



ANALYSIS OF THE
REQUIREMENTS FOR SAFETY
SYSTEMS AND EQUIPMENT ON
RO-RO-CAR DECKS
Work Package 4.1

ALBERO Project

Institut für Sicherheitstechnik/Schiffssicherheit e.V.

WP 4.1 Analyses of the Requirements for Safety Systems and Equipment on Ro-Ro Car Decks

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Introduction

Commercial vessels are basically classified by SOLAS and other regulations into passenger ships and cargo ships. Further subdivisions are found in one of these categories. Ships in which vehicles are transported are found in both categories. For example, ships generally referred to as ferries fall into the category "passenger ship", sub-classification "ro-ro passenger ship (ro-pax)", due to their ability to carry passengers too, whereas ro-ro ships are found in the category "cargo ship" due to the fact that they only carry rolling cargo as their cargo without being able to take on passengers.

The designation of the spaces and decks where vehicles are transported depends very much on the shape of these spaces. By definition, there are, for example, ro-ro cargo spaces, vehicle spaces and special spaces, and they can be open or closed. For example, rules for vehicle spaces affect passenger or cargo ships whenever such a defined space is existing. Conversely, rules for passenger vessels may also affect vehicle stowage areas when vehicles are stowed on a passenger vessel. If vehicles are transporting dangerous goods, rules applicable to these must also be applied.

If the specifications listed here are not directly related to ro-ro traffic, they are listed to provide an example of the status quo for considerations of feasible specification adoptions or adaptations.

Relevant definitions according to SOLAS:

English

German

Chapter II-2 Regulation 3 Definitions For the purpose of this chapter, unless expressly provided otherwise, the following definitions shall apply:	Kapitel II-2 Regel 3 Begriffsbestimmungen Im Sinne dieses Kapitels haben, soweit nicht ausdrücklich etwas anderes bestimmt ist, die nachstehenden Ausdrücke folgende Bedeutung:
5 <i>Bulkhead deck</i> is the uppermost deck up to which the transverse watertight bulkheads are carried.	Schottendeck ist das oberste Deck, bis zu dem die wasserdichten Querschotte hinaufgeführt sind.
6 <i>Cargo area</i> is that part of the ship that contains cargo holds, cargo tanks, slop tanks and cargo pump-rooms including pump-rooms, cofferdams, ballast and void spaces adjacent to cargo tanks and also deck areas throughout the entire length and breadth of the part of the ship over the above-mentioned spaces.	Ladungsbereich ist der Teil des Schiffes, der Laderäume, Ladetanks, Slop tanks und Ladepumpenräume einschließlich der an Ladetanks angrenzenden Pumpenräume, Kofferdämme, Ballast- und Leerräume umfasst, sowie auch Deckbereiche auf der ganzen Länge und Breite des Teils des Schiffes, der sich über den genannten Räumen befindet.
7 <i>Cargo ship</i> is a ship as defined in regulation I/2 (g). [(g) A cargo ship is any ship which is not a passenger ship.]	Frachtschiff ist jedes Schiff, welches kein Fahrgastschiff ist.
8 <i>Cargo spaces</i> are spaces used for cargo, cargo oil tanks, tanks for other liquid cargo and trunks to such spaces.	Laderäume sind alle Räume, die für Ladung benutzt werden (einschließlich der Ladeöltanks und Tanks für andere flüssige Ladung), sowie die Schächte zu diesen Räumen.
12 <i>Closed ro-ro spaces</i> are ro-ro spaces which are neither open ro-ro spaces nor weather decks.	Geschlossene Ro-Ro-Laderäume sind Ro-Ro-Laderäume, die weder offene Ro-Ro-Laderäume noch Wetterdecks sind.

