



Safety of Ro-Ro Passenger & Cruise Ships

January 2018



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SAFETY OF RO-RO PASSENGER AND CRUISE SHIPS

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INTRODUCTION

Since the 80's, passenger ship design moved from cruise liners to leisure cruise ships. Passenger ships are now basically designed as hotel accommodation fitted inside a ship, where public spaces and leisure areas demand larger space. Size and capacity of cruise ships have increased during the last years, creating new challenges with respect to fire safety and evacuation. Furthermore nearly all new designs apply alternative design for the accommodation area and even lifesaving appliances.

Calculation tools and Rules notes have been developed to cope with new designs for large passenger ships, such as the use of aluminum, extensive glass superstructures, large multi-deck spaces as well as extra-large lifeboats.

One major step in 2010 has been that passenger ships above a certain size have to be able to safely return to port under their own power, and to provide passengers with safe areas onboard after a pre-defined flooding or fire incident. This has considerable impact on the design and system arrangement.

From the beginning BV has been involved in working groups for the elaboration of explanatory notes to facilitate harmonized application of these new amendments. Based on experience gained on projects already certified or under progress, BV has established its own understanding notes providing solutions to unclear and/or vague issues. Whilst BV and the industry has gained extensive experience in applying the requirements, the associated IMO interpretations and our own notes, BV still see room for further improvement and development.

Recent adoptions of IGF and POLAR Code in 2016 are considered as further milestones having impact on design and operation of cruise ships. Gas as fuel can be used for propulsion and/or electrical production due to environmental reasons. Small and even large ferries have been the first to be built acc. to the Code and to operate on LNG. Gas fueled cruise ships are also under construction now. The POLAR Code contains technical and operational requirements for ships going to and operate in Polar waters, both for new (constructed on or after 1st January 2017) and existing ships (1st January 2018).

Bureau Veritas is actively contributing to draw up the SOLAS Conventions, participating to IMO Committees and publishing Rules and Guidance Notes formalizing their implementation and helping owners and shipyards to achieve compliance with safety always at the forefront.

1 - CLASSIFICATION OF PASSENGER SHIPS

A- WHY CLASSIFICATION?

Classification is the expression of confidence given by the Classification Society to a ship, for a particular use or service and for a certain period of time, by reference to its Rules, Rule or Guidance Notes and other documents.

B- CLASSIFICATION WORK

The classification of a ship includes, in accordance with the Rule book:

- Review of design drawings and documents
- Surveys of materials and equipment
- Survey during construction of the ship
- Attendance to trials alongside and at sea
- Issuance of Classification documents
- In service surveys.

The ship, the construction and condition of which satisfy the applicable Rule requirements, is registered with the corresponding classification symbols, marks and notations.

C- BV CLASS NOTATIONS

A typical entry for a passenger ship would be:

I	<i>main class symbol</i>
Passenger ship - SRTP	<i>service notation & additional service feature</i>
Unrestricted Navigation	<i>navigation notation</i>
⌘ HULL, ⌘ MACH	<i>construction marks</i>
⌘ AUT-UMS	<i>additional class notation</i>

- Main Class symbol & construction marks -

“**I**” is the main Class symbol assigned to ships built in accordance with the rule requirements, and maintained in a condition considered satisfactory by the Society.

“**⌘**” is the construction mark when ship has been constructed under BV special survey.

- Service notations and additional service features -

“**Passenger ship**” is granted to ships intended to carry more than 12 passengers.

“**Ro-ro passenger ship**” assigned to passenger ships specially equipped to carry complete trains or wheeled vehicles.

“**SRTP**” is added for ships having to comply with SOLAS “Safe Return to Port” requirements

“**DUALFUEL**” or “**GASFUEL**” are for ships fitted with engines using gas as fuel.

