

Guide for

Fire-Fighting Systems for Cargo Areas of Container Carriers



May 2022



GUIDE FOR

**FIRE-FIGHTING SYSTEMS FOR CARGO AREAS OF
CONTAINER CARRIERS
MAY 2022**

**American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862**

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Foreword (1 May 2022)

Container Carriers have grown much larger in recent years and the volume of cargo carried has expanded significantly. Fires involving containers, especially with the volume of cargo now being carried, can present a substantial risk to the safety of the crew and the vessel.

The requirements of SOLAS Chapter II-2 Regulation 10 have been revised in accordance with IMO Resolution MSC 365(93) to address the risk and came into effect for ships designed to carry containers on or above the weather deck, constructed on or after 1 January 2016. While the basic SOLAS requirements are incorporated by reference in the *ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)*, this Guide has been developed to provide for further enhancement of the fire-fighting and fire protection capabilities for cargo areas of Container Carriers beyond that required by SOLAS.

This Guide replaces the existing *Guide for Fire-Fighting Systems for On-Deck Cargo Areas of Container Carriers*.

This Guide is for the use of designers, builders, owners and operators in the marine industry and specifies the ABS requirements and criteria for obtaining the following optional notations:

- **FOC** (Fire-fighting On-deck Container),
- **FOC-R** (Fire-fighting On-deck Container – Restricted),
- **FOC+** (Fire-fighting On-deck Container Plus),
- **FOC-R+** (Fire-fighting On-deck Container – Restricted Plus),
- **CCH** (Container Carrier House/Structures),
- **FBC** (Fire-protection Below-deck Container),
- **CHF** (Container Hold Flooding).

The September 2021 edition replaces the requirements for surveys after construction with references to Section 7-9-30 of the *ABS Rules for Survey After Construction (Part 7)*.

The May 2022 edition of the Guide adds requirements for fixed water monitor system and fixed water spray (curtain) system in Sections 1, 2 and 8 as an alternative to mobile water monitor system indicated in Section 2.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.



GUIDE FOR

FIRE-FIGHTING SYSTEMS FOR CARGO AREAS OF CONTAINER CARRIERS

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1 Scope (1 October 2019)

This Guide identifies the required criteria for obtaining the optional notations for Container Carriers classed with ABS as follows:

- **FOC** (Fire-fighting On-deck Container),
- **FOC-R** (Fire-fighting On-deck Container – Restricted),
- **FOC+** (Fire-fighting On-deck Container Plus),
- **FOC-R+** (Fire-fighting On-deck Container – Restricted Plus).
- **CCH** (Container Carrier House/Structures),
- **FBC** (Fire protection Below-deck Container),
- **CHF** (Container Hold Flooding).

3 Application (1 October 2019)

Container Carriers provided with a fire-fighting piping system and additional fire-fighting equipment in compliance with Section 2 of this Guide will be eligible for the notation **FOC**. Container Carriers fitted with fire-fighting equipment and arrangements complying with Section 3 of this Guide will be eligible for the notation **FOC-R**. A vessel also in compliance with the enhanced requirements of Section 4 of this Guide will be eligible for either the notation **FOC+** or **FOC-R+**, as applicable.

The **FOC** notation is being offered primarily to recognize enhanced container deck firefighting capability onboard Container Carriers beyond that required by SOLAS Chapter II-2 Regulation 10 requirements [as amended by IMO Resolution MSC 365(93)].

The **FOC-R** notation is being offered primarily to recognize container deck firefighting capability onboard Container Carriers when full compliance with the **FOC** notation requirements is not practical. It is applicable to container carriers constructed either before 1 January 2016 (designed to carry any number of container tiers on deck) or those constructed after 1 January 2016 (designed to carry 4 or less tiers of containers on deck), but do provide on deck firefighting arrangements that exceed the SOLAS requirements applicable to those vessels.

The **FOC+** and **FOC-R+** notations invoke additional requirements addressing the protection of the hatch covers.

The **CCH** notation is being offered for Container Carriers that are provided with specific cooling arrangements, air monitoring, and other arrangements intended to protect crew within the

accommodations, services spaces, machinery spaces and other normally manned locations from the heat as well as smoke that may be created during a cargo fire.

The **FBC** notation is being offered for Container Carriers that are provided with enhanced fire detection, extinguishing and cooling arrangements within a container hold beyond that required by SOLAS Chapter II-2 Regulations.

The **CHF** notation is being offered to vessels with appropriate arrangements and established procedures to flood a container hold to support extinguishing a fire in the hold.

5 Definitions

5.1 Bay

A *Bay* is an athwartship block of containers associated with a hatch or hatch cover containing multiple stacks extending longitudinally between two adjacent lashing bridges or lashing stations.

5.3 Container Carrier

A *Container Carrier* is a seagoing vessel specifically designed, constructed, and equipped with the appropriate facilities to carry cargo containers. These containers are stowed in cargo spaces (i.e., in cargo holds below deck) and on hatches and cargo areas located on the weather deck. A fully cellular type carries only containers with cell-guides under deck and the necessary fittings and equipment on deck.

5.5 Container Hold (1 October 2019)

A *Container Hold* (i.e., cargo hold) is the area below the weather deck and hatch covers, if fitted, located between adjacent watertight bulkheads and intended to carry cargo containers. *Container Holds* may be arranged to carry one or more bays of containers.

5.7 Dangerous Goods

Dangerous Goods are the substances, materials, and articles covered by the International Maritime Dangerous Goods Code (IMDG Code).

5.9 Mobile Water Monitors

Mobile Water Monitors are large bore water discharge devices of portable or wheeled type, consisting of inlet fitting(s), monitor waterway, swivel fittings, and discharge nozzle.

5.11 On-deck Cargo Area

On-deck Cargo Area is the portion of the weather deck, including hatch covers, arranged with the necessary fittings and equipment to stow a number of container stacks.

5.13 Open Top Container Hold (1 October 2019)

An *Open Top Container Hold* is a container hold not fitted with hatch covers

5.15 Stack

Stack is a single vertical row of containers containing one or more tiers. Also referred to as a *row*.

5.17 Tier

Tier is an indication of the vertical position of a container in a stack. The first tier is the lowest or bottom-most position in the stack.

5.19 Water Mist Lance

A *Water Mist Lance* consists of a tube with a piercing nozzle which is capable of penetrating a container wall and producing a water mist inside the container when connected to the fire main.

7 Submission of Design Plans and Data

Plans should generally be submitted electronically to ABS. However, hard copies will also be accepted. For details, see 4-1-1/5.1 of the *ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)*.

In addition to the submission of plans according to the requirements stated in 4-1-1/5.3 and 4-7-1/7 of the *Marine Vessel Rules*, the following design plans and data are to be submitted:

7.1 FOC and FOC-R Notations (1 May 2022)

- i) Diagrammatic plans of the piping system for the fire main and the fire protection of the on-deck cargo area. These plans are to be accompanied by lists of material denoting:
 - Size, wall thickness, maximum working pressure, material and standards of all pipes
 - Type, size, pressure rating, material and standards of any fittings, valves, and fire hydrants
 - Type, capacity, pressure rating and the performance curves of pumps
- ii) Detailed specifications including operating flow rates, pressures, spray patterns and throw distance of all types of **fixed and mobile water monitors** (see **2/7.3 and 2/5.3 respectively**) and water mist lances
- iii) Detailed specifications including operating flow rates and pressure rating of the water mist lances and analysis/testing results or other information validating that the water mist lance is of a type capable of penetrating a standard container (see 2/9)
- iv) Flow rate and pressure analysis of the fire protection piping system during operations at the most hydraulically remote location
- v) Operating procedures for the fire protection system of the on-deck cargo area. As a minimum, these procedures are to include:
 - The storage location, handling and operation instructions of the mobile water monitors, hoses, fittings, and fixing hardware.
 - Arrangements showing the locations and attachment methods of the mobile water monitors for each bay
 - Storage location, handling and operation instructions of the water mist lance
 - Storage location of fire protection equipment for the crew
 - Manufacturer's operating manual for the mobile water monitors which includes information on the safe operations of the monitors
- vi) **Fixed Water spray (curtain) system (where provided)**
 - **Shadow diagram indicating spray pattern covering all the bay areas on the deck**
 - **Nozzle and piping arrangements**
 - **Diagrammatic plans of the piping system for the water-spray system. These plans are to be accompanied by lists of material giving:**
 - **Size, wall thickness, maximum working pressure, material and standards of all pipes**
 - **Type, size, pressure rating, material and standards of any fittings, valves, and spray nozzles**
 - **Type, capacity, and pressure rating of pumps**

- Flow rate and pressure analysis of the piping system
- Control arrangements

7.3 FOC+ and FOC-R+ Notations (1 May 2017)

In addition to 1/7.1, the following is to be submitted:

- i) Diagrammatic plans of the piping system for the water-spray system of 4/3.1. These plans are to be accompanied by lists of material giving:
 - Size, wall thickness, maximum working pressure, material and standards of all pipes
 - Type, size, pressure rating, material and standards of any fittings, valves, and spray nozzles
 - Type, capacity, and pressure rating of pumps
- ii) Flow rate and pressure analysis of the piping system for hatch cover.

7.5 CCH Notation (1 October 2019)

- i) List of spaces expected to be occupied by crew during a container bay fire (see 5/3.1)
- ii) Ventilation systems
 - Ventilation arrangements for occupied spaces
 - Ventilation shut down arrangements
 - Ventilation local and remote closing arrangements
- iii) Air monitoring system
 - Monitoring system, equipment, components, sensors, etc.
 - Locations of sensors
 - Alarm conditions and locations
 - Standards of construction
 - Documentation verifying compliance with Part 4, Chapter 8 and Section 4-9-9 of the *Marine Vessel Rules*.
- iv) Dedicated Assembly Space location and arrangements
- v) Water spray system
 - Shadow diagram indicating spray pattern
 - Nozzle and piping arrangements
 - Diagrammatic plans of the piping system for the water-spray system. These plans are to be accompanied by lists of material giving:
 - Size, wall thickness, maximum working pressure, material and standards of all pipes
 - Type, size, pressure rating, material and standards of any fittings, valves, and spray nozzles
 - Type, capacity, and pressure rating of pumps
 - Flow rate and pressure analysis of the piping system
 - Control arrangements
- vi) Structural fire protection arrangements for spaces to be occupied during container bay fire
- vii) Essential equipment
 - List of equipment for fighting a cargo hold fire

- Location and protection arrangements

7.7 FBC Notation (1 October 2019)

- i)* Dedicated Cargo Fire Control Station location and arrangements
- ii)* Details showing locations of all container hold openings and closure arrangements
- iii)* Container Hold standard fire detection system
- iv)* Container Hold enhanced monitoring and detection system
 - a)* Fixed Temperature Monitoring System Documentation to be Submitted
 - 1)* Standards and specifications for the equipment and sensors.
 - 2)* System details necessary to verify compliance with the capabilities and requirements identified in 6/7.5.1 and 6/7.5.2
 - 3)* Results for the tests identified in 6/7.5.3
 - 4)* Location and arrangements of the equipment, sensors and cabling within the container holds
 - 5)* Documentation from the manufacturer or a certified Fire Protection Engineer verifying:
 - The equipment and individual components (i.e., sensors, etc.) are capable of accurately monitoring the temperatures of the containers under all environmental conditions that could be expected.
 - The system and its design, including the layout and arrangements of the sensors within the container hold are suitable to monitor the container temperatures and identify elevated temperatures that may be related to a fire within a container under all environmental conditions that could be expected.
 - The system and any associated software are suitable for providing the alarm conditions and other information identified in 6/7.5.1.
 - Values and criteria for the selected high temperature alarm point(s) and temperature rate of rise alarm point(s).
 - Documentation for the system verifying compliance with the provisions of Section 4-9-3 of *the Marine Vessel Rules*, as applicable.
 - i)* Sensor calibration, calibration frequency, and functionality test plans.
 - ii)* Verification of system independence, as applicable, see 4-9-2/3.1.2 of the *Marine Vessel Rules*.
 - iii)* System/equipment documentation verifying the system is of the self-monitoring type, see 4-9-2/7.13 of the *Marine Vessel Rules*.
 - iv)* System design documentation demonstrating the system/equipment complies with fail safe principles, see 4-9-2/3.1.1, 4-9-3/5.1.8, 4-9-8/1.7.3(b).v of the *Marine Vessel Rules*.
 - b)* Smoke and Heat Detection and Monitoring System Documentation to be submitted
 - 1)* System details necessary to verify compliance with the capabilities and requirements identified in 6/7.7.1 and 6/7.7.2
 - 2)* Results for the tests identified in 6/7.7.3
 - 3)* Standards and specifications for the equipment and sensors.