<p>13 <i>Closed vehicle spaces</i> are vehicle spaces which are neither open vehicle spaces nor weather decks.</p>	<p>Geschlossene Fahrzeigräume sind Fahrzeigräume, die weder offene Fahrzeigräume noch Wetterdecks sind.</p>
<p>35 <i>Open ro-ro spaces</i> are those ro-ro spaces that are either open at both ends or have an opening at one end, and are provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides.</p>	<p>Offene Ro-Ro-Laderäume sind Ro-Ro-Laderäume, die entweder an beiden Enden offen sind oder die an einem Ende offen sind und durch dauerhafte Öffnungen in der Seitenbeplattung, der Decke oder von oberhalb verteilte Öffnungen, deren Gesamtfläche mindestens 10 % der gesamten Seitenflächen des Raumes beträgt, mit einer über ihre ganze Länge wirkenden, angemessenen natürlichen Lüftung versehen sind.</p>
<p>36 <i>Open vehicle spaces</i> are those vehicle spaces either open at both ends, or have an opening at one end and are provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides.</p>	<p>Offene Fahrzeigräume sind Fahrzeigräume, die entweder an beiden Enden offen sind oder die an einem Ende offen sind und durch dauerhafte Öffnungen in den Seitenbeplattung, der Decke oder von oberhalb verteilte Öffnungen, deren Gesamtfläche mindestens 10 % der gesamten Seitenflächen des Raumes beträgt, mit einer über ihre ganze Länge wirkenden, angemessenen natürlichen Lüftung versehen sind.</p>
<p>37 <i>Passenger ship</i> is a ship as defined in regulation 1/2(f). [(f) <i>A passenger ship</i> is a ship which carries more than twelve passengers.]</p>	<p>Passagierschiff ist ein Seeschiff, das mehr als zwölf Passagiere befördert.</p>
<p>39 <i>Public spaces</i> are those portions of the accommodation which are used for halls, dining rooms, lounges and similar permanently enclosed spaces.</p>	<p>Gesellschaftsräume sind diejenigen Teile der Unterkunftsräume, die als Hallen, Speiseräume, Salons und ähnliche, ständig abgegrenzte Räume Verwendung finden.</p>
<p>41 <i>Ro-ro spaces</i> are spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.</p>	<p>Ro-Ro-Laderäume sind Räume, die normalerweise in keiner Weise unterteilt sind und die sich entweder über einen erheblichen Teil der Länge oder über die Gesamtlänge des Schiffes erstrecken und bei denen Kraftfahrzeuge mit flüssigem Brennstoff für ihren Eigenantrieb in den Tanks und/oder Güter (verpackt oder als Massengut in oder auf Schienen- oder Straßenfahrzeugen — einschließlich Straßentankwagen oder Eisenbahn-Kesselwagen —, Trailern, Containern, Paletten, abnehmbaren Tanks oder in oder auf ähnlichen Beförderungsmitteln oder anderen Behältern) normalerweise in horizontaler Richtung ge- oder entladen werden können.</p>
<p>42 <i>Ro-ro passenger ship</i> means a passenger ship with ro-ro spaces or special category spaces.</p>	<p>Ro-Ro-Fahrgastschiff ist ein Fahrgastschiff mit Ro-Ro-Frachträumen oder Sonderräumen.</p>
<p>45 <i>Service spaces</i> are those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, storerooms, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.</p>	<p>Wirtschaftsräume sind Küchen, Pantrys mit Kocheinrichtungen, Abstellräume, Post- und Verschlussräume, Vorratsräume, Werkstätten, die nicht Teil der Maschinenräume sind, und ähnliche Räume sowie die Schächte zu diesen Räumen.</p>

<p>46 <i>Special category spaces</i> are those enclosed vehicle spaces above and below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be accommodated on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.</p>	<p>Sonderräume sind geschlossene Fahrzeugräume über oder unter dem Schottendeck, in die und aus denen Fahrzeuge gefahren werden können und zu denen Fahrgäste Zutritt haben. Sonderräume können unter der Voraussetzung, dass die gesamte lichte Höhe für Fahrzeuge 10 Meter nicht überschreitet, mehr als ein Deck umfassen.</p>
<p>49 <i>Vehicle spaces</i> are cargo spaces intended for carriage of motor vehicles with fuel in their tanks for their own propulsion.</p>	<p>Fahrzeugräume sind Laderäume, die für die Beförderung von Kraftfahrzeugen mit flüssigem Brennstoff für ihren Eigenantrieb in ihren Tanks bestimmt sind.</p>
<p>50 <i>Weather deck</i> is a deck which is completely exposed to the weather from above and from at least two sides.</p>	<p>Wetterdeck ist ein Deck, das nach oben hin und auf mindestens zwei Seiten völlig dem Wetter ausgesetzt ist.</p>
<p>56 <i>Vehicle carrier</i> means a cargo ship which only carries cargo in ro-ro spaces or vehicle spaces, and which is designed for the carriage of unoccupied motor vehicles without cargo, as cargo. (Replaced by Res.MSC.421(98))</p>	<p>Fahrzeugtransportschiff ist ein Frachtschiff mit Ro-Ro-Räumen auf mehreren Decks, das für die Beförderung von leeren Personenkraftwagen und Lastkraftwagen als Ladung gebaut ist.</p>

Technical Requirements / Installation in General

SOLAS II-1 D 45.5.3 Ro-Ro Passenger Ships

In ro-ro passenger ships cabling for emergency alarms and public address systems installed shall be approved by the administration having regard to IMO recommendation MSC.1/Circ.808.

Structural Requirements

SOLAS II-2 C 9.2.2.1.1 Passenger Ships

In ships carrying more than 36 passengers, the hull, superstructure and deckhouses shall be subdivided into main vertical zones by "A-60" class divisions.

In ships carrying not more than 36 passengers, the hull, superstructure and deckhouses in way of accommodation and service spaces shall be subdivided into main vertical zones by "A" class divisions.

SOLAS II-2 C 9.2.2.1.5 Passenger Ships designed for Special Purposes

On ships designed for special purposes, such as automobile or railroad car ferries, where the provision of main vertical zone bulkheads would defeat the purpose for which the ship is intended, equivalent means for controlling and limiting a fire shall be substituted and specifically approved by the Administration. Service spaces and ship stores shall not be located on ro-ro decks unless protected in accordance with the applicable regulations.

However, in a ship with special category spaces, such spaces shall comply with the applicable provisions of regulation 20 and where such compliance would be inconsistent with other requirements for passenger ships specified in this chapter, the requirements of regulation 20 shall prevail.

