top level of the fuel package is at 3.8 to 3.9 m above the floor.

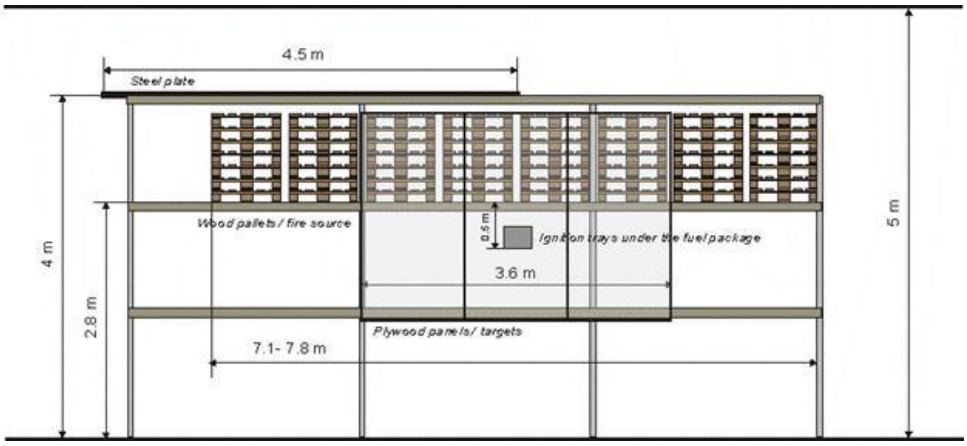
b.2. The support frame for the wood pallet array of paragraphT4.303.b.i should be constructed using open steel racks. The wood pallet piles should be standing freely on horizontal steel beams without any solid bottoms.

b.3. The fuel pallet array should be half-shielded by a 4.5 m long, 2.6 m wide steel plate (thickness at least 2 mm) at 4 m height. The plate should be properly fixed so that during a test it does not bend to provide an unobstructed passage of water onto the fuel package.

b.4. Plywood panel targets (acting also as obstructions) of dimensions 3.6 m (wide) x 2.4 m (high) should be arranged symmetrically on both sides of the fuel package at 1 m distance so that the top edge is at the same level as the top level of the wood pallet array.

b.5. The fire should be ignited by two steel trays centrally located under the fuel package as shown in figures F.T5.303.1 to F.T54.303.3. The square trays are 25 cm high and 0.1 m^2 of free surface area. The trays should be filled with water and 1 *l* of heptane so that the free rim height above the liquid surface is 4 cm. The distance between the bottom of the wood pallet piles and liquid surface is 29 cm.