- 4) Location and arrangements of the equipment, sensors and cabling within the container holds.
 - 5) Documentation from the manufacturer or a certified Fire Protection Engineer verifying:
 - The equipment and individual components (i.e., sensors, etc.) are capable of accurately monitoring for smoke and heat in the specific application under all environmental conditions that could be expected.
 - The system and its design, including the layout and arrangements of the sensors within the container hold are suitable to monitor the container hold areas identified above and detect smoke and heat that may be related to a fire within a container under all environmental conditions that could be expected.
 - The system and any associated software are suitable for providing the alarm conditions identified in 6/7.3.
 - 6) Verification that any optical detection arrangements will be suitable with the variations of light that could be expected within the container holds.
 - 7) Verification of the ability of the thermal imaging cameras to identify the location of any container(s) with elevated surface temperatures.
 - 8) Selected smoke density and high temperature alarm activation point(s) and basis for the same.
 - 9) Documentation verifying compliance with the provisions of Section 4-9-3 of the *Marine Vessel Rules*, as applicable.
 - 10) Sensor calibration, calibration frequency, and functionality test plans.
 - 11) Verification of system independence, as applicable, see 4-9-2/3.1.2 of the *Marine Vessel Rules*.
 - 12) System/equipment documentation verifying the system is of the self-monitoring type, see 4-9-2/7.13 of the *Marine Vessel Rules*.
 - 13) System design documentation demonstrating the system/equipment is complies with fail safe principles, see 4-9-2/3.1.1, 4-9-3/5.1.8, 4-9-8/1.7.3(b).v of the *Marine Vessel Rules*.
- v) Container Hold fire extinguishing system
- vi) Oxygen monitoring system
- Monitoring system, equipment, components, sensors, etc.
 - Locations of sensors
 - Standards of construction
 - Documentation verifying compliance with Part 4, Chapter 8 and Section 4-9-8 of the *Marine Vessel Rules*.
- vii) Container hold water spray system and dewatering system
- Piping and nozzle arrangements
 - Shadow diagram indicating spray patterns
 - Type, capacity, pressure rating and the performance curves of pumps
 - Diagrammatic plans of the piping system for the water-spray system. These plans are to be accompanied by lists of material giving:
 - Size, wall thickness, maximum working pressure, material and standards of all pipes

- Type, size, pressure rating, material and standards of any fittings, valves, and spray nozzles
 - Type, capacity, and pressure rating of pumps
 - Flow rate and pressure analysis of the piping system
- Dewatering arrangements
- viii)** Structural fire protection arrangements for listed spaces
- ix)** Essential systems and equipment
 - List of systems and equipment for fighting a cargo hold fire
 - Location and protection arrangements
- x)** Fire Safety Plan showing the following:
 - Radios
 - Portable thermal imaging cameras
 - Fire-fighter’s outfits – arrangements, locations, etc.
 - Portable thermometers
 - Air compressors for breathing apparatus
 - Water Lances
- xi)** Electrical Equipment
 - Location and arrangements of the electric equipment, sensors and cabling within the container holds
 - Identify the Insulation Protection Level
 - Fixed Temperature Monitoring System as identified in Section 6/7.5
 - Smoke and Heat Monitoring System as identified in Section 6/7.5
 - Oxygen (O₂) Concentration Monitoring System as identified in Section 6/9.15
 - Certified safe electrical equipment, if applicable
 - Power source distribution and alarm point list in the cargo holds

7.9 CHF Notation (1 October 2019)

- i)** Detailed arrangements and procedures for one (1) single container hold to be flooded
- ii)** List of pumps, piping, materials and any electrical systems
- iii)** Details on the controls for the filling and dewatering of the container holds
- iv)** Container hold water level indication location and details for each container hold and duct keel
- v)** Container hold filling arrangement
 - Container hold capacity
 - Fixed filling arrangements using pumps
 - Gravity flooding arrangements
 - Alternative arrangements
- vi)** Container hold dewatering arrangements for container holds
- vii)** Details on prevention of progressive flooding measures
 - Isolation arrangements

- viii)* Details on Dangerous Goods considerations
 - Piping arrangements
- ix)* Vessel structural integrity analysis information
- x)* Details on loading conditions and stability software calculation
- xi)* Details on marine casualty response center program

SECTION 2 FOC Notation

1 General (1 May 2017)

The **FOC** notation is being offered primarily to recognize enhanced container deck firefighting capability onboard Container Carriers beyond that required by SOLAS Chapter II-2 Regulation 10 requirements [as amended by IMO Resolution MSC 365(93)]. Where the optional **FOC** notation is requested, the following fire safety equipment and arrangements, which includes the basic SOLAS requirements, are to be provided.

3 Cargo Deck Area Fire Main System

3.1 General

Every vessel is to be provided with pumps, water service pipes, and hydrants complying with the provisions of this Subsection, as applicable.

3.3 Capacity (1 May 2022)

The total combined capacity of the fire pumps and fire main diameter are to be sufficient to supply the required pressure and volume for adequate and simultaneous operation of the following:

- i) Fire main system required by 4-7-3/1.5.6 of the *Marine Vessel Rules*, supplying four (4) hoses on the weather deck at the pressure identified in 2/3.5 below, equally divided between both sides,
- ii) A flow rate of water through the required number of monitors equivalent to 2.0 liters/min/m² (0.05 gal/min/ft²) times the maximum projected area of the combined faces of the largest bay (forward and aft) that could be engaged in a fire, but not less than the minimum capacity of the required monitors [see 2/5.3.iii],
- iii) A flow rate of water required by the fixed water spray (curtain) system (see 2/7.1), where installed as an alternative to the hydrants and mobile water monitors in 2/3.9 and 2/5,
- iv) A flow rate of water required by the fixed water monitor system (see 2/7.3), where installed as an alternative to the hydrants and mobile water monitors in 2/3.9 and 2/5,
- v) Water mist lance, see 2/9,
- vi) Any additional water arrangements required by 4-7-2/7.3 of the *Marine Vessel Rules* for dry cargo spaces intended to carry dangerous goods,
- vii) Any other fixed fire-fighting systems served by the fire pumps that could be expected to operate at the same time, and
- viii) If applicable, the fixed water-spray system for hatch covers, see 4/3.1.
- ix) The application of water on container bays forward and aft of a bay engaged in a fire as specified in 2/3.11

The drainage of the cargo holds is to be independent of the cargo area fire main system. Dewatering of the cargo holds by eductors supplied from the fire pumps may be used provided the available capacity is adequate to simultaneously supply all required firefighting services as well as the eductors of any two adjacent holds.

3.5 Pressure (1 August 2016)

With the combined fire pumps in operation, the system is to be capable of delivering the quantity of water necessary to simultaneously supply all required mobile water monitors at the most hydraulically remote location at the required flow rate and with the pressure necessary to reach the top tier of the containers on deck [see 2/5.3.v] along with all other fire-fighting systems and equipment identified above in 2/3.3 at their required flow rates and pressures while maintaining the following minimum pressures at all hydrants on the vessel:

- i)* Vessels of 6,000 gross tonnage and upwards: 0.27 N/mm² (2.8 kgf/cm², 40 psi)
- ii)* Vessels less than 6,000 gross tonnage: 0.25 N/mm² (2.6 kgf/cm², 37 psi)

During all possible operating scenarios, the maximum pressure at any hydrant is not to exceed that at which the effective control of a fire hose can be demonstrated.

3.7 Cargo Deck Area Fire Main Piping (1 August 2016)

The fire main piping serving the on-deck cargo area is to consist of two runs, one on each side of the vessel, traversing the length of the on-deck cargo area and located outboard of the cargo hatch area. The port and starboard lines are to be interconnected at the forward and aft ends of the vessel (i.e., loop fire main). The combined diameters of this piping are to be sufficient for the effective distribution of the discharge required by the equipment and systems identified in 2/3.3 at the required pressures from the fire pumps while operating simultaneously.

The water piping serving the cargo area is to be provided with manually operable isolation valves every 40 meters (130 feet). Also, isolation valves are to be installed adjacent to an accommodation superstructure or deck house and located before entering the on-deck cargo areas forward and aft of the superstructure or deck house. A normally closed isolation valve is to also be installed where the two fire lines connect together at the forward and aft ends of the vessel.

Drainage arrangements are to be provided to protect against freezing water damage.

3.9 Weather Deck Hydrants Arrangements (1 August 2016)

3.9.1 Number and Position

The number and position of hydrants in the cargo area are to comply with the following:

- i)* All required monitors are to be capable of operating simultaneously
- ii)* There are to be a sufficient number of hydrants immediately forward and aft of each container bay to supply the total required number of monitors; each from a separate hydrant and at least half the required number through a single 15 m (50 ft) length of fire hose.
- iii)* The locations of the hydrants are to allow the monitors to be evenly distributed along the width of the spaces between the container bays, to the extent practicable;
- iv)* At least one hydrant is to be located immediately outboard on each side of the space between the container bays. Where a lashing bridge is fitted, these hydrants are to be located on the top of the lashing bridge. The jet of water from a mobile water monitor connected to these hydrants is to be capable of reaching inboard at least two thirds the breadth of the vessel.

3.9.2 Protection of Hoses and Hydrants

Arrangements are to be provided to cool the hoses and hydrants that will be located between the container bays from the effects of the heat of the fire, unless otherwise determined to be suitable for prolonged exposure under such conditions.

3.11 Application of Water on Container Bays Forward and Aft of Bay Engaged in a Fire (1 May 2017)

3.11.1 Application (1 October 2019)

The system is to provide for the simultaneous operation of all required monitors evenly distributed between the forward and aft of any bay that could be engaged in a fire at the required capacity and pressure (refer to 3/3.5) in addition to any other system identified in 2/3.3.

3.11.2 Lashing Bridge Hoses and Hydrants (1 May 2022)

The hydrant discharge arrangements and lengths of hoses for supplying monitors on the lashing bridges are to be such that the monitors can be supplied without the need to reverse direction or create a “U” bend in the supply hose between the hydrant and the monitor. These arrangements are to consider the required number of monitors, evenly distributed across the breadth of the lashing bridges forward and aft of any bay and supplied to the extent possible by hydrants located on the lashing bridges. Hoses of less than ten (10) meters (32.8 feet) are to be marked for water monitor use only.

3.13 Relief Valves, Pipes and Hydrants

Relief valves are to comply with 4-7-3/1.5.6 of the *Marine Vessel Rules*.

Pipes and hydrants are to comply with 4-7-3/1.11.1 and 4-7-3/1.11.2 of the *Marine Vessel Rules*.

All piping, valves, and hydrants are to be suitably protected from damage and corrosion.

5 Mobile Water Monitors (1 May 2017)

5.1 Minimum Number of Mobile Water Monitors

- i) Vessels with a breadth less than 30 m (98 ft) carrying containers on the weather deck are to be provided with at least four (4) mobile water monitors.
- ii) Vessels with a breadth of at least 30 m (98 ft) but less than 45 m (147.6 ft) carrying containers on the weather deck are to be provided with at least six (6) mobile water monitors.
- iii) Vessels with a breadth of at least 45 m (147.5 ft) but less than 60 m (197 ft) carrying containers on the weather deck are to be provided with at least eight (8) mobile water monitors.
- iv) Vessels with a breadth of 60 m (197 ft) or more are to be provided with at least ten (10) mobile water monitors.

5.3 Mobile Water Monitors (1 October 2019)

Each mobile water monitor, as a minimum, is to comply with the following:

- i) Constructed of lightweight, corrosion-resistant materials.
- ii) Equipped with a coupling allowing connection to the vessel’s fire hydrants via a fire hose. The coupling and hose are to be sized for the proper flow and pressure to support the performance of the monitor.
- iii) The minimum capacity is to be 60 m³/hr (1,000 liters/min, 265 gpm) at the pressure necessary to reach the top tier of the containers on deck (see 2/5.3v below).
- iv) Capable of a minimum horizontal throw of 40 m (131 ft) at an inlet pressure of 0.4 N/mm² (4.1 kgf/cm², 58 psi), when discharging at a horizontal elevation of 30-35°.

- v) Capable of a minimum vertical throw sufficient to reach the top of the highest tier of containers when discharging at an elevation of not more than 75°.
- vi) Allows swiveling of the discharge nozzle for adjusting the throw direction of the water in both the horizontal and vertical planes, while in continuous operation. The vertical swivel range is to be 0° to 90°. If lubrication is required, external lubrication fittings are to be provided for the swivel joints.
- vii) The discharge nozzle is to be of a dual-purpose spray/jet type incorporating a shutoff and capable of discharging an effective water spray between container bays in the event of a container fire in the on-deck cargo area.
- viii) The design configuration is to minimize nozzle thrust reaction, and is to permit unattended operation once the monitor is placed in position.
- ix) Provide means for a secure/safe fixing to the vessel's weather deck, lashing bridge, or other applicable structure.
- x) Provide a carrying handle or other means for ease of transport. Monitors weighing more than 23 kg (50 lbs) are to be fitted with wheels.
- xi) Where monitors are to be used on a lashing bridge, arrangements such as davits or hoists are to be provided on the port and starboard sides of each lashing bridge to raise and lower the monitors.

The mobile water monitors, all necessary hoses, fittings, and required fixing hardware are to be kept ready for use in a location outside the cargo space area and accessible in the event of a fire in the cargo spaces.

Efficient drainage of water from deck surfaces is to be provided when the mobile water monitors are in operation.

7 Alternative Arrangements (1 May 2022)

As an alternative arrangement to the hydrants and mobile water monitors in section 2/3.9 and 2/5 respectively, a fixed water spray system or a fixed water monitor system may be accepted provided the following requirements are complied with in addition to the requirements of SOLAS Chapter II-2 Regulation 10.