“**POLAR CAT-A (or B or C)**” are mandatory for ships operating in polar waters (as defined in SOLAS and MARPOL)

- Additional class notations particularly adapted to passenger ships –

- Class notations related to Technical Design of the ship:

ACCOMODATION for ships found in compliance with the criteria of MLC 2006 for design and construction of crew accommodation.

AUT-UMS or IMS, indicate compliance with different Rule requirements for unattended machinery spaces.

AUT-CCS assigned to ships which are fitted with machinery installations operated and monitored from a centralized control station.

AUT-PORT if the automation of the machinery is also required when the ship is at berth.

ALP, ALM & ALS: notations for special certification & test of lifting appliances.

AVM-DPS and AVM-IPS for ships fitted with duplicated or independent propulsion systems, insuring redundancy of propulsion, electrical production and steering.

ERS assuring technical assistance in case of maritime accident at sea by providing information on ship's remaining strength and stability in the resulting damaged condition.

HEL assigned to ships fitted with helicopter facilities subject to design review and construction survey by the Society.

ICE class notations of different levels for ships strengthened for navigation in icy waters.

INWATERSURVEY for ships having suitable arrangements to facilitate afloat bottom surveys

LI supplemented by "HG" and/or "S1" to "S3" for ships equipped with a loading instrument performing hull girder calculation and/or different extends of intact & damage stability calculations

MON-SHAFT assigned to ships fitted with a Tailshaft Monitoring system allowing the vessel to be granted with a reduced scope for complete tailshaft surveys.

POLAR CLASS 1 to 7 notations are relevant to ships intended for navigation in ice-infested polar waters except icebreakers.

COLD DI & COLD (H t_{DG}, E t_{DE}) are assigned to ships intended to operate in cold climate environments.

REF-STORE covering refrigerating plants intended for the preservation of ship's provisions.

SYS-NEQ and SYS-NEQ-1 for ships equipped with centralized navigation control system.

VeriSTAR Machinery class notation is granted to vessels on which a maintenance plan taking into account a risk analysis review of the installation is implemented.

- Class Notations related to Comfort and Protection of Environment:

BATTERY SYSTEM for ships when batteries are used for propulsion and/or el. power supply

ELECTRIC HYBRID (PM, PB, ZE) for ships provided with an energy storage system (ESS) used to supply the electric propulsion and/or main electrical power distribution system

URN-controlled/advanced or specified vessel for ships meeting the different underwater radiated noise limits complying with the requirements of BV Rule note NR614.

COMFORT & COMFORT+ for ships with levels of noise and/or vibration in different spaces being in compliance with BV Rule Part; It can be divided in **COMF-PAX & COMF-CREW** when different severity grades are applied respectively in passenger areas and crew living spaces

CLEANSHIP & CLEANSHIP SUPER for ships designed, built and operated to achieve additional protection of the environment. They can be supplemented with following notations:

AWT A/B, for ships fitted with Advanced Water Treatment plant for grey and black water verifying specific requirements for operation in Alaska and/or Baltic waters.

NDO-x days, when the vessel is designed for No Discharge Operation during x days,

HVSC, granted to ships fitted with certified installation for “cold ironing”

BWT, when the vessel is fitted with approved Ballast Water Treatment plant

GREEN PASSPORT, covering inventory of any potentially hazardous materials

EGCS-SCRUBBER for ships fitted with an exhaust gas cleaning system using scrubber installed in accordance with the provisions of BV Rules.

GAS-PREPARED for new ships having suitable arrangements to accommodate future installation of an LNG fuel gas system for propulsion or el-generation.

The notation “GAS PREPARED” can be completed by the following additional notations:

S, when specific arrangements are implemented for the ship structure

P, for piping

ME-DF, when the main engine(s) is (are) of dual fuel type

AEB, when aux. engines and oil-fired boilers are of dual fuel type, or designed to be converted to dual fuel

SCRUBBER READY when the ship is prepared for a later installation of an Exhaust Gas Cleaning System as described in BV NR 644.