FIGURE F.T5.303.1 - SIDE VIEW OF THE CARGO FUEL PACKAGE IN A SIMULATED TRUCK



FIRUGE F.T5.303.2 - END VIEW OF THE CARGO FUEL PACKAGE IN A SIMULATED TRUCK

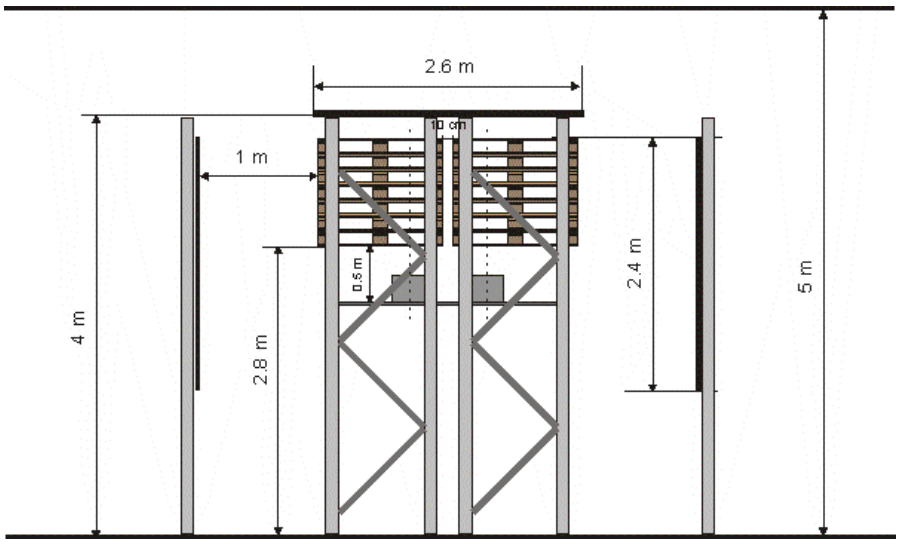
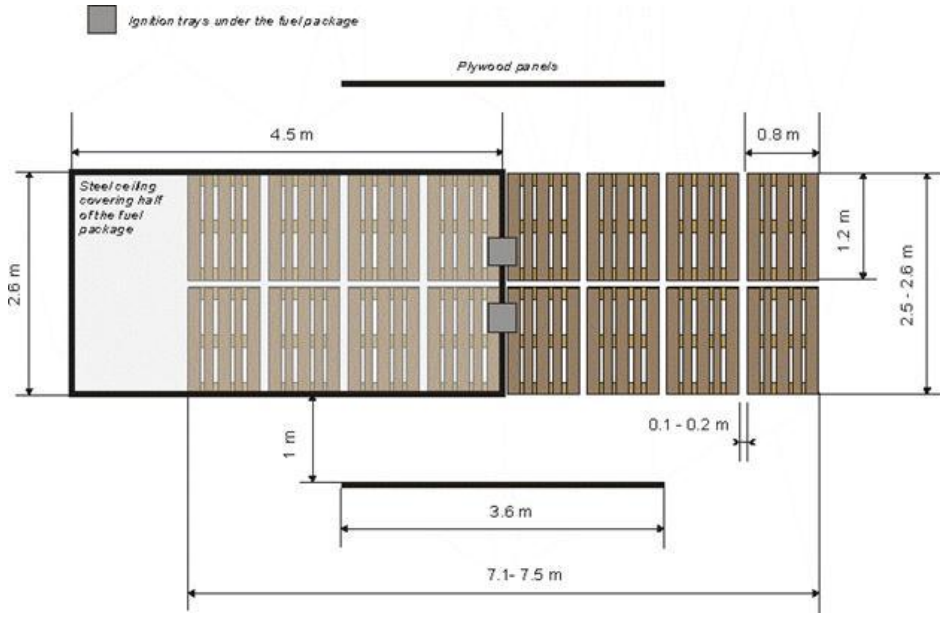


FIGURE F.T5.3036.3 - TOP VIEW OF THE CARGO FUEL PACKAGE IN A SIMULATED TRUCK



c. **Fire scenario 2: passenger vehicle fire** (see figures F.T5.303.4 and F.T5.303.5)

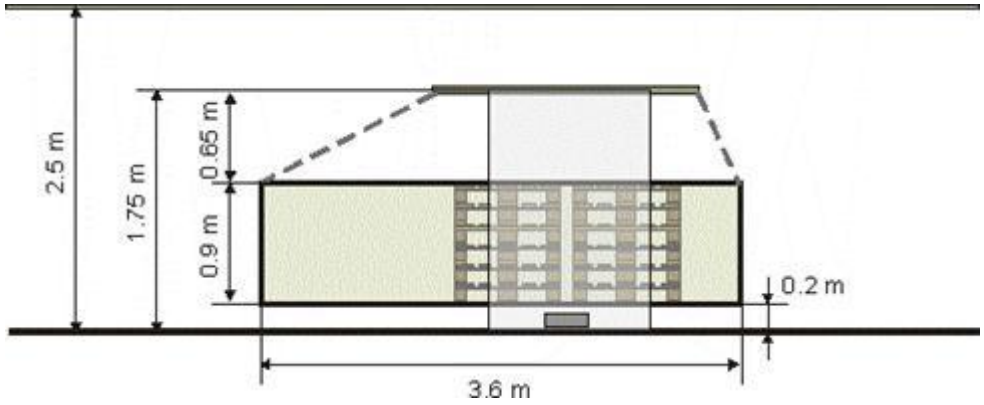
c1. The primary fuel package consists of 12 wood pallets arranged in an array of 1 pallet (wide) x 6 pallets (high) x 2 pallets (long) constructed inside a passenger vehicle mock-up.