7.1 Fixed Water Spray (Curtain) System (1 May 2022)

A fixed water spray (curtain) system for the protection of deckhouse, engine casing and container bays is to be provided with a flow rate of at least 2.0 liters/min/m² (0.05 gal/min/ft²) times the maximum projected area of the combined faces of the largest bay (forward and aft ends) that could be engaged in a fire. The fixed water spray (curtain) system is to be provided with both local and remote means of control due to the risk of being isolated from a fire in a container hold or on the deck.

All pipes, valves, nozzles and other fittings of the water spray system shall be corrosion resistant and are to meet the applicable requirements of *Marine Vessel Rules* 4-6-2. Specifically, for the use of stainless-steel piping, requirements of *Marine Vessel Rules* 4-6-2/3.1.2 are to be met. The material of the piping components is not to be rendered ineffective by heat. Suitable drainage arrangements are to be provided to protect the piping against freezing water damage.

Effective drainage of water from the deck surface is to be provided when the water spray system is in operation.

7.3 Fixed Water Monitor System (1 May 2022)

A fixed water monitor system is to be capable of covering the entire deck area to prevent the spreading of fire from one container bay to an adjacent container bay or deck house and engine room casing. The monitors are to be located at elevated positions on the deckhouse with adequate throw for the required coverage. The number and location of the fixed fire monitors are to be such that each uppermost tier container on the deck can be reached by at least two fixed water monitors.

The capacity of fire monitors should be such that the top tier of the containers can be cooled at a rate of at least 2 liters/m²/min. The horizontal swivel range of each monitor shall be at least 90°, with minimum coverage across the vessels center line of 30°. The angular movement in the vertical direction is determined by the required height of throw of the water jet and the elevated position of the monitors. The fixed water monitors are to be of corrosion-resistant materials and the piping is to meet the applicable requirements of *Marine Vessel Rules* 4-6-2.

In addition to the local and manual controls, each fixed water monitor should be able to be remotely operated and controlled due to the potential of smoke and toxic gas spreading caused by a fire. The foundation of the water monitors is to be designed to withstand the dynamic loads to which they may be subjected during operation.

9 Water Mist Lance (1 October 2019)

Vessels carrying containers on the weather deck are to be provided with at least one water mist lance. The water mist lance is to be of a type capable of penetrating a standard container. If one water mist lance is provided as per 5C-5-7/3.5.1 of the *Marine Vessel Rules*, no additional lance is required.

11 Fire-fighter's Breathing Apparatus (1 August 2016)

For each required breathing apparatus, four spare charges are to be provided in addition to the requirements of 4-7-3/15.5.1(b) of the *Marine Vessel Rules*.

SECTION 3 FOC-R Notation

1 General

The **FOC-R** notation is being offered primarily to recognize container deck firefighting capability onboard Container Carriers when full compliance with the **FOC** notation requirements is not practical.

It is applicable to container carriers constructed either before 1 January 2016 designed to carry any number of container tiers on deck or those constructed after 1 January 2016 designed to carry 4 or less tiers of containers on deck, but do provide on deck firefighting arrangements that exceed the SOLAS requirements applicable to those vessels. The notation is intended to recognize the additional level of fire protection being provided on such vessels and is available for all Container Carriers that comply with this section.

3 Cargo Deck Area Fire Main System

3.1 General

Every vessel is to be provided with pumps, water service pipes, and hydrants complying with the provisions of this Subsection, as applicable.

3.3 Capacity

The total combined capacity of the fire pumps and fire main diameter are to be sufficient to supply the required pressure and volume for adequate and simultaneous operation of the following:

- i) Fire main system required by 4-7-3/1 of the *Marine Vessel Rules*, supplying the minimum number of hoses required by the *Marine Vessel Rules* on the weather deck at the pressure identified in 3/3.5 below
- ii) The minimum required flow rate of water through each of the required number of monitors as specified in 3/5.3.iii,
- iii) Any other fixed fire-fighting systems served by the fire pumps that could be expected to operate at the same time
- iv) If applicable, the fixed water-spray system for hatch covers, see 4/3.1.
- v) The application of water on container bays forward and aft of a bay engaged in a fire as specified in 3/3.11

The drainage of the cargo holds is to be independent of the cargo area fire main system. Dewatering of the cargo holds by eductors supplied from the fire pumps may be used provided the available capacity is adequate to simultaneously supply all required firefighting services as well as the eductors of any two adjacent holds.

3.5 Pressure

With the combined fire pumps in operation, the system is to be capable of delivering the quantity of water necessary to simultaneously supply all required mobile water monitors at the most hydraulically remote location at the required flow rate and with the pressure necessary to reach the top tier of the containers on deck along with all other fire-fighting systems and equipment identified above in 3/3.3 at their required flow rates and pressures while maintaining the following minimum pressures at all hydrants on the vessel:

- i) Vessels of 6,000 gross tonnage and upwards: 0.27 N/mm² (2.8 kgf/cm², 40 psi)
- ii) 0.25 N/mm² (2.6 kgf/cm², 37 psi)

During all possible operating scenarios, the maximum pressure at any hydrant is not to exceed that at which the effective control of a fire hose can be demonstrated.

3.7 Cargo Deck Area Fire Main Piping

The fire main piping serving the on deck cargo area is to consist of two runs, one on each side of the vessel, traversing the length of the on-deck cargo area and located outboard of the cargo hatch area. The combined diameters of this piping are to be sufficient for the effective distribution of the discharge required by the equipment and systems identified in 3/3.3 at the required pressures from the fire pumps while operating simultaneously.

The water piping serving the cargo area is to be provided with manually operable isolation valves every 40 meters (130 feet). Also, isolation valves are to be installed adjacent to an accommodation superstructure or deck house and located before entering the on-deck cargo areas forward and aft of the superstructure or deck house.

Drainage arrangements are to be provided to protect against freezing water damage.

3.9 Weather Deck Hydrants Arrangements

3.9.1 Number and Position

The number and position of hydrants in the cargo area are to comply with the following:

- i) All required monitors are to be capable of operating simultaneously.
- ii) There are to be a sufficient number of hydrants immediately forward and aft of each container bay to supply the total required number of monitors
- iii) At least one hydrant is to be located within one (1) hose length outboard on each side of the space between the container bays. The jet of water from a mobile water monitor connected to these hydrants is to be capable of reaching inboard at least two thirds the breadth of the vessel.

3.9.2 Protection of Hoses and Hydrants

Arrangements are to be provided to cool any hoses and hydrants that may be located between the container bays from the effects of the heat of the fire, unless otherwise determined to be suitable for prolonged exposure under such conditions.

3.11 Application of Water on Container Bays Forward and Aft of Bay Engaged in a Fire

The system is to provide for the simultaneous operation of all required monitors evenly distributed between the forward and aft of any bay that could be engaged in a fire at the required capacity and pressure (refer to 3/3.5) in addition to any other system identified in 3/3.3.

3.13 Relief Valves, Pipes, Hydrants and Hoses

- i) Relief valves are to comply with 4-7-3/1.5.6 of the *Marine Vessel Rules*.
- ii) Pipes and hydrants are to comply with 4-7-3/1.11.1 and 4-7-3/1.11.2 of the *Marine Vessel Rules*.
- iii) All piping, valves, and hydrants are to be suitably protected from damage and corrosion.

- iv)* Hoses are to comply with 4-7-3/1.13 of the *Marine Vessel Rules* and be of sufficient number and size to support the arrangements identified in 3/3.11 above as well as all required hose streams.

5 Mobile Water Monitors

5.1 Minimum Number of Mobile Water Monitors

- i)* Vessels with a breadth less than 30 m (98 ft) are to be provided with at least two (2) mobile water monitors.
- ii)* Vessels with a breadth of 30 m (98 ft) and above are to be provided with at least four (4) mobile water monitors.

5.3 Mobile Water Monitors (1 October 2019)

Each mobile water monitor, as a minimum, is to comply with the following:

- i)* Constructed of lightweight, corrosion-resistant materials.
- ii)* Equipped with a coupling allowing connection to the vessel's fire hydrants via a fire hose. The coupling and hose are to be sized for the proper flow and pressure to support the performance of the monitor.
- iii)* Monitors are to have a minimum capacity of not less than 33 m³/hr (550 liters/min, 145 gpm) at the pressure necessary to reach the top tier of the containers on deck.
- iv)* Capable of a minimum horizontal throw of 40 m (131 ft) at an inlet pressure of 0.4 N/mm² (4.1 kgf/cm², 58 psi), when discharging at a horizontal elevation of 30-35°.
- v)* Allows swiveling of the discharge nozzle for adjusting the throw direction of the water in both the horizontal and vertical planes, while in continuous operation. The vertical swivel range is to be 0° to 90°. If lubrication is required, external lubrication fittings are to be provided for the swivel joints.
- vi)* The discharge nozzle is to be of a dual-purpose spray/jet type incorporating a shutoff and capable of discharging an effective water spray between container bays in the event of a container fire in the on-deck cargo area.
- vii)* The design configuration is to minimize nozzle thrust reaction, and is to permit unattended operation once the monitor is placed in position.
- viii)* Provide means to for a secure/safe fixing to the vessel's weather deck, lashing bridge, or other structure.
- ix)* Provide a carrying handle or other means for ease of transport. Monitors weighing more than 23 kg (50 lbs) are to be fitted with wheels.
- x)* Where monitors are to be used on a lashing bridge, arrangements such as davits or hoists are to be provided on the port and starboard sides of each lashing bridge to raise and lower the monitors.

The mobile water monitors, all necessary hoses, fittings, and required fixing hardware are to be kept ready for use in a location outside the cargo space area and accessible in the event of a fire in the cargo spaces.

Efficient drainage of water from deck surfaces is to be provided when the mobile water monitors are in operation.

7 Alternative Arrangements

A fixed water spray system or a combination of a fixed and mobile water monitor system may be specially considered as an alternative to the hydrants and mobile water monitors addressed above provided it is established to provide an equivalent level of protection.

9 Water Mist Lance (1 October 2019)

Vessels carrying containers on the weather deck are to be provided with at least one water mist lance. The water mist lance is to be of a type capable of penetrating a standard container. If one water mist lance is provided as per 5C-5-7/3.5.1 of the *Marine Vessel Rules*, no additional lance is required.

11 Fire-fighter's Breathing Apparatus

For each required breathing apparatus, four spare charges are to be provided in addition to the requirements of 4-7-3/15.5.1(b) of the *Marine Vessel Rules*.

SECTION 4 FOC+ and FOC-R+ Notations (1 May 2017)

1 General

Vessels complying with the requirements of Section 2 or 3, as applicable, and 4/3 are eligible for either the notation **FOC+** or **FOC-R+**, as applicable.

3 Hatch Cover Protection

3.1 Fixed Water-spray System

The water-spray system is to provide cooling to the appropriate hatch cover areas. The water-spray system is to be arranged such that:

- i)* All hatch cover areas are protected by spray nozzles incorporated into the hatch covers.
- ii)* The spray nozzles are to be appropriately distributed in the hatch cover area and arranged so as to uniformly discharge water onto the top of the hatch cover area.
- iii)* Nozzles are to be grouped into separate sections, and each section is to contain the nozzles necessary to cover the hatch cover area for a cargo bay. Each section of nozzles is to be capable of being isolated by one stop valve only. The stop valve in each section is to be readily accessible.
- iv)* The nozzles and supply piping are to be suitably protected from mechanical damage that could occur due to the handling or operation of the hatch covers or containers.
- v)* Where the nozzles and supply piping are fixed on the hatch cover, quick connect arrangements are to be provided to connect the supply piping on the hatch covers to the fixed supply piping on deck.
- vi)* The total pumping capacity is provided by at least two independently driven pumps. The pumps and the piping system are capable of maintaining the necessary pressure to provide a continuous output of water sufficient for the coverage of the hatch cover area for the largest cargo bay at the application rate specified in 4/3.1.iii.

With any one pump inoperable, the availability of water is at least 50 percent of the total capacity with adequate spray patterns on a hatch cover area .

If pumps for other fire protection systems are used, they are provided with sufficient capacity to provide pressure and volume for adequate operation of the other fire protection systems and the water-spray system, simultaneously.

- vii)* Nozzles are placed and spaced in a suitable pattern to maintain an average application rate of not less than 5 liters/min/m² (0.12 gpm/ft²) over the hatch cover area.
- viii)* All piping, valves, and nozzles are suitably protected from damage and corrosion.
- ix)* Drainage arrangements are provided to protect against freezing water damage.

- x) Efficient drainage of water from deck surfaces is provided when the water-spray system is in operation.

3.3 Novel Concepts

In lieu of 4/3.1, special consideration will be given to novel concepts such as mechanical or structural means to direct the flow of water from monitors onto the hatch cover area. Any novel concept is to comply with the application rate of 4/3.1.iii and the drainage of 4/3.1.vi.