SOLAS II-2 C 9.2.2.3/9.2.2.4 Passenger Ships

For subdivisions within a main vertical zone, the fire integrity requirements are stated in the following regulations depending on the general risk of the fire load when subdivisions have been determined and utilized:

Fire integrity of bulkheads and decks in ships carrying more than 36 passengers
Reference Table 9.1 und 9.2

Fire integrity of bulkheads and decks in ships carrying not more than 36 passengers
Reference Table 9.3 und 9.4

SOLAS II-2 C 9.2.3(.3) Cargo Ships

Fire integrity of bulkheads and decks in cargo ships other than tankers
Reference Table 9.5 und 9.6

Ventilation / Ventilation Installation

SOLAS II-2 C 9.7.2-9.7.5 Any Ships

The ventilation systems for, among others, vehicle spaces, ro-ro spaces, special category spaces and cargo spaces shall, in general, be separated from each other and from the ventilation systems serving other spaces.

Ventilation for vehicle spaces, ro-ro spaces or special category spaces and ventilation for accommodation areas, service spaces or control stations shall not pass through the other unless they meet specific criteria described in SOLAS Regulations 9.7.4 and 9.7.5. In general, they must be made of steel and have fire dampers with suitable controls in addition to certain material thicknesses, cross-sectional areas, or heavy insulation, such as supports and stiffeners. If ventilation is not routed through, but along the respective other area in the case of shared use of partitions, these must comply with special insulation criteria.

Fire Suppression Systems

SOLAS II-2 C 10.2.1.5 Any Ships

The number and position of hydrants shall be such that at least two jets of water not emanating from the same hydrant, one of which shall be from a single length of hose, may reach any part of the ship normally accessible to the passengers or crew while the ship is being navigated and any part of any cargo space when empty, any ro-ro space or any vehicle space in which latter case the two jets shall reach any part of the space, each from a single length of hose. Furthermore, such hydrants shall be positioned near the accesses to the protected spaces.

Escape Routes and Means of Escape

SOLAS II-2 D 13.5.1/13.5.2 Passenger Ships

For the purpose of determining means of escape on passenger ships from special category spaces and open ro-ro spaces to which passengers being carried may have access, the following regulations, among others, shall apply:

In special category spaces and open ro-ro spaces to which passengers being carried may have access, the number and location of escape routes both below and above the bulkhead deck shall meet the satisfaction of the Administration. Basic safety for access to the embarkation deck is regulated by other SOLAS paragraphs. In the above mentioned spaces, marked traffic routes leading to the escape routes must be provided with a width of at least 600 mm. The parking arrangement of the vehicles must be such that the traffic routes are kept clear at all times. At least one of the escape routes from frequently occupied engine rooms must not lead directly to a special category space.

SOLAS II-2 D 13.6 Any Ships (with Ro-Ro Spaces)

Means of escape from ro-ro spaces in which the crew is normally employed shall have at least two escape routes. The means of escape shall provide safe escape to the lifeboat and liferaft embarkation decks and shall be located at the fore and aft ends of the space.

Carriage of Dangerous Goods – Fire Suppression Systems, Fire Protection

SOLAS II-2 G 19.3.1-19.3.3 Any Ships

If dangerous goods are carried the immediate availability of extinguishing water must be ensured by keeping the extinguishing water pipe under water pressure at all times or by suitable remote starting devices for the fire pumps. The quantity of water delivered shall be capable of supplying four nozzles in accordance with regulation 10.2 and it shall be possible to reach any part of the empty hold. The quantity of water may also be provided by equipment to the satisfaction of the Administration as being comparable to the following.

It must be possible to cool the cargo space with at least 5l/m² of water by spraying nozzles or by flooding in the horizontal area. The bilge capacity must be 125% of the extinguishing water delivery capacity. Instead of the previously specified flooding, an extinguishing agent particularly suitable for this purpose can also be used below deck.

Potential sources of ignition such as electrical equipment and wiring shall not be installed in enclosed cargo spaces or vehicle compartments unless, in the opinion of the Administration, they are necessary for operational purposes. However, if electrical equipment is present in such spaces, it shall be of a type of explosion protection approved for use in hazardous environments to which it may be exposed; unless it is possible to completely disconnect the electrical system (by removing connections in the system, not by removing fuses). Cable penetrations in decks and bulkheads shall be sealed against the passage of gases and vapors. Cables passing through and inside cargo holds

must be protected against mechanical damage. Other equipment that may form a source of ignition for flammable vapors is not permitted.

In ro-ro spaces, there shall be a fixed fire detection and fire alarm system that complies with the provisions of the Fire Safety Systems Code. In all other types of cargo spaces, there shall be either a fixed fire detection and fire alarm system or an exhaust smoke detection system complying with the provisions of the Fire Safety Systems Code. Where an exhaust smoke detection system is provided, special attention shall be paid to paragraph 2.1.3 of chapter 10 of the Fire Safety Systems Code to prevent the entry of toxic fumes into areas where persons are present.

SOLAS II-2 G 19.3.9 Any Ships

When carrying dangerous goods an approved fixed pressure water spray system with manual release shall be provided in each open ro-ro space over which a deck is located and in each enclosed ro-ro space that cannot be sealed, to protect all decks and vehicle platforms in that space; however, a fixed fire extinguishing system tested to be equally effective may be permitted for use by the Administration. Bilge and pump arrangements shall be capable of preventing the formation of free surfaces. The drainage system shall be sized to remove no less than 125% of the combined capacity of both the water spraying system pumps and the required number of fire hose nozzles. [...]