c2. The passenger vehicle mock-up is constructed of nominally 2 mm steel.

c3. Plywood panel targets (acting also as obstructions) of dimensions 1.2 m (wide) x 1.75 m (high) should be arranged symmetrically on both sides of the mock-up at 0.6 m distance so that the top edge is at the same level as the top level of the mock-up car.

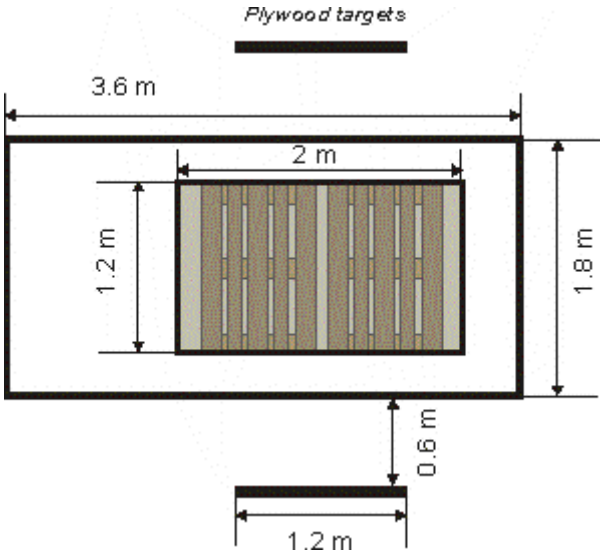
c4. The fire should be ignited by a steel tray centrally located under the fuel package as shown in figures F.T5.303.4 and F.T5.30354. The square tray is 10 cm high and 0.1 m2 of free surface area. The tray should be filled with water and 1 l of heptane so that the free rim height above the liquid surface is 4 cm.

F.T5.303.4 - SIDE VIEW OF THE PASSENGER VEHICLE FUEL PACKAGE



(The dashed lines visualize the shape of a car; the ceiling plate is to be fixed in its location as found most practical)

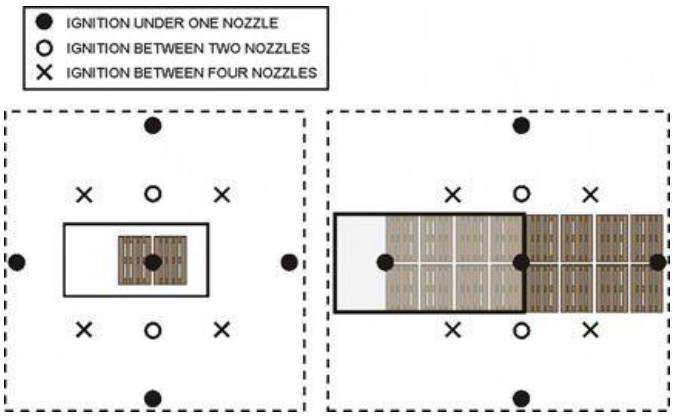
F.T5.303.5 - TOP VIEW OF THE PASSENGER VEHICLE FUEL PACKAGE



304. **Nozzle positioning**

a. Nozzles should be installed in an array at the ceiling level in accordance with the manufacturer's design and installation criteria. Tests should be repeated with three different relative locations between the nozzle array and the fuel package, i.e. centre of ignition under one nozzle, between two nozzles and between four nozzles, as shown in figure F.T4.304.1.