SECTION 5

CCH Notation (1 October 2019)

1 General

The **CCH** (Container Carrier House/Structures) notation is offered for Container Carriers that are provided with specific cooling arrangements air monitoring, and other arrangements intended to protect crew within the accommodations, service spaces, machinery spaces and other normally manned locations from the heat as well as smoke that may be created during a cargo fire. Where the optional **CCH** notation is requested, the following fire safety arrangements are to be provided.

3 Manned and Essential Locations During Container Bay Fire

3.1 General

All enclosed spaces on the vessel that would be expected to be occupied or that contain equipment considered to be essential during a fire in a container bay are to be provided with the arrangements identified below. These spaces include but are not limited to the bridge, control stations, machinery spaces and the dedicated assembly space (see 5/9 below). A list identifying all such spaces on the vessel is to be developed and submitted for reference.

3.3 Positive Pressure Ventilation

The spaces identified in 5/3.1 above are to be provided with positive pressure ventilation arrangements, unless specifically prohibited elsewhere (i.e., required to have negative pressure ventilation). The ventilation arrangements are to also comply with the following:

- i)* There are to be at least two (2) different air intake points, one (1) on each side of the vessel and separated as widely as practicably possible from each other.
- ii)* Arrangements are to be provided to isolate each individual air inlet point. These controls are to be provided from within the space.
- iii)* Means are to be provided from within the space to stop and start the mechanical ventilation.
- iv)* The power for the mechanical ventilation is to be supplied from the main and emergency sources of power with suitable change-over arrangement in the event of loss of power supply.
- v)* Clear instructions identifying the locations of the intakes and the controls for their isolation arrangements are to be posted permanently on the spaces identified in 5/3.1 above, and appropriate instruction with location arrangement are to be displayed.

5 Ventilation Systems

5.1 General

The ventilation arrangements serving the spaces identified in 5/3.1 above, all other spaces on the vessel that are normally occupied (e.g., accommodations, public spaces, service spaces, etc.) and spaces containing equipment considered essential during a fire in a cargo bay are to comply with section 5.3 – 5.9 below.

5.3 Ventilation Arrangements

The air inlets, air outlets and other ventilation openings serving the spaces identified in 5/5.1 above are not to face container bay areas.

5.5 Ventilation Shutdown

- i)* Means to stop mechanical ventilation systems, other than those serving machinery spaces, are to be provided at the following locations:
 - a)* The bridge,
 - b)* One location on either side of the vessel at the entrances to the spaces from the open deck, and
 - c)* The Dedicated Cargo Fire Control Station (see Subsection 6/3), if fitted.
- ii)* Means to stop the mechanical ventilation systems serving the machinery spaces are to be provided at the main engine control station.

5.7 Closure Arrangements

All exterior openings that could allow smoke or gases to enter the spaces mentioned in 5/5.1 above are to be provided with a means of closure from a location that would not be rendered inaccessible by the heat or smoke from a fire within a container bay. The closure arrangements are to be of a design and material that would not be rendered ineffective by the heat.

5.9 Remote Means of Closure

Where the arrangements addressed in 5/5.7 above may not be able to be closed locally due to the possibility of heat or smoke from a fire within a container bay, a remote means of closure is to be provided and are to comply with the following:

- i)* The controls for the remote means of closure are to be from a location that would not be rendered inaccessible by the heat or smoke from an ongoing fire within any container bay.
- ii)* The remote means of closing is to be of a design and materials that would not be rendered ineffective by heat.
- iii)* A placard is to be placed at the controls for the closing devices that clearly identify the function and opening being served.

7 Air Monitoring

7.1 General

A fixed system capable of monitoring the oxygen (O₂), carbon monoxide (CO) and carbon dioxide (CO₂) concentrations at all ventilation inlets, exterior accesses or other openings which could allow the communication of smoke or gases into the spaces identified in 5/5.1 is to be provided.

In addition to the above, the system is to also provide monitoring of the oxygen (O₂), carbon monoxide (CO) and carbon dioxide (CO₂) concentrations of the air within the spaces identified in 5/3.1.

7.3 Alarm Conditions

The air monitoring system is to provide an audible and visual alarm if:

- i) The oxygen (O₂) concentration is below 19.5%.
- ii) The carbon monoxide (CO) concentration average exceeds 35 ppm parts per million (ppm) over an 8-hour time period (Time Weighted Average - TWA) or 200 ppm over a 15-minute time period (Short Term Exposure Limit – STEL-TWA), or as otherwise established by a recognized national or international standards.
- iii) The carbon dioxide (CO₂) concentration average exceeds 10,000 ppm parts per million (ppm) over an 8-hour time period (TWA) or 30,000 ppm over a 15-minute time period (STEL), or as otherwise established by a recognized national or international standards.

7.5 Alarm Placement

Audible and visual alarms for the air monitoring system are to be provided at the following locations:

- i) The bridge,
- ii) A continuously manned location other than the bridge. If unmanned notation applies, the second alarm may be located in the combination of (1) the engine room ACCU console and (2) the ACCU monitoring station at the Engineer's quarters. The air monitoring alarms are to have a separate visual display and a distinct sound from the fire alarm, and other alarms where fitted.
- iii) The Dedicated Assembly Space, and
- iv) The Dedicated Cargo Fire Control Station (see Subsection 6/3), if fitted.

In addition to the above, the system is to also provide an audible and visual alarm in the area or space where the condition has been detected.

7.7 Identification of Alarm Point Location

The system arrangements at the locations identified in 5/7.3 above are to provide the crew with the ability to identify the location of the sensor that has detected the alarm condition.

7.9 Standards

The system and components are to comply with recognized standards for air monitoring systems. In addition, the system design, components and installation are to comply with Part 4, Chapter 8 and Part 4, Chapter 9 of the *Marine Vessel Rules*. Documentation is to be submitted verifying the equipment and components are suitable for the service and the marine environment.

7.11 Portable Monitors

Portable means to monitor the oxygen (O₂), carbon monoxide (CO) and carbon dioxide (CO₂) concentrations in the air are to be provided on the bridge, in the dedicated assembly space and in the main machinery space.

9 Dedicated Assembly Space

9.1 Location

An assembly space is to be designated for the crew to shelter during a container bay fire when the individuals are not needed elsewhere. The arrangements for the space are to comply with the following:

- i) Be located within the structure and provide ready access to the lifeboats.
- ii) Be accessible from the other portions of the structure via enclosed corridor(s).
- iii) Not have any direct exterior openings onto the open deck that would be exposed directly to a fire in a container bay area or to allow the movement of smoke gases into the space.

- iv) Any boundaries of the space that are common with the exterior of the structure that faces a container bay area are to be constructed with a fire rating of not less than A-60 and be covered by the water spray system addressed below. Other boundaries of the space are to have a fire-rated integrity equivalent to that of a control station.

Where the vessel has multiple deck house structures that could be occupied (i.e., separate accommodations/ bridge structure and engine room structure) a Designated Assembly Space is to be provided in each structure.

9.3 Arrangements

A Dedicated Assembly Space is to be provided with the following:

- i) Means within the room to stop and start the ventilation.
- ii) Means to select the location from which the air is to be drawn (see 5/3.3.i above).
- iii) Means of communication with the bridge and the Dedicated Cargo Fire Control Station (see Subsection 6/3), if fitted.

9.5 Area

The dedicated assembly space is to have sufficient floor area for the maximum number of individuals that gather there, but in no case less than 1.0 m²/person (10.76 ft²/person).

11 Water Spray System

11.1 General

A water spray system for cooling, fire prevention and crew protection is to be provided and is to cover the following areas:

- i) The exterior boundaries of the superstructures and deckhouses containing the spaces identified in 5/5.1 above that face the container bay areas.
- ii) The locations of exposed lifeboats, life rafts and muster stations that could be exposed directly to the heat of a fire in a container bay.

11.3 Water Application Rate

The system is to be capable of a uniform distributed water application rate of at least 10 liters/min/m² (0.25 gal/min/ft²) for horizontal surfaces and 4 liters/min/m² (0.10 gal/min/ft²) for vertical surfaces. For structures having no clearly defined horizontal or vertical surfaces, the capacity of the water spray system shall not be less than the projected horizontal surface multiplied by 10 liters/min/m² (0.25 gal/min/ft²).

11.5 System Capacity

The capacity of the water spray pumps, and piping are to be capable of providing a sufficient flow rate and pressure that is needed to simultaneously cover all of the surface areas identified in 5/11.1 above that could be exposed to heat from a fire in any container bay. The supply of water is to be provided by not less than two (2) pumps.

Where the water spray system is supplied from the fire main system or fire pumps (main or emergency), the system is to be capable of simultaneously providing for the coverage identified above as well as the capacity and pressure for all other firefighting requirements supplied by that system or pump.

11.7 Nozzle and Piping Arrangements

- i) On vertical surfaces, spacing of nozzles protecting lower areas may take account of anticipated rundown from higher areas to the satisfaction of the attending Surveyor.

- ii)* Stop valves are to be fitted in the main supply line(s) of the water-spray system, at intervals not exceeding 40 m (131 ft), for the purpose of isolating damaged sections. Alternatively, the system may be divided into two or more sections that may be operated independently, provided the necessary controls are located together in a readily accessible position during any container hold fire.
- iii)* The vertical distances between water spray nozzles for the protection of vertical surfaces is not to exceed 3.7 m (12 ft).

11.9 Piping

- i)* All pipes, valves, nozzles and other fittings in the water spray systems are to be resistant to corrosion by seawater.
- ii)* Piping, fittings and related components within the cargo area (except gaskets) shall be designed to withstand 925°C (1697°F).
- iii)* The water-spray system is to be arranged with in-line filters to prevent blockage of pipes and nozzles.
- iv)* Means are to be provided to back-flush the system with fresh water.
- v)* For water spray systems in which sea water may be retained within the piping system in a stagnant or low flow condition [i.e., less than 1 m/sec (3.28 ft/sec)], there is a potential for chloride pitting and the following grades are not to be used for the piping or piping components:
 - 304 and 304L stainless steels
 - 316 and 316L stainless steels with a molybdenum content of less than 2.5%Other stainless grades when used are to be confirmed suitable for the application by the manufacturer.
- vi)* Where the water spray system will be maintained in a dry condition and the system will only be exposed to seawater during actual operations of the water spray, 316 and 316L stainless steels with a molybdenum content of less than 2.5% may be used provided there are provisions to immediately flush the system with fresh water and then dry the internal portions of the system piping and components. The requirement for flushing and drying of the system and the procedures to carry out these efforts are to be clearly posted.
- vii)* Drainage arrangements are to be provided to protect against freezing water damage.

11.11 Controls

Remote starting of the pumps supplying the water spray system and remote operation of any normally closed valves in the system are to be arranged in suitable locations outside the cargo area, adjacent to the structures being covered and readily accessible and operable in the event of fire in the cargo area. Alternatively, the controls may be located in the Designated Cargo Fire Control Room (see Subsection 6/3), if fitted or in the wheelhouse.

13 Protection for Spaces and Equipment Adjacent to Container Holds

13.1 Structural Fire Protection Arrangements

Structural boundaries of the spaces listed in 5/3.1 above, both above and below deck, that are immediately adjacent to a container bay are to be fitted with A-60 structural fire protection arrangements.

Any windows in the spaces listed in 5/3.1 above that are immediately adjacent to a container bay are to be of the “A-60” class, fixed (non-opening) type. Wheelhouse windows may be “A-0” class and non-fixed so long as they are so designed in a manner that a rapid and efficient vapor tightening of the wheelhouse can be provided.

13.3 Essential Systems and Equipment

A list of the systems and equipment considered essential during a fire in a container bay is to be developed and submitted for reference.

Equipment essential for the safe operation of the vessel as well as that for fighting a fire in a container bay are to be located at least 1 m (3.3 ft) from any bulkhead that is common with a container bay (excluding on deck equipment), unless the bulkhead is provided with water cooling arrangements which comply with the following:

- i)* The water spray coverage area is at least twice the height and width of the equipment.
- ii)* The water spray rate is at least 10 liters/min/m² (0.25 gal/min/ft²) over the coverage area.

1 General

The **FBC** (Fire-protection Below-deck Container) notation recognizes the installation of fire protection arrangements and capabilities within the container holds of Container Carriers beyond those required by SOLAS. This Section provides the criteria for the optional notation **FBC** and is intended to reduce the consequences should a fire occur in the container hold of a Container Carrier through the installation of additional detection, extinguishment and cooling measures.

3 Dedicated Cargo Fire Control Station

A location where pertinent information and arrangements necessary to identify and address a fire in a container hold is to be provided. It may be located separately or with another fire control station such as the *Fire-Fighting Station* required in 4-9-6/21.1 of the *Marine Vessel Rules*. The dedicated fire control station is to comply with section 6/3.1 and 6/3.3.

3.1 Location

The dedicated cargo fire control station is to be readily accessible to the crew on duty and in a location that will not be cut off by a fire in a container hold.