Carriage of Dangerous Goods – Ventilation

SOLAS II-2 G 19.3.4 Any Ships

When carrying dangerous goods in enclosed cargo spaces adequate power ventilation shall be provided. The arrangement shall be such as to provide for at least six air changes per hour in the cargo space based on an empty cargo space and for removal of vapours from the upper or lower parts of the cargo space, as appropriate. The fans shall be such as to avoid the possibility of ignition of flammable gas air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings.

Carriage of Dangerous Goods – Separation

SOLAS II-2 G 19.3.8 Any Ships

When carrying dangerous goods bulkheads forming boundaries between cargo spaces and machinery spaces of category A shall be insulated to "A-60" class standard, unless the dangerous goods are stowed at least 3 m horizontally away from such bulkheads. Other boundaries (e.g. decks) between such spaces shall be insulated to "A-60" class standard.

SOLAS II-2 G 19.3.10 Any Ships

A separation shall be provided between a closed ro-ro space and an adjacent open ro-ro space. The separation shall be such as to minimize the passage of dangerous vapours and liquids between such

spaces. Alternatively, such separation need not be provided if the ro-ro space is considered to be a closed cargo space over its entire length and shall fully comply with the relevant special requirements of this regulation.

A separation shall be provided between a closed ro-ro space and the adjacent weather deck. The separation shall be such as to minimize the passage of dangerous vapours and liquids between such spaces. Alternatively, a separation need not be provided if the arrangements of the closed ro-ro spaces are in accordance with those required for the dangerous goods carried on adjacent weather deck.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 1 General Requirements

SOLAS II-2 G 20.1 Any Ships

The purpose of this regulation is to provide additional safety measures in order to address the fire safety objectives of this chapter for ships fitted with vehicle, special category and ro-ro spaces. For this purpose, the following functional requirements shall be met:

- .1 fire protection systems shall be provided to adequately protect the ship from the fire hazards associated with vehicle, special category and ro-ro spaces;
- .2 ignition sources shall be separated from vehicle, special category and ro-ro spaces; and
- .3 vehicle, special category and ro-ro spaces shall be adequately ventilated.

SOLAS II-2 G 20.2 Any Ships

In addition to complying with the requirements of SOLAS II-2 Parts B, C, D and E, as appropriate, vehicle, special category and ro-ro spaces shall comply with the requirements of this regulation.

On all ships, vehicles with fuel in their tanks for their own propulsion may be carried in cargo spaces other than vehicle, special category or ro-ro spaces, provided that all the following conditions are met:

- .1 the vehicles do not use their own propulsion within the cargo spaces;
 - .2 the cargo spaces are in compliance with the appropriate requirements of regulation 19; and
 - .3 the vehicles are carried in accordance with the IMDG Code, as defined in regulation VII/1.1.
- By these measures the vehicles become equivalent to general goods being transported.

SOLAS II-2 G 20.2.2 Passenger Ships

The basic principle underlying the provisions of this regulation is that the main vertical zoning required by regulation 9.2 may not be practicable in vehicle spaces of passenger ships and, therefore, equivalent protection must be obtained in such spaces on the basis of a horizontal zone concept and by the provision of an efficient fixed fire suppression system. Based on this concept, a horizontal zone for the purpose of this regulation may include special category spaces on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m. Basically this also applies to ro-ro spaces.

The requirements of ventilation systems, openings in "A" class divisions and penetrations in "A" class divisions for maintaining the integrity of vertical zones in this chapter shall be applied equally to decks and bulkheads forming the boundaries separating horizontal zones from each other and from the remainder of the ship.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 2 Ventilation Systems

SOLAS II-2 G 20.3.1 Passenger Ships / Cargo Ships

Precautions against ignition of flammable vapors in enclosed vehicle spaces, enclosed ro-ro spaces and special spaces by ventilation systems:

Power of ventilation systems - there shall be provided an effective power ventilation system sufficient to give at least the following air changes:

passenger ships with special category spaces - 10 air changes per hour

passenger Ships with closed ro-ro and vehicle spaces other than special category spaces for ships carrying more than 36 passengers - 10 air changes per hour

passenger ships with closed ro-ro and vehicle spaces other than special category spaces for ships carrying not more than 36 passengers - 6 air changes per hour

cargo ships - 6 air changes per hour

The Administration may require an increased number of air changes when vehicles are being loaded and unloaded.

In passenger ships, the power ventilation system shall be separate from other ventilation systems.

The power ventilation system shall be operated to give at least the number of air changes previously required at all times when vehicles are in such spaces, except where an air quality control is provided. Ventilation ducts serving such cargo spaces capable of being effectively sealed shall be separated for each such space. The system shall be capable of being controlled from a position outside such spaces.