FIGURE F.T5.304.1 - NOZZLE POSITIONING IN THE TWO SCENARIOS



305. **Instrumentation**

Instrumentation for the continuous measuring and recording of test conditions should be employed. At least the following measurements should be made:

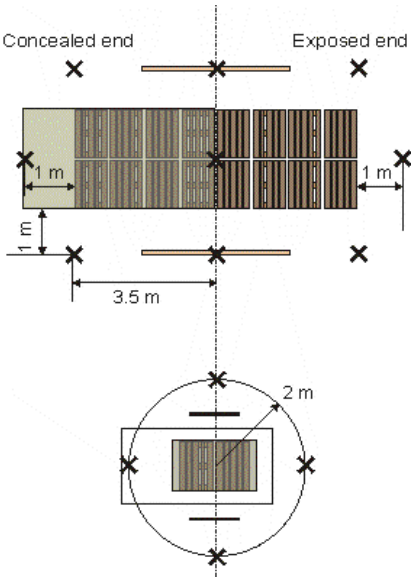
a. gas temperature at 7.5 cm below the ceiling at locations shown in figure F.T5.305.1;

b. gas temperature at the targets to indicate ignition of targets as shown in figure F.T5.305.2; and

c. system water pressure near the centre of the piping array.

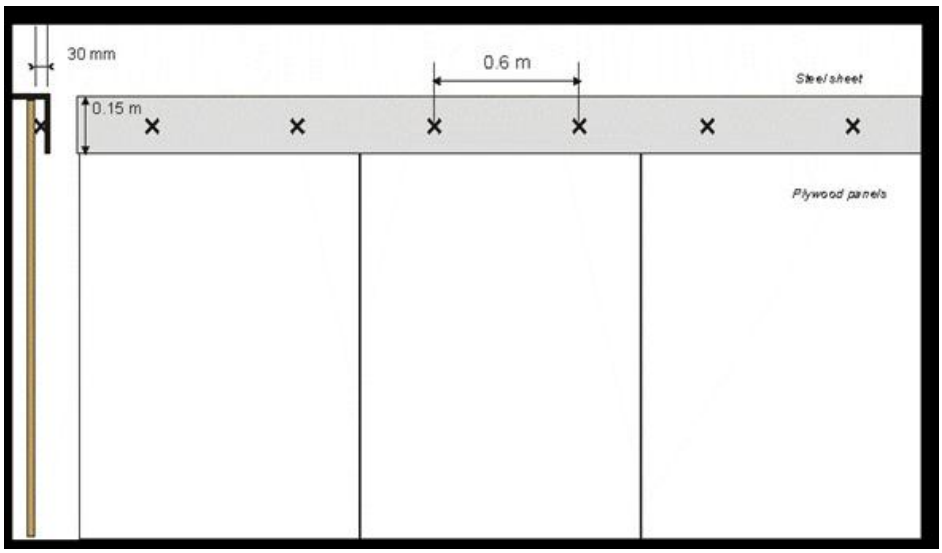
307. System water flow rate should be defined with suitable means for the system.

FIGURE F.T5.305.1 - THERMOCOUPLE LOCATIONS IN THE TWO SCENARIOS



Note: For the truck fuel package the three locations at both ends are used for acceptance evaluation, the three locations at and around the centre of ignition are for safety purposes to define during the test whether the ceiling is at danger. For the passenger car fuel package all four locations are used for acceptance evaluation.

FIGURE F.T5.305.2 - THERMOCOUPLE LOCATIONS AT THE PLYWOOD TARGETS FOR DETERMINING IGNITION OF TARGETS



Note: A thin (about 1 mm) steel sheet is bent on top of the plywood panels as shown in the figure. Plain charring of panels is seen as a sharp edge between the black charring on the exposed surface and intact surface under the metal sheet. When ignited in flames charring is seen also under the sheet and verified by significant increase in the gas temperature under the metal sheet.