3.3 Arrangements

The dedicated cargo fire control station is to be provided with the following:

- i)* Audible and visual alarms upon activation of:
 - a)* The container hold fire detection system identified in 6/7.1 below.
 - b)* The detection of an elevated container temperature by the system addressed in 6/7.5, or the container hold smoke or heat detection system addressed in 6/7.7.
- ii)* Means to identify the container hold where fire, heat and/or smoke have been detected.
- iii)* Where the fixed temperature monitoring system addressed in 6/7.5 is installed, a display indicating the temperatures of the various containers in the container holds.
- iv)* Where the heat and smoke detection system addressed in 6/7.7 is installed, a video display to monitor the thermal cameras.
- v)* Means for the crew to manually actuate the fire extinguishing system serving the container holds.
- vi)* Indication of the oxygen (O₂) concentration(s) in holds.
- vii)* Indication of the water pressure in the container hold water spray system.
- viii)* Means of communications with the radios required in Subsection 6/15.

- ix)* A list identifying all openings to each container hold and a diagram indicating the locations of the controls for the remote closure devices required in Subsection 6/5.
- x)* Shut down arrangements for any mechanical ventilation systems serving the container holds.
- xi)* Shut down arrangements for the equipment on any refrigerated container unit in the container holds.
- xii)* Shut down of any mechanical ventilation serving the deckhouse, accommodations or superstructure.
- xiii)* Where the **CCH** notation is also to be pursued, the alarms and indications for the air monitoring system identified in Subsection 5/7.

5 Closure Arrangements of Container Hold Openings

5.1 Closure Arrangements

All openings to each container hold are to be provided with a means of closure from a point that would be readily accessible from the open deck and at a location that would not be rendered inaccessible by the heat or smoke from an ongoing fire within the container hold served.

5.3 Remote Means of Closure

Where the local closing arrangements for the openings may not be accessible due to heat or smoke concerns, remote means of closure are to be provided and are to comply with the following:

- i)* The location of the controls for the remote means of closure are to comply with 6/5.1 above.
- ii)* The remote means of closing is to be of a design and materials that would not be rendered ineffective by heat.
- iii)* A placard is to be placed at the controls for the closing devices clearly identifying the function and opening being served.

7 Fire Detection Arrangements

7.1 Standard Fire Detection System

A fire detection system complying with 4-7-3/11 of the *Marine Vessel Rules* or a sample extraction smoke detection system complying with 4-7-3/13 of the *Marine Vessel Rules* is to be installed in each container hold.

7.3 Enhanced Monitoring and Detection Arrangements

In addition to the system required in 6/7.1 above, each container hold is to also be provided with one of the systems identified in 6/7.5 or 6/7.7 below. Alternative arrangements capable of providing an equivalent level of monitoring and detection to that identified in 6/7.5 or 6/7.7 below will be specially considered.

7.5 Fixed Temperature Monitoring System

A fixed temperature measurement system capable of monitoring the temperature of at least one point on every other horizontal stringer of the container hold at least every sixty (60) seconds.

7.5.1 System Capabilities

- i)* Identify the temperature of at least one point on or in the immediate vicinity of every other horizontal stringer of the container hold to within 1.4°C (2.5°F).
- ii)* Visually indicate the temperatures of every other horizontal stringer within the hold on a display located at the designated cargo fire control station.
- iii)* Activation of an audible and visual alarm upon either of the following conditions at the designated cargo fire control station and at a continuously manned location:

- a)* A container surface temperature exceeds a designated high temperature setting or
 - b)* An unacceptable rate of rise temperature pattern occurs.
- iv)* Identify the hold and the location of the container(s) within the hold associated with the alarm condition on a display located at the designated cargo fire control station.
- v)* Where containers of different heights may be carried within a container hold, the system is to be capable of taking the same into account in identifying the temperature and location of the container.

7.5.2 System Requirements

- i)* The system is to comply with recognized national or international standards for temperature monitoring systems. Systems with arrangements or equipment not addressed by recognized national or international standards will be subject to special consideration.
- ii)* Computer-based systems where used for control, monitoring safety or internal communication systems are to comply with the provisions of Section 4-9-3 of the *Marine Vessel Rules*, as applicable.
- iii)* The system's equipment and components are to be suitable for the range of the environmental conditions that may be expected within the container holds including but not limited to water spray, humidity, variations of lighting, motion and vibration. For hazardous areas, see Subsection 6/27 below.
- iv)* Equipment in locations that could be subject to water spray systems are to be provided with at least an IP 56 level of protection.
- v)* Power, control and communication cables meet the flammability and fire resistance requirements, as applicable, see 4-8-3/9.7, 4-8-4/1.11, 4-8-4/21.17 of the *Marine Vessel Rules*.

7.5.3 Testing

The following tests are applicable:

- i)* Prototype environmental tests (see 4-9-9/13.1 of the *Marine Vessel Rules*)
- ii)* Testing in accordance with a national, international or other recognized standard (e.g. IEC 60751, ASTM E2208- 02, etc.). As there are many new technology sensors/equipment available, the designer or integrator is to propose the standard to be used for their application. Testing includes the following, unless specifically accepted otherwise:
 - a)* Insulation resistance
 - b)* Dimensional test
 - c)* Tolerance acceptance test
 - d)* Thermal response time
 - e)* Self-heating
 - f)* Dielectric strength
 - g)* Drop test
- iii)* Acceptance Tests - see 4-9-9/15.7 of the *Marine Vessel Rules*

7.7 Smoke and Heat Detection and Monitoring System

A detection system utilizing optical or thermal imaging, laser beam detection and/or other fire safety technology capable of continuously monitoring and detecting both smoke as well as elevated levels of heat within the container holds.

7.7.1 System Capabilities

The system is to provide the following:

- i)* Continuous monitoring for heat as well as smoke in the following locations:
 - a)* All portions of the overhead area of the container holds,
 - b)* All portions of open spaces within the container holds,
 - c)* Inlet or outlet points of the container holds where smoke could accumulate or pass (e.g., Access openings, vents, gaps in hatch covers, etc.), and
 - d)* Areas of refrigerated container equipment, if carried.
- ii)* Activation of an audible and visual alarm upon any of the following conditions at the designated cargo fire control station and at a continuously manned location
 - a)* Smoke obscuration value that exceeds a value established in accordance with a recognized standard.
 - b)* A temperature that exceeds a designated high temperature setting.
 - c)* An unacceptable rate of rise temperature pattern occurs.
- iii)* Identify the container hold associated with the alarm condition on a display located at the designated cargo fire control station.
- iv)* Have permanently installed thermal imaging cameras, or equivalent means, within the container holds that allow the crew in the dedicated cargo fire control station to identify the specific container(s) with elevated surface temperatures.

7.7.2 System Requirements

- i)* The system is to comply with recognized national or international standards for smoke and heat monitoring systems. Systems with arrangements or equipment not addressed by recognized national or international standards will be subject to special consideration.
- ii)* Computer-based systems where used for control, monitoring safety or internal communication systems are to comply with the provisions of Section 4-9-3 of the *Marine Vessel Rules*, as applicable.
- iii)* The system's equipment and components are to be suitable for the range of the environmental conditions that may be expected within the container holds including but not limited to water spray, humidity, variations of lighting, motion and vibration. For hazardous areas, see Subsection 6/27 below.
- iv)* Equipment in locations that could be subject to water spray systems are to be provided with at least an IP 56 level of protection.
- v)* Power, control and communication cables meet the flammability and fire resistance requirements, as applicable, see 4-8-3/9.7, 4-8-4/1.11, 4-8-4/21.17 of the *Marine Vessel Rules*.

7.7.3 Testing

The following tests are applicable:

- i)* Prototype environmental tests (see 4-9-9/13.1 of the *Marine Vessel Rules*)
- ii)* Testing in accordance with a national, international or other recognized standard (e.g., IEC 60751, ASTM E2208- 02, etc.). As there are many new technology sensors/equipment available, the designer or integrator is to propose the standard to be used for their application. Testing includes the following, unless specifically accepted otherwise:
 - a)* Insulation Resistance
 - b)* Dimensional test

- c) Tolerance acceptance test
 - d) Thermal Response time
 - e) Self-heating
 - f) Dielectric strength
 - g) Drop test
- iii) Acceptance Tests (see 4-9-9/15.7 of the *Marine Vessel Rules*)

7.9 Impact of Hold Ventilation, Environmental Conditions and Container Configurations

The selection and layout of the detection system(s) are to take into consideration the ventilation arrangements for the container holds, variations of environmental conditions, and any possible variations in the container stack configuration that could impact the effectiveness of the detection system. Any potential impacts on the detection system capabilities are to be identified and verification submitted that the finalized arrangement will be effective regardless of such conditions.

Suitable documentation is to also be submitted verifying that the above possible variations in conditions will not result in false alarms.

7.11 General Electrical Requirements

The design, construction and installation of the system are to comply with Part 4, Chapter 8 of the *Marine Vessel Rules*.

7.13 Source of Power

The detection systems are to be supplied from both the main and emergency sources of power.

7.15 Mechanical Protection

The equipment and cabling are to be located where they would not be subject to mechanical damage from handling of the containers or hatch covers. Where this is not possible, adequate mechanical protection is to be provided.

9 Fire Extinguishing for Closed Container holds – High Pressure and Low-Pressure CO₂ Total Flooding Systems

9.1 General

Closed container holds (i.e., container holds fitted with hatch covers) are to be protected by a fixed carbon dioxide (CO₂) fire extinguishing system complying with the provisions of 4-7-3/3 of the *Marine Vessel Rules* and the following:

9.3 Quantity of CO₂

- i) The quantity of CO₂ available is to be sufficient to give a minimum volume of free gas equal to 45% of the gross volume of the largest container hold.
- ii) Where small openings exist in the upper portion of the container hold that cannot be completely closed (e.g., gaps between hatch covers, coaming, etc.), an additional amount of CO₂ based on a leakage rate of 5 kg/m² (0.01 psi) of gap/min for at least thirty (30) minutes is to be added to arrive at the total quantity to be made available on board the vessel. Alternatively, detailed calculations showing that a lesser amount of CO₂ would be lost over the thirty (30) minute time period will be specially considered.

9.5 Controls

Controls for the release of the CO₂ into the container holds are to be located in the medium storage room and remotely from the designated cargo fire control station. Further, the arrangements are to comply with the following:

- i) Be readily accessible to the crew on duty and in a location that will not be cut off by a fire in any container hold.
- ii) In addition to the requirements of 4-7-3/3.3.4 of the *Marine Vessel Rules*, provide for the discharge of smaller quantities of CO₂, as may be needed to maintain a CO₂ concentration in the container hold over an extended period of time.

9.7 CO₂ Release Arrangements – Marking and Instructions

The CO₂ system release arrangements are to be simple to operate, clearly marked and provided with adequate instructions for each different release scenario. Further, where a release station has the controls necessary to release CO₂ into more than one space, CO₂ system diagram of the protected spaces and related controls is to be provided.

9.9 CO₂ Storage Room

The storage room for the CO₂ fire extinguishing medium is to be:

- i) Easily accessible and in a location that will not be cut off by a fire in a protected container hold.
- ii) In addition to the required local control within the CO₂ storage room to activate the system specified in 6/9.5 above, means are to also be provided for the crew to manually open each valve necessary to facilitate the release of CO₂ (i.e., via a handle or lever). The normal and local manual actuation positions for each such valve are to be clearly identified along with any necessary instructions and precautions needed to facilitate a safe release.

9.11 Piping and Valves

The CO₂ piping is to comply with the following:

- i) A pressure gauge is to be fitted on each CO₂ system manifold.
- ii) The piping for the fire extinguishing medium located outside the cargo spaces is to be galvanized or otherwise protected internally and externally against corrosion.
- iii) The moving parts of the CO₂ section valves are to be of corrosion-resistant materials (stainless steel or equivalent), and there is not to be any metal to metal contact between the main moving part (e.g., ball) and the valve housing of each valve.
- iv) Arrangements to safely vent any CO₂ in the manifold out to the weather.

9.13 Low Pressure CO₂ Total Flooding Systems

In addition to the above, low pressure CO₂ systems, where installed, are to be provided with the following:

9.13.1 Indication of Liquid Level

Means are to be provided for the crew to directly determine the liquid level in the CO₂ storage tank. Float indicators are not considered as being equivalent to a direct means of level indication.

9.13.2 Bypass Valves

An adequately sized manual bypass valve is to be installed at the main tank valve and at each section valve. A placard stating required time for the valve to be open for each protected space is to be posted adjacent to the bypass valves.

9.15 Oxygen (O₂) Concentration Monitoring System in Container Holds

Means are to be provided to monitor the oxygen concentration in each container hold during and after a CO₂ system discharge in order to verify that an inert atmosphere is being maintained. Accordingly, each container hold is to be fitted with an oxygen concentration monitoring system that complies with the following.

- i)* At least one oxygen (O₂) concentration sensor is to be installed in the upper portion of the container hold near each corner.
- ii)* The system is to provide an indication of the oxygen concentration at the:
 - a)* Designated cargo fire control station, and
 - b)* Other locations from which the container hold CO₂ system can be activated.
- iii)* The monitoring system, components and wiring are to comply with internationally recognized standards.
- iv)* The monitoring system, components and wiring are to comply with Part 4, Chapter 8 and Part 4, Chapter 9 of the *Marine Vessel Rules*, as applicable.
- v)* The system is to be supplied from the main and emergency sources of power.
- vi)* Where it is possible that hazardous areas may exist, see Subsection 6/27 below.