In cargo ships, the ventilation fans shall normally be run continuously and give at least the number of air changes required by regulation whenever vehicles are on board, except where an air quality control system in accordance with regulation is provided. Where this is impracticable, they shall be operated for a limited period daily as weather permits and in any case for a reasonable period prior to discharge, after which period the ro-ro or vehicle space shall be proved gas-free. One or more portable combustible gas detecting instruments shall be carried for this purpose. The system shall be entirely separate from other ventilation systems. Ventilation ducts serving ro-ro or vehicle spaces shall be capable of being effectively sealed for each cargo space. The system shall be capable of being controlled from a position outside such spaces.

The ventilation system shall be such as to prevent air stratification and the formation of air pockets.

On all vessels with an approved air quality control system, the ventilation system may be operated with a reduced number of air changes and / or a reduced amount of ventilation. This relaxation shall not apply to spaces for which at least ten air changes per hour are required by this regulation and to spaces subject to regulations 19.3.4.1 (enclosed cargo spaces) and 20-1 (vehicle carrier transporting motor vehicles that are carrying compressed hydrogen or compressed natural gas for self-propulsion in their tanks).

Means shall be provided on the navigation bridge to indicate any loss of the required ventilating capacity.

Arrangements shall be provided to permit a rapid shutdown and effective closure of the ventilation system from outside of the space in case of fire, taking into account the weather and sea conditions. Ventilation ducts, including dampers, within a common horizontal zone shall be made of steel. In passenger ships, ventilation ducts that pass through other horizontal zones or machinery spaces shall be "A-60" class steel ducts constructed in accordance with regulations 9.7.2.4.1.1 and 9.7.2.4.1.2.

Permanent openings in the side plating, the ends or deckhead of the space shall be so situated that a fire in the cargo space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the cargo spaces.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 3 Electrical Equipment

SOLAS II-2 G 20.3.2 Passenger Ships / Cargo Ships

Unless otherwise specified below, electrical equipment and wiring must be suitable for use in an explosive gasoline-air mixture.

Except in special category spaces, in spaces below the bulkhead deck, above a height of 45 inches above the deck and, where provided, above each vehicle platform, except for platforms with openings large enough to permit gasoline vapors to escape downward, electrical equipment of an enclosed and protected type that prevents the escape of sparks may be permitted as an alternative provided that the ventilation system is designed and operated to ventilate the hold continuously at a rate of at least 10 air changes per hour while vehicles are on board.

Electrical equipment and wiring, if installed in an exhaust ventilation duct, shall be of a type approved for use in explosive petrol and air mixtures and the outlet from any exhaust duct shall be sited in a safe position, having regard to other possible sources of ignition.

Other equipment which may constitute a source of ignition of flammable vapours shall not be permitted.

Scuppers and discharges shall not be led to machinery or other spaces where sources of ignition may be present.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 4 Surveillance

SOLAS II-2 G 20.4 Passenger Ships / Cargo Ships

Fixed Fire Detection and Fire Alarm Systems

Except as provided in the following paragraph, there shall be provided a fixed fire detection and fire alarm system complying with the requirements of the Fire Safety Systems Code. The fixed fire detection system shall be capable of rapidly detecting the onset of fire. The type of detectors and their spacing and location shall be to the satisfaction of the Administration taking into account the effects of ventilation and other relevant factors. After being installed the system shall be tested under normal ventilation conditions and shall give an overall response time to the satisfaction of the Administration.

Monitoring by Exhaust Smoke Detection Systems

Except open ro-ro spaces, open vehicle spaces and special category spaces, a sample extraction smoke detection system complying with the requirements of the Fire Safety Systems Code may be used as an alternative of the fixed fire detection and fire alarm system.

Special Category Spaces

An efficient fire patrol system shall be maintained in special category spaces. However, if an efficient fire patrol system is maintained by a continuous fire watch at all times during the voyage, a fixed fire detection and fire alarm systems is not required. Manually operated call points shall be spaced so that no part of the space is more than 20 m from a manually operated call point, and one shall be placed close to each exit from such spaces.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 5 Structural Protection

SOLAS II-2 G 20.5 Passenger Ships

Notwithstanding the provisions about separation areas, in passenger ships carrying more than 36 passengers, the boundary bulkheads and decks of special category spaces and ro-ro spaces shall be insulated to "A-60" class standard. However, where a category space, as defined in regulation 9.2.2.3, is on one side of the division the standard may be reduced to "A-0". Where fuel oil tanks are below a special category space or a ro-ro space, the integrity of the deck between such spaces, may be reduced to "A-0" standard.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 6 Fire Suppression Systems

SOLAS II-2 G 20.6 Passenger Ships / Cargo Ships (and Any Ships)

Fixed Fire Suppression Systems

(A part of the following regulations apply to vessels built after July 1, 2014. Vessels built before July 1, 2014 must comply with the previously applicable regulations).

Vehicle spaces and ro-ro spaces, which are not special category spaces and are capable of being sealed from a location outside of the cargo spaces, shall be fitted with one of the following fixed fire suppression systems:

- .1 a fixed gas fire suppression system complying with the provisions of the Fire Safety Systems Code;
- .2 a fixed high-expansion foam fire suppression system complying with the provisions of the Fire Safety Systems Code; or
- .3 a fixed water-based fire fighting system for ro-ro spaces and special category spaces complying with the provisions of the Fire Safety Systems Code and which also corresponds to the following paragraphs.