306. **Test programme and test procedure**

a. Test programme

a.1. Tests should be conducted at the minimum system water pressure at the minimum distance between the lowest part of the nozzles and the ceiling, as specified by the manufacturer.

a.2. Three tests should be conducted at ceiling heights 5 m and/or 2.5 m, with different nozzle grid locations relative to the fuel package as specified in figure F.T5.304.1.

b. **Test procedure**

b.1. Prior to starting the test the moisture content of the fuel package should be measured at several locations along the full

package with a probe-type moisture meter and the results should be reported.

b.2. The actual test procedure for all tests is as follows:

i. the water pressure used at the start of the test should be set at the minimum value for the system specified by the manufacturer, flowing six open nozzles. If more than six nozzles operate during the test, the water supply pressure should be adjusted accordingly, to keep the required minimum system water pressure;

ii. the tray should be filled with 1 litre of heptane on the water base as described in paragraph 303.b.v5 or 303.c.iv;

iii. the measurements are started;

iv. the flammable liquid pool fire(s) should be lit by means of a torch or a match;

v. the fire should be allowed to burn freely for a period of 2.5 min;

vi. If automatic sprinklers activate already during the 2.5 min pre-burn period, feeding water to the system should be delayed till after the 2.5 min.

vii. the test is continued for 30 min after system activation;

viii. any remaining fire should be manually extinguished; and

ix. the test is terminated.

307. **Acceptance criteria**

The principal acceptance criteria are based on the following factors:

a. gas temperatures measured at locations not directly affected by impinging flames;

b. damage to the fuel package; and/or

c. ignition of targets.

Note 1: Damage to the fuel package is defined by the fraction of charring of the full package. The damage to each individual wood pallet should be evaluated separately and the total fraction calculated based on the detailed results. Totally black, i.e. totally charred pallet is denoted as 100 per cent damage of the pallet (even though the pallet may have maintained its shape) and totally intact pallet is denoted as 0 per cent damage. Partially charred pallets should be visually evaluated. Proper and adequate photographs of the damaged fuel package should be included in the test report.

Note 2: Ignition of targets is defined by the method described in figure F.T4.305.2, if the visibility during the test is such that it cannot be visually observed.

308. **Fire scenario 1: cargo fire in a simulated freight truck (ceiling height 5 m)**

The following four criteria should be met:

a. after system activation the maximum five minute average at any of the three measurement locations at the exposed end of the fuel package should not exceed 300°C;

b. after system activation the maximum five minute average at any of the three measurement locations at the concealed end of the fuel package should not exceed 350°C;

c. total damage to the wood pallet array should not exceed 45 per cent as defined after the test; and

d. the plywood targets should not ignite during the test.

309. **Fire scenario 2: passenger vehicle fire**

The following two criteria should be met:

a. after system activation the maximum five minute average at any of the four measurement locations should not exceed 350°C; and

b. the plywood targets should not ignite during the test.

400. Determination of area of operation

401. Both fire scenarios include hidden fires that burn intensely throughout the tests. The suppression tests as defined in paragraph T4.306.a can be applied in establishing the area of operation of wet pipe, dry pipe and pre-action systems. The evaluation is based on the test with the largest number of nozzles activating.

402. The ceiling area of 100 m^2 as defined in paragraph T4.303.a most likely is not sufficient for defining the area of operation. The ceiling should be large enough to allow installation of a sufficient number of nozzles so that it is unambiguous that the nozzles activating truly represent the maximum number of active nozzles.

403. The area of operation is determined by multiplying the largest number of nozzles activating in the tests by two and defining the corresponding coverage area.

500. Test report

501. The test report should, as a minimum, include the following information:

a. name and address of the test laboratory;

b. date of issue and identification number of the test report;

c. name and address of applicant;

d. name and address of manufacturer or supplier of the nozzles;

e. test method and purpose;

f. nozzle identification;

g. . description of the tested nozzles and system performance;

h. detailed description of the test set-up including drawings and photos of the fuel package and targets before and after the tests;

i. date of tests;

j. measured nozzle pressure and flow characteristics;

k. identification of the test equipment and used instruments;

l. test results including observations and measurements made during and after the test;

m. deviations from the test method;

n. conclusions; and

o. date of the report and signature.

Circular issued by IMO following meetings of the Maritime Safety Committee

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