9.17 Alternative Extinguishing Medium

Arrangements associated with the use of a fire extinguishing medium other than carbon dioxide will be specially considered.

11 Below Deck Container Hold Water Spray System

11.1 General

A fixed water spray system is to be provided and is to cover each container bay in each container hold. The system is to comply with section 11.3 – 11.11.

11.3 Water Spray System Coverage

The fixed water spray system is to be capable of uniformly distributing the quantity of water specified below onto the following surfaces simultaneously:

- i)* A rate of 5 liters/min/m² (0.12 gal/min/ft²) based on the horizontal area of the container bay within the container hold. The water is to be uniformly and evenly distributed between:
 - a)* The underdeck structure immediately above the container bay.
 - b)* Underside surfaces of the portions of the hatch covers immediately above the container bay.
 - c)* The tops of all container stacks in the container bay.
- ii)* Across the forward and the aft faces of the ends of the containers in the container bay at a rate of 2 liters/min/m² (0.05 gal/min/ft²). The water is to be uniformly and evenly distributed across the following surfaces:
 - a)* The faces of the containers, if accessible.
 - b)* Where there is limited access to the faces of the containers due to their proximity to a partial bulkhead, then the water is to be uniformly and evenly distributed onto the faces of the containers at the rate mentioned above, as accessible, and the remainder of the water uniformly distributed across the width of the bulkhead and allowed to run down.

- c)* Where no access is available to the faces of the containers due to the containers being located immediately against a full height bulkhead, then the water is to be distributed across the upper portion of the bulkhead and allowed to run down.

11.5 Fixed Water-spray System Design and Arrangements

11.5.1 System Capacity

- i)* The total pumping capacity is to be provided by at least two independently driven pumps.
- ii)* The system is to be capable of providing the continuous pressure and flow rate required for the simultaneous coverage of the areas identified in 6/11.3 at the most hydraulically demanding container bay (hold).
- iii)* With any one pump inoperable, the availability of water is to be at least 50 percent of the total capacity.
- iv)* Where pumps for other fire protection systems are used, there is to be sufficient capacity to provide for the water spray system calculated for the largest designated cargo space and the adequate operation of any other fire protection systems that may be expected to operate simultaneously.

11.5.2 System Arrangements

The water spray system arrangements are to comply with the following.

- i)* The spray nozzles are to be appropriately distributed and arranged in a manner to uniformly discharge the water onto the surfaces noted in 6/11.3 above simultaneously, to the satisfaction of the attending Surveyor.
- ii)* The nozzles are to be grouped into separate sections to the satisfaction of the attending Surveyor. Each section of nozzles is to be capable of being isolated by one stop valve.
- iii)* The forward bulkhead and the aft bulkhead of each container hold are to each be supplied by a section that is separate from the other portions of the system covering the container bay.
- iv)* The stop valve for each section is to be readily accessible from outside of the container hold and in a position that would be readily accessible during a fire in the container hold.
- v)* The nozzles and supply piping are to be suitably protected from mechanical damage that could occur due to the handling or operation of the hatch covers or containers.
- vi)* Where the nozzles and supply piping are attached or installed on the hatch covers, quick connect arrangements are to be provided to connect the supply piping on the hatch covers to the fixed supply piping on deck.
- vii)* All piping, valves, and nozzles are to be suitably protected from corrosion.
- viii)* Drainage arrangements are to be provided to protect against freezing water damage.
- ix)* Where dangerous goods with flammable or toxic vapors are permitted to be carried within a hold, arrangements are to be provided so that flammable vapors cannot propagate to other spaces through the sprinkler system piping.

11.7 Open Top Container Holds

Vessels with open top container holds are to be provided with the fixed water spray system coverage identified in 6/11.3.ii as well as the arrangements identified in Section 2 of this Guide for the **FOC** notation.

11.9 Dewatering Arrangements

Container holds are to be provided with dewatering arrangements that comply with the following:

- i)* The drainage and pumping arrangements are to be such as to prevent the build-up of free surfaces. If this is not possible, the adverse effect upon the structure and the stability of the added weight and free surface of water are to be taken into account in the design of the container hold structure and in the stability of the vessel. Documentation verifying the same is to be submitted for review and approval.
- ii)* The drainage system is to be sized to remove no less than 125% of the combined discharge capacity of both the water spraying system pumps and the required number of fire hose nozzles.
- iii)* The dewatering system valves are to be operable from outside the protected space at a position that would be readily accessible during a fire in the container hold involved.
- iv)* Bilge wells are to be of sufficient holding capacity and are to be arranged at the side shell of the vessel at a distance from each other of not more than 40 m (131 ft) in each watertight compartment.
- v)* Bilge wells are to be provided with gratings or strainers that will prevent blockage of the dewatering system with debris.
- vi)* The drainage of the container holds is to be independent of the cargo area fire main system. However, dewatering of the container holds by eductors supplied from the fire pumps may be used provided the available capacity is adequate to simultaneously supply all required firefighting services as well as the eductors.
- vii)* A remote means of determining the water level in each container hold (i.e., remote water level indicator) is to be provided.
- viii)* Where dangerous goods are carried in a container hold, the dewatering arrangements are to also comply with 4-7-2/7.3.5, as applicable.

11.11 Dangerous Goods that may React Hazardously with Water

Where a container hold is designated to carry Class 4.3 Dangerous Goods or any other cargo that is known to react hazardously with water, notification of the hazard is to be posted in the designated cargo fire control station and at the valves controlling the water spray system for that container hold.

13 Additional Protection for Spaces Adjacent to Container Holds

13.1 Structural Fire Protection Arrangements

Any boundary separating a container hold from the following spaces is to be fitted with A-60 structural fire protection arrangements:

- i)* A machinery space, service space, accommodations space or any other space that may be manned.
- ii)* Any space that could be essential in fighting a fire in a container hold.
- iii)* Any tank containing combustible liquids.

13.3 Essential Equipment Arrangements

A list of the systems and equipment considered essential during a fire in a container hold is to be developed and submitted for reference.

Equipment essential for the safe operation of the vessel as well as that for fighting a fire in a container bay are to be located at least 3 m (10 ft) from any bulkhead that is common with a container bay, unless the bulkhead is provided with water cooling arrangements which comply with the following:

- i)* The water spray coverage area is at least twice the height and width of the equipment.
- ii)* The water spray rate is at least 10 liters/min/m² (0.25 gal/min/ft²) over the coverage area.

15 Communications – Radios

15.1 Number and Type

The vessel is to be provided with a minimum of ten (10) two-way portable radios of a similar type.

15.3 Installation inside Helmets

At least two (2) of the radios are to be suitable for installation inside the helmets of fire-fighter's outfits.

15.5 Relay Stations

If a radio in a container hold cannot communicate with the navigation bridge or another radio in another container hold, then stations for relaying the signals of the radios are to be provided and supplied from the emergency switchboard or self-contained battery power.

15.7 Hazardous Areas

Where hazardous areas may exist due to the carriage of dangerous goods, the portable radios are to be certified safe for use in the environment to which it may be exposed (see 5C-5-7/3.3 of the *Marine Vessel Rules*) and Subsection 6/27 below.

17 Portable Thermal Imaging Cameras

At least two (2) portable thermal imaging (i.e. heat sensitive) cameras are to be carried on board and one (1) stored at each of the lockers for the fire-fighter's outfits.

Where hazardous areas may exist due to the carriage of dangerous goods, the portable thermal imaging cameras are to be certified safe for use in the environment to which it may be exposed (see 5C-5-7/3.3 of the *Marine Vessel Rules*) and Subsection 6/27 below.

19 Fire-fighter's Outfits

19.1 Quantity

A total of at least eight (8) fire-fighter's outfits are to be provided.

Where it is anticipated that more than eight (8) individuals may be actively engaged in fighting a container hold fire at any one time, the same is to be indicated on the Fire Safety Plan and additional fire-fighter's outfits are to be provided.

19.3 Fire-fighter's Outfit

Each fire-fighter's outfit is to consist of the equipment outlined below.

19.3.1 Personal Equipment

Personal equipment as identified in Chapter 3 of the IMO International Code for Fire Safety Systems Code (FSS Code).

19.3.2 Breathing Apparatus

The breathing apparatus is to be a self-contained compressed air-operated unit. The volume of the air contained in the cylinders is to be at least 1,800 liters (475.5 gal), unless otherwise determined to be capable of supplying the fire fighter with sufficient air for at least forty-five (45) minutes.

- i) The breathing apparatus is to be fitted with an audible alarm and a visual or other device which will alert the user before the volume of the air in the cylinder has been reduced to no less than 200 liters (52.8 gal) at atmospheric pressure.
- ii) Two spare charges are to be provided for each required breathing apparatus. All air cylinders for breathing apparatus are to be interchangeable.

- iii) The total weight of one apparatus (including cylinder filled with air, valves, and mask) is not to exceed 12.0 kg (26.4 lbs).
- iv) All cylinders, apparatus, and valves are to be of the same type.
- v) An apparatus with less capacity and less weight may be accepted if it is deemed to be more suitable for the intended service and more spares are provided.

19.3.3 Lifeline

Each breathing apparatus is to be provided with a lifeline complying with Chapter 3 of the IMO Fire Safety Systems (FSS) Code.

19.5 Standards

The components of the fire-fighter's outfit are to comply with appropriate recognized standards.

19.7 Portable Thermometers

At least one (1) portable infrared thermometer is to be available for each firefighter's outfit.

Where hazardous areas may exist due to the carriage of dangerous goods, the portable infrared thermometer is to be certified safe for use in the environment to which it may be exposed (see 5C-5-7/3.3 of the *Marine Vessel Rules*) and Subsection 6/27 below.

21 Storage of Fire-fighter's Outfits

21.1 Location

The firefighter's outfits are to be evenly distributed between two storage lockers that are widely separated from each other. The storage lockers are to be clearly marked and are to have access from the open deck. The boundaries of each locker are to have at least an "A-0" fire integrity rating separating it from other spaces.

21.3 Arrangements

The arrangements of the storage lockers for the fire-fighter's outfits are to provide easy access to the equipment and be such that each piece of equipment has its own location to be stowed. The protective clothing is to be hung up and stored in a suspended position.

23 Air Compressors for Breathing Apparatus

23.1 Capacity

At least two (2) compressors suitable to fill the cylinders for the breathing apparatus are to be provided on board. The compressors are to be driven by a separate diesel engine or from the emergency power plant. Each compressor is to have a capacity of not less than 125 liters/minute (33 gpm).

23.3 Location

The compressors and associated equipment for recharging the breathing cylinders are to be suitably located in a sheltered space above main deck level of the vessel.

23.5 Air Intakes

The intakes for the air compressors are to be located so that they will draw from a source of clean air at all times, including during a fire event. The air is to be filtered after compression to eliminate compressor oil contamination.

25 Water Mist Lances

Vessels are to be provided with at least two (2) water mist lances or other effective means of penetrating the exterior of a standard container. If one water mist lance is provided as per 5C-5-7/3.5.1 of the *Marine Vessel Rules* or 2/9 or 3/9 of this Guide, only one additional lance is required.

27 Electrical Equipment

27.1 General

- i) Equipment in locations that could be subject to water spray systems are to be provided with at least an IP 56 level of protection.
- ii) The enclosures of electrical equipment installed in container holds for the dewater system as well as any other equipment of systems considered essential to fire-fighting purposes are to provide protection to IPX8 standard as defined in IEC Publication 60529 for a water head equal to the height of the space in which the electrical equipment is installed for a time duration of at least 24 hours.

27.3 Hazardous Areas

Any hazardous areas due to the carriage of containers in holds designated to carry Dangerous Goods with the potential to flammable vapors (see 5C-5-7/3 TABLE 3 references to 4-7-2/7.3.2) are to be clearly identified. Further, any system or equipment to be installed or used in that space is to be certified safe for use in that environment and the arrangements are to comply with all requirements of 4-8-4/27 of the *Marine Vessel Rules*.

SECTION 7

CHF Notation (1 October 2019)

1 Application

The **CHF** notation recognizes Container Carriers that are provided with specific arrangements to flood individual container holds for the purpose of extinguishing a fire in a container hold and for the dewatering thereafter.

3 General

3.1 Single Container Hold to be Flooded

The arrangements and procedures are to permit only one (1) single container hold to be flooded at any time. Multiple holds are not to be flooded and the same is to be clearly posted at any controls associated with the arrangements.

3.3 Machinery and Piping

Pumps, piping, materials and any electrical systems are to be in accordance with the applicable requirements of Part 4 of the *Marine Vessel Rules*.

5 Controls

Controls for the filling and dewatering of the container holds are to comply with the following:

- i)* Be located in a position that would be readily accessible during a fire in the container holds.
- ii)* Not to be rendered ineffective by the heat of a container hold fire.
- iii)* Flooding and discharge valves are to be provided with valve position indicators.
- iv)* The components, cabling, etc., of control system are to comply with any applicable requirements in Part 4 of the *Marine Vessel Rules*.

7 Water Level Indication

- i)* Each container hold is to be provided with the means to identify the level of the water in the container hold.
- ii)* The water level indicator is to be provided at the same location as the controls.
- iii)* An audible and visual alarm is to be activated at the same location as the controls when water has been detected in a container hold. A means to manually silence the audible portion of the alarm may be provided.
- iv)* An audible and visual alarm is to be activated at the same location as the controls where the water level exceeds the elevation of the main deck.