Vehicle spaces and ro-ro spaces not capable of being sealed and special category spaces shall be fitted with a fixed water-based fire-fighting system for ro-ro spaces and special category spaces complying with the provisions of the Fire Safety Systems Code which shall protect all parts of any deck and vehicle platform in such spaces. Such a water-based fire-fighting system shall have:

- .1 a pressure gauge on the valve manifold;
- .2 clear marking on each manifold valve indicating the spaces served;
- .3 instructions for maintenance and operation located in the valve room; and
- .4 a sufficient number of drainage valves to ensure complete drainage of the system.

The Administration may permit the use of any other fixed fire suppression system* that has been shown that it is not less effective by a full-scale test in conditions simulating a flowing petrol fire in a vehicle space or a ro-ro space in controlling fires likely to occur in such a space.

The following regulations apply to vessels built on or after January 1, 2010. When fixed pressure waterspraying systems are fitted, in view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or decks during the operation of the fixed pressure water-spraying system, the following arrangements shall be provided:

In Passenger Ships:

In the spaces above the bulkhead deck, scuppers shall be fitted so as to ensure that such water is rapidly discharged directly overboard, taking into account the guidelines developed by the Organization.

In Ro-Ro Passenger Ships:

Discharge valves for scuppers, fitted with positive means of closing operable from a position above the bulkhead deck in accordance with the requirements of the International Convention on Load Lines in force, shall be kept open while the ships are at sea. Any operation of valves shall be recorded in the log-book. In the spaces below the bulkhead deck, the Administration may require pumping and drainage facilities to be provided additional to the requirements of regulation II-1/35-1. In such case, the drainage system shall be sized to remove no less than 125% of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles, taking into account the guidelines developed by the Organization*. The drainage system valves shall be operable from outside

the protected space at a position in the vicinity of the extinguishing system controls. Bilge wells shall be of sufficient holding capacity and shall be arranged at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment.

In Cargo Ships:

The drainage and pumping arrangements shall be such as to prevent the build-up of free surfaces. In such case, the drainage system shall be sized to remove no less than 125% of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles, taking into account the guidelines developed by the Organization*. The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls. Bilge wells shall be of sufficient holding capacity and shall be arranged at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment. If this is not possible, the adverse effect upon stability of the added weight and free surface of water shall be taken into account to the extent deemed necessary by the Administration in its approval of the stability information. Such information shall be included in the stability information supplied to the master as required by regulation II-1/5-1.

On All Ships:

For closed vehicles and ro-ro spaces and special category spaces, where fixed pressure water-spraying systems are fitted, means shall be provided to prevent the blockage of drainage arrangements, taking into account the guidelines developed by the IMO.

Protection of Vehicle, Special Category and Ro-Ro Spaces – 7 Fire Extinguisher

SOLAS II-2 G 20.6.2 Any Ships

Portable Fire Extinguishers

Portable extinguishers shall be provided at each deck level in each hold or compartment where vehicles are carried, spaced not more than 20 m apart on both sides of the space. At least one portable fire-extinguisher shall be located at each access to such a cargo space.

Additionally, the following fire extinguishing appliances shall be provided in vehicle, ro-ro and special category spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion:

- .1 at least three water-fog applicators; and
- .2 one portable foam applicator unit complying with the provisions of the Fire Safety Systems Code, provided that at least two such units are available in the ship for use in such ro-ro spaces.

Requirements for Vehicle Carriers carrying Motor Vehicles with compressed Hydrogen or Natural Gas in their Tanks for their own Propulsion as Cargo

SOLAS II-2 G 20-1.1/20-1.2 Any Ships

The purpose of this regulation is to provide additional safety measures in order to address the fire safety objectives of this chapter for vehicle carriers with vehicle and ro-ro spaces intended for carriage of motor vehicles with compressed hydrogen or compressed natural gas in their tanks for their own propulsion as cargo.

Vehicle carriers constructed on or after 1 January 2016 intended for the carriage of motor vehicles with compressed hydrogen or compressed natural gas in their tanks for their own propulsion as cargo shall comply with the relevant requirements (SOLAS Regulation 20).

Requirements for spaces intended for carriage of motor vehicles with compressed natural gas in their tanks for their own propulsion as cargo:

All electrical equipment and wiring shall be of a certified safe type for use in an explosive methane and air mixture. Electrical equipment and wiring, if installed in any ventilation duct, shall be of a certified safe type for use in explosive methane and air mixtures. The fans shall be such as to avoid the possibility of ignition of methane and air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings. Other equipment which may constitute a source of ignition of methane and air mixtures shall not be permitted.

Requirements for spaces intended for carriage of motor vehicles with compressed hydrogen in their tanks for their own propulsion as cargo:

All electrical equipment and wiring shall be of a certified safe type for use in an explosive hydrogen and air mixture. Electrical equipment and wiring, if installed in any ventilation duct, shall be of a certified safe type for use in explosive hydrogen and air mixtures and the outlet from any exhaust duct shall be sited in a safe position, having regard to other possible sources of ignition. The fans shall be designed such as to avoid the possibility of ignition of hydrogen and air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings. Other equipment which may constitute a source of ignition of hydrogen and air mixtures shall not be permitted.