- v) Means to monitor the water level in the duct keel is to be provided.
- vi) An audible and visual alarm is to be activated at the same location as the controls when water has been detected in the duct keel.

9 Container Hold Filling Arrangements

9.1 General

Every vessel is to be provided with the arrangements necessary to safely fill each container hold with sea water.

9.3 Capacity

The arrangements are to be capable of filling the largest container hold within twenty-four (24) hours assuming 10% of the volume of the container hold is filled with containers. Each container is assumed to have a 0.7 permeability rate. Calculations verifying the same are to be submitted.

9.5 Filling Arrangements

9.5.1 General

Filling arrangements for the container holds may consist of either portable or fixed arrangements. Further, the arrangements may be either a fixed filling arrangement using pumps or a combination of flooding and filling arrangements using pumps and are to comply with the following.

9.5.2 Fixed Filling Arrangements Using Pumps

- i) Any filling arrangement using pumps is to be independent of the bilge system.
- ii) The filling arrangements may be led from the firemain and/or the ballast system provided the arrangement complies with the following:
 - a) A branch pipe is to be provided for each individual container hold.
 - b) The connection between the main and the branches are to be located outside the machinery space.
 - c) Each branch line is to be fitted with a positive closing valve as well as a temporary connection arrangement (normally removed spool piece w/ blank flanges) where the branch leaves the main.
 - d) There is to be a remote operated positive closing valve fitted at the point where the piping enters the container hold and the valve as well as the controls are not to be rendered ineffective by heat from a fire within the container hold served.
 - e) No piping that is connected to a container hold carrying dangerous goods with toxic or flammable properties is to be routed through or connected to piping from any other container hold.

9.5.3 Gravity Flooding Arrangements

Piping arrangements for gravity flooding of a container hold will be subject to special consideration.

9.5.4 Alternative Arrangements

Other filling arrangements will be specially considered.

11 Dewatering Arrangements for Container Holds

11.1 General

- i) A fixed piping arrangement to dewater each of the container holds is to be provided.

- ii) The dewatering may be performed by eductors supplied from the ballast system or the fire main system. Where the eductors are supplied from the fire main, the fire pumps are to have sufficient capacity to simultaneously supply all required firefighting services as well as the eductors of any two adjacent holds.
- iii) Arrangements are to be provided to safely discharge any contaminated water to another vessel or treatment facility.
- iv) Other arrangements will be subject to special consideration.

13 Prevention of Progressive Flooding

13.1 General

Arrangements are to be provided to prevent water from a flooded container hold from passing to any other location on the vessel during and after a container hold fire.

Accordingly, any opening or interconnection within a container hold at an elevation that when the container hold is flooded could allow water to pass to another space of the vessel is to be fitted with adequate means of isolation.

13.3 Isolation Arrangements

In addition to any other requirements, arrangements or devices intended to prevent progressive flooding such as access hatches, penetration arrangements, valves in interconnecting piping systems, etc., are to comply with the following:

- i) Not to be rendered ineffective by heat.
- ii) Capable of maintaining its watertight integrity when exposed to the maximum head of water that may exist from either side of the device.

In addition, see 4-6-4/1.5 for requirements to protect against progressive flooding.

15 Dangerous Goods

15.1 Piping Arrangements

Where a container hold is designated to carry Class 4.3 Dangerous Goods or any other cargo that is known to react hazardously with water, notification of the hazard is to be posted in location of the controls to flood the hold.

17 Vessel Structural Integrity

The hull structure of the vessel is to be evaluated in accordance with Appendix A1 and A2 of this Guide with any one container cargo hold completely or partially flooded while in any operational condition. Physical properties of steel may be altered by high temperature fires, furthermore if fires are extinguished rapidly the quenching can potentially embrittle steel.

19 Trim and Stability

19.1 Trim and Stability Analysis

It is to be demonstrated through an appropriate analysis that the vessel complies with the ABS stability requirements in Section 3-3-1 of the *Marine Vessel Rules* considering one container cargo hold completely or partially flooded.

19.3 Trim and Stability Guidance Onboard

Software for calculating the damage stability associated with an actual loading condition and actual flooding case, using direct application of user defined damage is to be provided on board.

21 Marine Casualty Response Center

The Container Carrier is to be enrolled in the Rapid Response Damage Assessment (RRDA) program or in a similar program with another IACS Classification Society.

1 Initial and Annual Surveys

1.1 FOC and FOC-R Initial Installation Survey (1 May 2022)

The arrangements and equipment referred to in Section 2 or 3 are to be examined and tested to the satisfaction of the attending Surveyor upon completion of installation. This is to include:

- i)* Water service distribution piping for the on-deck cargo area
- ii)* Hydrants for the on-deck cargo area
- iii)* **Fixed and** Mobile water monitors and fixing hardware to the ship structure
- iv)* Water mist lance

It is to be demonstrated to the satisfaction of the attending Surveyor that the total capacity of the on deck fire protection system is sufficient to provide the required pressure and volume for the simultaneous operation of:

- i)* The fire main system supplying the required number of hoses for the on-deck cargo area equally divided between both sides,
- ii)* For a bay determined by the Surveyor, all required water monitors and that each monitor's water jet reaches the vertical distance equivalent to the top tier of containers
- iii)* Water mist lance,
- iv)* Any other fixed fire-fighting system served by the fire pumps, and
- v)* If applicable, the fixed water-spray system of Subsection 4/3 **and Section 2/7.1.**

It is to be verified that sufficient spare charges required by Subsections 2/11 or 3/11 are available for each breathing apparatus in addition to those required by 4-7-3/15.5.1(b) of the *Marine Vessel Rules*.

1.3 FOC and FOC-R Annual Surveys (1 September 2021)

See 7-9-30/1.1 of the *ABS Rules for Survey After Construction (Part 7)*.

1.5 Initial Survey – CCH (1 October 2019)

The arrangements and equipment referred to in Section 5 are to be examined and tested to the satisfaction of the attending Surveyor upon completion of installation. This is to include:

- i)* Ventilation shutdown
- ii)* Ventilation closing arrangements

- iii)* Remote means of closure
- iv)* Air monitoring systems and alarms
- v)* Dedicated safe space
- vi)* Water spray system
- vii)* Controls for remote starting of pumps supplying the water spray system and remote operation of any normally closed valves in the system
- viii)* Structural fire protection arrangements
- ix)* Essential equipment arrangements

1.7 Annual Survey – CCH (1 September 2021)

See 7-9-30/3.1 of the *ABS Rules for Survey After Construction (Part 7)*.

1.9 Initial Survey – FBC (1 October 2019)

The arrangements and equipment referred to in Section 6 are to be examined and tested to the satisfaction of the attending Surveyor upon completion of installation. This is to include:

- i)* Dedicated cargo fire control station
- ii)* Closure arrangements of container hold
- iii)* Standard fire detection system
- iv)* Enhanced monitoring and detection system
- v)* CO₂ Release Arrangements – Marking and Instructions
- vi)* CO₂ storage room
- vii)* Piping and valves
- viii)* Low Pressure CO₂ Total Flooding Systems
- ix)* Carbon Dioxide (CO₂) or Oxygen (O₂) Concentration Monitoring System in Cargo Holds
- x)* Below Deck Cargo Hold Water Spray System
- xi)* Fixed Water Spray System
- xii)* Dewatering Arrangements
- xiii)* Notification of Class 4.3 Dangerous Goods or any other cargo that is known to react hazardously with water the hazard is posted in the designated cargo hold fire control station and at the valves controlling the water spray system for that hold.
- xiv)* Structural Fire Protection Arrangements
- xv)* Two-way portable radios of a similar type. A minimum of ten (10) are to be provided.
- xvi)* If a radio in a cargo hold cannot communicate with the navigation bridge or another radio in another cargo hold, then stations for relaying the signals of the radios are provided.
- xvii)* At least two (2) portable thermal imaging cameras are carried on board and one (1) stored at each of the lockers for the fire-fighter's outfits.
- xviii)* A total of at least eight (8) fire-fighter's outfits are provided. Additional fire-fighter's outfits are to be provided where the Fire Safety Plan indicates more than eight (8) individuals may be engaged in fighting a cargo hold fire at any one time.
- xix)* At least one (1) portable infrared thermometer is available for each firefighter's outfit.

- xx)** At least two (2) compressors suitable to fill the cylinders for the breathing apparatus are provided on board. The compressors are to be driven by a separate diesel engine or from the emergency power plant.
- xxi)** At least two (2) water mist lances or other effective means of penetrating the exterior of a standard container are provided.
- xxii)** Any system or equipment used or installed is to be certified safe for use in that environment.

1.11 Annual Survey – FBC (1 September 2021)

See 7-9-30/5.1 of the *ABS Rules for Survey After Construction (Part 7)*.

1.13 Initial Survey – CHF (1 October 2019)

The arrangements and equipment referred to in Section 7 are to be examined and tested to the satisfaction of the attending Surveyor upon completion of installation. This is to include:

- i)** Controls for the filling and dewatering of the cargo holds
- ii)** Flooding and discharge valves
- iii)** Water level indicators
- iv)** Dewatering arrangements for cargo holds
- v)** Arrangements for prevention of progressive flooding
- vi)** Isolation arrangements
- vii)** Piping arrangements
- viii)** Notification of Class 4.3 Dangerous Goods or any other cargo that is known to react hazardously with water the hazard is posted in the location of the controls to flood the hold.
- ix)** Trim and Stability Guidance with an actual loading condition and actual flooding case is on board
- x)** Confirmation that the Container Carrier is enrolled in the Rapid Response Damage Assessment (RRDA) program, or similar program with another IACS Classification Society.

1.15 Annual Survey – CHF (1 September 2021)

See 7-9-30/7.1 of the *ABS Rules for Survey After Construction (Part 7)*.

Boundary Structure of Flooded Container Cargo Holds (1 October 2019)

1 General

For Container Carriers with the **CHF** notation, the boundary structure of the flooded individual container cargo holds is to be verified for the flooded condition, which may be taken as the container cargo hold completely or partially filled, in accordance with this Appendix.

When the analysis is based on partially filled cargo holds, the Trim and Stability Booklet is to clearly indicate filling limits for cargo hold flooding.

3 Boundary Structure

3.1 Pressure for Flooding Condition

The pressure in flooded condition, P_f , for a completely or partially filled container cargo hold is to be calculated from the following formula:

$$P_f = \rho g(h + k_u h_d) \geq 0 \quad \text{in N/cm}^2 \text{ (kgf/cm}^2, \text{ lbf/in}^2\text{)}$$

where

ρg = specific weight of sea water, not to be taken less than 1.005 N/cm²-m (0.1025 kgf/cm²-m, 0.4444 lbf/in²-ft)

h = local coordinate in vertical direction for container cargo hold boundaries measured from the point considered to the starboard top of the completely filled container cargo hold, or to the free surface of a partially filled container cargo hold, in m (ft)

k_u = 1.0

h_d = wave induced pressure head, including force and added pressure head
 = $k_c(h \cdot a_i/g + \Delta h_i)$, m (ft)

k_c = 1.0

a_i = effective resultant acceleration, in m/sec² (ft/sec²), at the point considered, may be approximated by $0.71C_{dp}[w_v a_v + w_\ell(\ell/h)a_\ell + w_t(b/h)a_t]$

g = acceleration due to gravity
 = 9.807 m/sec² (32.2 ft/sec²)

C_{dp} = 1.0

Δh_i = added pressure head due to pitch and roll motions at the point considered, in m (ft), for bow down and starboard down as given for flooded holds on the starboard side, that extend to the top of the cargo hold coaming, refer to 5C-5-3/5.5.3(a) of the *Marine Vessel Rules* with C_ϕ and C_θ specified in A1/3.1 TABLE 1.

ℓ = length of the hold considered, in m (ft)

b = breadth of the hold considered, in m (ft)

h = height of the hold considered, in m (ft)

a_v , a_ℓ and a_t are as given in 5C-5-3/5.5.1(c) of the *Marine Vessel Rules*.

w_v , w_ℓ , and w_t are weighted coefficients, showing directions, as specified in A1/3.1 TABLE 1.

TABLE 1
Design Pressure for Plating and Longitudinals/Stiffeners

<i>Structural Member</i>	<i>Draft/Wave Heading Angle</i>	<i>Loading Pattern</i>	w_v	w_ℓ	w_t	C_ϕ	C_θ
Inner Bottom	Full Draft / 0°C	Flooded Cargo Hold and Ballast Tank Empty	0.75	0.25	0.0	-0.35	0.0
Inner Skin Bulkhead and Watertight Flat	Full Draft / 60°C	Flooded Cargo Hold and Ballast Tank Empty	0.4	0.2	0.4	-0.3	0.3
Transverse Bulkhead	Full Draft / 0°C	Flooded Cargo Hold	0.75	0.25	0.0	-0.35	0.0

3.3 Plating

In the case of container cargo hold flooding, an ultimate strength approach considering plasticity may be employed to estimate the plate thickness of the inner bottom, inner skin bulkhead, watertight flat and transverse watertight bulkhead to the corresponding pressure for flooding condition.

The net thickness of the plating t , is not to be less than:

$$t = k_1 \alpha_p s [P_f / (C_d f_y)]^{0.5} / C_d \quad \text{mm (in.)}$$

where

$$k_1 = 0.5$$

$$\alpha_p = \text{correction factor for the panel aspect ratio} \\ = 1.2 - [s / (k_2 \ell)] \text{ but not to be taken as greater than } 1.0$$

$$k_2 = 2100 \text{ (2100, 25.2)}$$

$$s = \text{spacing of longitudinal or transverse frames, in mm (in.)}$$

$$\ell = \text{unsupported span of the frame, in m (ft)}$$

$$P_f = \text{pressure for flooding condition, in N/cm}^2 \text{ (kgf/cm}^2 \text{, lbf/in}^2 \text{)}$$

$$C_d = \text{plate capacity correction coefficient}$$

$$= 1.0$$

- C_a = permissible bending stress coefficient
 = 1.0
 f_y = minimum specified yield point of the material, in N/cm² (kgf/cm², lbf/in²)

3.5 Longitudinals and Stiffeners

In the case of container cargo hold flooding, an ultimate strength approach considering plasticity may be employed to estimate section modulus of longitudinals/stiffeners on inner bottom, inner skin bulkhead, watertight flat and transverse watertight bulkhead to the corresponding pressure for the flooding condition.

The net plastic section modulus, SM_{pl} , is not to be less than:

$$SM_{pl} = kP_f s \ell^2 / (f_{bdg} C_a f_y) \quad \text{cm}^3 \text{ (in}^3\text{)}$$

where

- k = 1000 (1000, 144)
 P_f = pressure for flooding condition, in N/cm² (kgf/cm², lbf/in²)
 s = spacing of stiffener, in mm (in.)
 ℓ = unsupported span of stiffener, in m (ft)
 f_{bdg} = bending moment factor
 = $8(1 + n_s/2)$
 n_s = 2.0 for continuous stiffener or where stiffener is bracketed at both ends
 C_a = permissible bending stress coefficient
 = 0.9
 f_y = minimum specified yield point of the material, in N/cm² (kgf/cm², lbf/in²)

The associated effective breadth of plating may be taken as the spacing of stiffener.

The net plastic section modulus is to be calculated using the following formulae.

When the cross-sectional area of the attached plate exceeds the cross-sectional area of the stiffener to which the plate flange is attached, the actual net plastic section modulus, Z_p , in cm³ (cm³, in³) is given by:

$$Z_p = A_{pn} t_{pn} / (2c_4) + \frac{h_w^2 t_{wn} \sin \phi_w}{2c_4^3} + A_{fn} (h_{fc} \sin \phi_w - b_w \cos \phi_w) / c_4$$

where

- A_{pn} = net cross-sectional area of the attached plate, in cm² (cm², in²)
 t_{pn} = net attached plate thickness, in mm (mm, in.)
 h_w = height of stiffener web, in mm (mm, in.), see A1/3.5 FIGURE 1
 A_{fn} = net cross-sectional area of stiffener flange, in cm² (cm², in²)
 h_{fc} = height of stiffener measured to center of the flange area, mm (mm, in.), see A1/3.5 FIGURE 1

- b_w = distance from mid thickness plane of stiffener web to the center of the flange area, in mm (mm, in.), see A1/3.5 FIGURE 1
- c_4 = 10 (10, 1)
- h = height of stiffener, in mm (mm, in.), see A1/3.5 FIGURE 1
- t_{wn} = net web thickness, in mm (mm, in.)
= $t_w - t_c$
- t_w = gross web thickness, in mm (mm, in.), see A1/3.5 FIGURE 1
- t_c = corrosion deduction, in mm (mm, in.), to be subtracted from the web and flange thickness
- φ_w = smallest angle between attached plate and stiffener web, measured at the midspan of the stiffener, see A1/3.5 FIGURE 1. The angle w may be taken as 90 degrees provided the smallest angle is not less than 75 degrees.
- s = spacing of longitudinal or transverse frames, in m (m, in.)

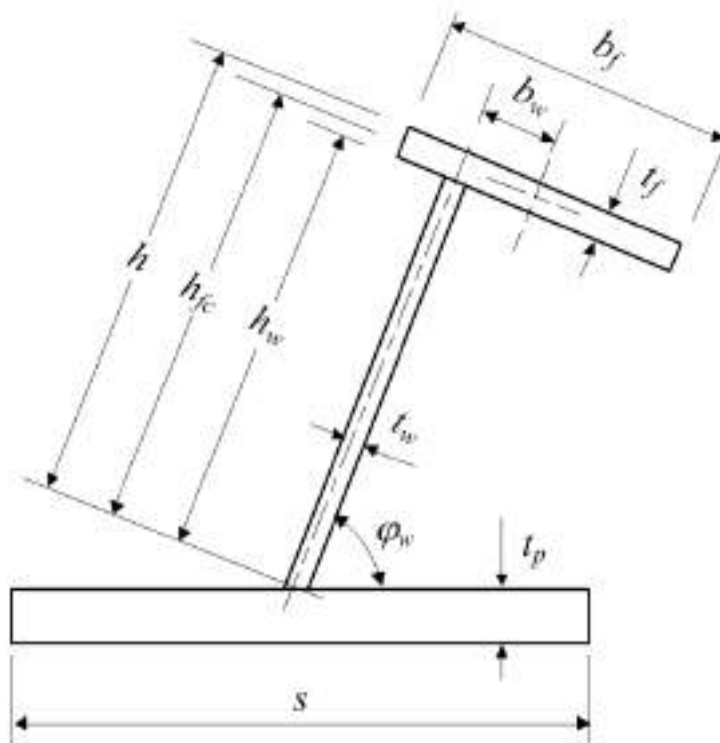
When the cross-sectional area of the stiffener exceeds the cross-sectional area of the attached plate, the plastic neutral axis is located a distance z_{na} , in mm (mm, in.), above the attached plate, given by:

$$z_{na} = (c_4^2 A_{fn} + h_w t_{wn} - c_4^3 t_{pn} s) / (2 t_{wn})$$

and the net plastic section modulus, Z_p , in cm^3 (cm^3 , in^3) is given by:

$$Z_p = t_{pn} s (z_{na} + t_{pn} / 2) \sin \varphi_w + \left[\frac{[(h_w - z_w)^2 + z_{na}^2] t_{wn} \sin \varphi_w}{2 c_4^3} + A_{fn} [(h_{fc} - z_{na}) \sin \varphi_w - b_w \cos \varphi_w] / c_4 \right]$$

FIGURE 1
Stiffener Geometry



3.7 Main Supporting Members

The strength evaluation of horizontal girders and vertical webs on the watertight bulkhead may be performed using a finite element model in conjunction with pressure for flooding condition specified in A1/3.7 TABLE 2 and the corresponding permissible bending and shear stresses in the following:

- i) Nominal shear stresses in member web plates to be less than $f_y/\sqrt{3}$
- ii) Von-mises stresses in member flanges to be less than $1.15f_y$

Recognized structural modeling and calculation methods are to be applied, with detailed requirements agreed upon with ABS.

If openings in the webs of main supporting members are not modelled in the finite element analysis, the element shear stress in way of the openings is to be corrected for loss in shear area.

Alternatively, the strength of main supporting members on the watertight bulkhead may be verified by plastic analysis with the detailed method agreed upon with ABS and a safety factor of 1.2.

For boundaries between cargo holds and engine room, main supporting members are to be verified to the flooding pressure specified for inner bottom in A1/3.1.

TABLE 2
Design Pressure for Main Supporting Members

<i>Structural Member</i>	<i>Draft/Wave Heading Angle</i>	<i>Loading Pattern</i>	w_v	w_ℓ	w_t	C_ϕ	C_θ
Horizontal Webs and Vertical Girders on Transverse Watertight Bulkhead	Full Draft / 0°C	Flooded Cargo Hold	0.4	0.2	0.0	-0.3	0.0

Longitudinal Strength of Container Carriers in Flooded Condition*(1 October 2019)***1 General**

For Container Carriers with the **CHF** notation, the hull girder strength is to be verified for specified flooded conditions. The hull girder strength in the elastic range is acceptable, provided that the hull girder ultimate residual strength is satisfactory for specified flooded conditions with the design limit specified in Appendix A2 of the *ABS Guide for Application of Higher Strength Hull Structural Thick Steel Plates in Container Carriers*.

3 Flooding Conditions**3.1 Floodable Holds**

Each container hold is to be considered individually flooded, which may be taken up to the top of the container hold or partially filled.

When the analysis is based on partially filled cargo holds, the Trim and Stability Booklet is to clearly indicate filling limits for cargo hold flooding.

3.3 Loads

The still water loads in the flooded conditions are to be calculated for the above cargo loading conditions.

The wave loads in the flooded condition are assumed to be equal to 85% of those given in 3-2-1/3.5 of the *Marine Vessel Rules*.

3.5 Flooding Criteria

To calculate the weight of flooded water, the following assumption is to be made:

- The permeability of container hold is to be taken as 0.7 and there is no loss of container weight due to fire.

5 Strength Assessment**5.1 General**

For boundary structure of flooded container cargo hold, the requirements of local panel bending, t_1 and t_2 , and section modulus specified in 5C-5-4/9.3.2, 5C-5-4/9.5, 5C-5-4/19.5 and 5C-5-4/19.7 of the *Marine Vessel Rules* are to be verified to the flooding pressure in A1/3.1. Where panels and stiffeners on the boundary of the flooded container cargo hold are unsatisfactory for the requirements, the panels and

stiffeners are assumed to be yielded and the yielded panels and stiffeners are to be removed from the calculation of hull girder strength and ultimate residual strength.

For the requirements of the longitudinal bulkhead plating in 5C-5-4/19.5 of the *Marine Vessel Rules*, the permissible bending stress is to be obtained from the following:

$$\begin{aligned} f_1 &= 1.1[1.0 - 0.33(z/B) - 0.52\alpha_1(SM_{RB}/SM_B)(y/y_n)]S_m f_y && \text{below neutral axis} \\ &= 1.1[1.0 - 0.33(z/B) - 0.52\alpha_2(SM_{RD}/SM_D)(y/y_n)]S_m f_y && \text{above neutral axis} \\ f_2 &= 0.9S_m f_y \end{aligned}$$

where z , B , α_1 , α_2 , SM_{RB} , SM_B , SM_{RD} , SM_D , y , y_n , S_m and f_y are as defined in 5C-5-4/19.1 of the *Marine Vessel Rules*.

For hull girder ultimate residual strength, maximum wave-induced bending moment, M_w is to be calculated in accordance with 5C-5-3/5.1.1 of the *Marine Vessel Rules* with $k_w = 1.0$ for wave hogging bending moment and $k_w = 1.25$ for wave sagging bending moment.

5.3 Stress Calculation

For strength evaluation, the hull structure is to be assumed to remain fully effective in resisting the applied loading. The actual hull girder bending stress, s_{bf} , in kN/cm^2 (tf/cm^2 , Ltf/in^2) at any location is given by:

$$\sigma_{bf} = (M_{swf} + 0.85M_w) / SM$$

where

M_{swf} = still water bending moment, in kN-m (tf-m , Ltf-ft), in the flooded condition for the section under consideration

M_w = wave bending moment, in kN-m (tf-m , Ltf-ft), as given in 3-2-1/3.5.2 of the *Marine Vessel Rules* for the section under consideration

SM = gross hull girder section modulus, in $\text{cm}^2\text{-m}$ ($\text{in}^2\text{-ft}$) for the section under consideration

The shear strength of the side shell and inner hull at any location of vessel, is to be checked according to the requirements specified in 3-2-1/3.9 of the *Marine Vessel Rules* in which F_{sw} and F_w are to be replaced respectively by F_{swf} and F_{wf} , where:

F_{swf} = still water shear force, in kN (tf , Ltf), in the flooded conditions for the section under consideration

F_w = wave shear force, in kN (tf , Ltf), as given in 3-2-1/3.5.3 of the *Marine Vessel Rules* for the section under consideration

$$F_{wf} = 0.85F_w$$

The still water shear force, F_{swf} may be modified in accordance with 3-2-1/3.9.3 of the *Marine Vessel Rules* to account for the loads transmitted through the double bottom structure to the side shell through the transverse bulkhead.

5.5 Strength Criteria

The calculated hull girder bending and shear stresses are not to be exceed the value given below:

in bending: f_{bf}

in shear: $k_a f_{sf}$

where

$$f_{bf} = 17.5/Q \text{ kN/cm}^2 (1.784/Q \text{ tf/cm}^2, 11.33/Q \text{ Ltf/in}^2)$$

$$f_{sf} = 11.0/Q \text{ kN/cm}^2 (1.122/Q \text{ tf/cm}^2, 7.122/Q \text{ Ltf/in}^2)$$

$$k_a = 1.1 \text{ for flooded container cargo hold area}$$

$$= 1.0 \text{ for other intact areas}$$

Q is as defined in 3-2-1/5.5 of the *Marine Vessel Rules*.