Vehicle carrier also built before January 1, 2016, including those also built before July 1, 2012, must additionally comply with the relevant requirements (SOLAS Regulation 20).

When a vehicle carrier carries as cargo one or more motor vehicles with either compressed hydrogen or compressed natural gas in their tanks for their own propulsion, at least two portable gas detectors shall be provided. Such detectors shall be suitable for the detection of the gas fuel and be of a certified safe type for use in the explosive gas and air mixture.

Fixed Gas Fire-Fighting System

FSS-Code 05 Any Ships

General Requirements for the System Setup:

Means shall be provided for automatically giving audible and visual warning of the release of fire suppression medium into any ro-ro spaces, container holds equipped with integral reefer containers, spaces accessible by doors or hatches, and other spaces in which personnel normally work or to which they have access. The audible alarms shall be located so as to be audible throughout the protected space with all machinery operating, and the alarms should be distinguished from other audible alarms by adjustment of sound pressure or sound patterns. The pre-discharge alarm shall be automatically activated (e.g., by opening of the release cabinet door). The alarm shall operate for the length of time needed to evacuate the space, but in no case less than 20 s before the medium is released. Conventional cargo spaces and small spaces (such as compressor rooms, paint lockers, etc.) with only a local release need not be provided with such an alarm.

Carbon Dioxide Systems - Quantity of Extinguishing Agent

For cargo spaces, the quantity of carbon dioxide available shall, unless otherwise provided, be sufficient to give a minimum volume of free gas equal to 30% of the gross volume of the largest cargo space to be protected in the ship.

For vehicle spaces and ro-ro spaces which are not special category spaces, the quantity of carbon dioxide available shall be at least sufficient to give a minimum volume of free gas equal to 45% of the gross volume of the largest such cargo space which is capable of being sealed, and the arrangements shall be such as to ensure that at least two thirds of the gas required for the relevant space shall be introduced within 10 min. Carbon dioxide systems shall not be used for the protection of special category spaces.

Carbon dioxide systems for the protection of ro-ro spaces, container holds equipped with integral reefer containers, spaces accessible by doors or hatches, and other spaces in which personnel normally work or to which they have access shall comply with the following requirements:

Two separate controls shall be provided for releasing carbon dioxide into a protected space and to ensure the activation of the alarm. One control shall be used for opening the valve of the piping which conveys the gas into the protected space and a second control shall be used to discharge the gas from its storage containers. Positive means shall be provided so they can only be operated in that order; and

The two controls shall be located inside a release box clearly identified for the particular space. If the box containing the controls is to be locked, a key to the box shall be in a break-glass-type enclosure conspicuously located adjacent to the box.

Fixed Foam Fire-Fighting System

FSS-Code 06 Any Ships

This chapter describes the specifications for installed foam extinguishing systems for the protection of, inter alia, cargo spaces in accordance with SOLAS Regulation II-2 / 10.7.1.1 and vehicle, special and ro-ro spaces in accordance with SOLAS Regulation II-2 / 20.6.1.3. Unless expressly provided otherwise, the requirements of this chapter shall apply to ships constructed on or after 1 January 2014.

Basic Requirements of Fixed Light Foam Fire Extinguishing Systems

The system shall be capable of manual release, and shall be designed to produce foam at the required application rate within 1 minute of release. Automatic release of the system shall not be permitted unless appropriate operational measures or interlocks are provided to prevent any local application systems required by SOLAS Regulation II-2/10.5.6 (fixed object protection fire extinguishing systems) from interfering with the effectiveness of the system.

Performance Criteria and more [...]

In, among others, vehicle spaces, ro-ro spaces and special category spaces shall be provided with audible and visual alarms within the protected space warning of the release of the system. The alarms shall operate for the length of time needed to evacuate the space, but in no case less than 20 seconds.

Inside Air Foam Systems for the protection of vehicle, ro-ro, special category and cargo spaces

The system shall be supplied by the ship's main power source. An emergency power supply is not required. Sufficient foam-generating capacity shall be provided to ensure the minimum design filling rate for the system is met and in addition shall be adequate to completely fill the largest protected space within 10 min. However, for systems protecting vehicle and ro-ro spaces and special category spaces, with decks that are reasonably gas-tight and that have a deck height of 3 m or less, the filling rate shall be not less than two thirds of the design filling rate and in addition sufficient to fill the largest protected space within 10 min. The system may be divided into sections, however, the capacity and design of the system shall be based on the protected space demanding the greatest volume of foam. Adjacent protected spaces need not be served simultaneously if the boundaries between the spaces are "A" class divisions. The arrangement of foam generators shall in general be designed based on the approval test results. The number of generators may be different, but the minimum design filling rate determined during approval testing shall be provided by the system. A minimum of two generators shall be installed in every space. The foam generators shall be arranged to uniformly distribute foam in the protected spaces, and the layout shall take into consideration obstructions that can be expected when cargo is loaded on board. As a minimum, generators shall be located on every second deck, including movable decks. The horizontal spacing of the generators shall ensure rapid supply of foam to all parts of the protected space. This shall be established on the basis of full scale tests 1 m. The foam generators shall be arranged with at least 1 m free space in front of the foam outlets, unless tested with less clearance.

Outside Air Foam Systems for the protection of vehicle and ro-ro spaces and special category and cargo spaces

The system shall be supplied by the ship's main power source. An emergency power supply is not required. Sufficient foam-generating capacity shall be provided to ensure the minimum design filling rate for the system is met and in addition shall be adequate to completely fill the largest protected space within 10 min. However, for systems protecting vehicle and ro-ro spaces and special category spaces, with decks that are reasonably gas-tight and that have a deck height of 3 m or less, the filling rate shall be not less than two thirds of the design filling rate and in addition sufficient to fill the largest protected space within 10 min. The system may be divided into sections, however, the capacity and design of the system shall be based on the protected space demanding the greatest volume of foam. Adjacent protected spaces need not be served simultaneously if the boundaries between the spaces are "A" class divisions. The arrangement of foam delivery ducts shall in general be designed based on the approval test results. The number of ducts may be different, but the minimum design filling rate determined during approval testing shall be provided by the system. A minimum of two ducts shall be installed in every space. The foam generators shall be arranged to uniformly distribute foam in the protected spaces, and the layout shall take into consideration obstructions that can be expected when cargo is loaded on board. As a minimum, ducts shall be led to every second deck, including movable decks. The horizontal spacing of the ducts shall ensure rapid supply of foam to all parts of the protected space. This shall be established on the basis of full scale tests. The system shall be arranged with at least 1 m free space in front of the foam outlets, unless tested with less clearance. The arrangement of the foam delivery ducts shall be such that a fire in the protected space will not affect the foam-generating equipment. If the foam generators are located adjacent to the protected space, foam delivery ducts shall be installed to allow at least 450 mm of separation between the generators and the protected space, and the separating divisions shall be class "A-60" rated. Foam delivery ducts shall be constructed of steel having a thickness of not less than 5 mm. In addition, stainless steel dampers (single or multi-bladed) with a thickness of not less than 3 mm shall be installed at the openings in the boundary bulkheads or decks between the foam generators and the protected space. The dampers shall be automatically operated (electrically, pneumatically or hydraulically) by means of remote control of the foam generator related to them, and arranged to remain closed until the foam generators begin operating. The foam generators shall be located where an adequate fresh air supply can be arranged.

Fixed Pressure Water-Spraying and Water-Mist Fire Suppression Systems

FSS-Code 07 Any Ships

This chapter details the specifications for fixed pressure water-spraying and water mist fire suppression systems as required by chapter II-2 of the Convention.

General Technical Requirements for Fixed Pressure Water-Spraying Fire Suppression Systems to protect vehicle, ro-ro, special category and cargo spaces

Fixed water-based fire suppression systems for ro-ro spaces, vehicle spaces, and special spaces shall be approved by the Administration based on guidance developed by the Organization (fixed water-based fire suppression systems for ro-ro spaces and special category spaces (MSC.1 / Circ.1430).

Fixed Fire Detection and Fire Alarm Systems

FSS-Code 09 Any Ships

This chapter details the specification of fixed fire detection and fire alarm systems as required by chapter II-2 of the Convention. Unless expressly provided otherwise, the requirements of this chapter shall apply to ships constructed on or after 1 July 2012.

General Technical Requirements:

Any required fixed fire detection and fire alarm system with manually operated call points shall be capable of immediate operation at all times (this does not require a backup control panel).

Notwithstanding this, particular spaces may be disconnected, for example, workshops during hot work and ro-ro spaces during on and off-loading. The means for disconnecting the detectors shall be designed to automatically restore the system to normal surveillance after a predetermined time that is appropriate for the operation in question. The space shall be manned or provided with a fire patrol when detectors required by regulation are disconnected. Detectors in all other spaces shall remain operational.

Installation Requirements:

Detectors and manually operated call points shall be grouped into sections. A section of fire detectors which covers a ro-ro space shall not include a machinery space of category A. For fixed fire detection systems with remotely and individually identifiable fire detectors, a section covering fire detectors in accommodation, service spaces and control stations shall not include fire detectors in machinery spaces of category A or ro-ro spaces. [...]

The maximum spacing of detectors shall be in accordance with the table below:

Table 9.1 - Spacing of detectors

Type of detector	Heat	Smoke
Maximum floor area per detector (m ²)	37	74
Maximum distance apart between centres (m)	9	11
Maximum distance away from bulkheads (m)	4.5	5.5

The Administration may require or permit other spacing based upon test data which demonstrate the characteristics of the detectors. Detectors located below moveable ro-ro decks shall be in accordance with the above.

Smoke Detection Systems

FSS-Code 10 Any Ships

This chapter details the specification of sample extraction smoke detection systems in cargo spaces as required by chapter II-2 of the Convention. Unless expressly provided otherwise, the requirements of this chapter shall apply to ships constructed on or after 1 January 2012.

Technical Requirements for monitoring the system

Suitable instructions and component spares shall be provided for the testing and maintenance of the system. After installation, the system shall be functionally tested using smoke generating machines or equivalent as a smoke source. An alarm shall be received at the control unit in not more than 180 seconds for vehicle decks, and not more than 300 seconds for container and general cargo holds, after smoke is introduced at the most remote accumulator.