D- SPECIAL BV RULES FOR PASSENGER SHIPS

Hull

In addition to the general requirements applicable for all ships, **passenger ships** have to comply with specific provisions as defined in **Part D Ch. 11 of the Rules, and Ch. 12 for Ro-ro passenger ships**.

Due to their specific design (large rooms, stairs, lifts, large openings in decks and side shell, design point of view and safety consideration), the structural strength is to be particularly checked.

An overall calculation using **Finite Element Method (FEM)** analysis is performed. The model includes all the different elements of the ship, such as all the decks, superstructure ... Results show among others which part is taken by these elements in the longitudinal strength, and allow refinement of the steel structure by determining the highly stressed areas.

Another particular item necessary to verify is the longitudinal and transverse behavior of the structure (i.e. the strength of end parts of the ship in way of large openings in side shell and the racking study due to rolling acceleration).

Equipment

The main and auxiliary machinery systems, piping systems and electrical plant are checked and surveyed for compliance with appropriate parts of the rules.

Special expertise has been developed within BV organization regarding **electrical propulsion** and **azimuth propulsion thrusters** which is quite popular for these types of ships.

Specific rules requirements have been developed to cover installation of **propulsion and el-production plants using gas as fuel**. Risk analysis covering the vessel itself and the interface with the bunkering facilities (trucks, barge or shore storage plant) are mandatory for this type of installation.

The regulations specific to passenger ships generally cover the requirements of Load Line and SOLAS Conventions (e.g. bilge systems, emergency source of power).

Fire Safety

In addition to the survey of fire-fighting systems on board a passenger ship, BV will systematically review and survey the fire prevention and associated safety measures such as escape arrangement.

In service, the Classification Society need be involved in any modification of accommodation spaces with respect to structural fire protection, the use of proper material and modifications related to SRtP and alternative design.

This review includes, at the design stage or even at the project stage the appraisal of the general arrangement of the ship, to ensure the correct arrangement of main fire bulkheads and of escape routes, the presence, enclosure and sizing of stairways, the relative location

of spaces such as main and emergency sources of power, etc. Further, the fire resistance of all bulkheads and decks are checked, including doors and penetrations.

Ventilation systems are to be designed to limit the spread of fire and smoke. Fire detection and alarm systems, sprinkler systems or equivalent systems are also thoroughly checked.

Materials used in the construction of accommodation and service spaces are to demonstrate satisfactory properties of fire reaction (e.g. non combustibility, low flame spread, smoke and toxicity levels, etc.). This practically implies that these materials are granted with a type approval certificate showing conformity with testing schemes listed in IMO “Fire Testing Procedures” code (FTP Code).

Membership in IACS, participation to the drafting of IMO instruments and experience as one of the leading classification societies for passenger ships allow BV to develop its interpretations. Specific requirements of Flag Administrations will also be taken into account.

Safe Return to Port

SOLAS requirement for “Safe Return to Port”, which entered into force for ships keel laid on or after 01st July 2010, applies to passenger ships of minimum 120m in length or having three or more main vertical zones. The meaning of it is to enable ships to return to a safe port under their own propulsion after a fire or flooding casualty which remains within well-defined casualty threshold.

Bureau Veritas was actively participating in the development of explanatory notes issued by IMO and since then in several passenger ship projects having to comply with these requirements. Working with administrations, shipyards, operators and suppliers of concerned systems, Bureau Veritas has gained a wide knowledge and expertise allowing us to help owners and designers to find safe and efficient solutions for ships having to comply with these requirements. *For technical details see Appendix 1.*

2. BUREAU VERITAS STATUTORY ACTIVITIES

A- INTERNATIONAL REGULATIONS

Bureau Veritas is recognized by more than one hundred thirty Administrations to act on their behalf on various statutory matters. A number of Flag Administrations have granted BV to issue, within the scope of **SOLAS Convention**, the **Passenger Ship Safety Certificates** (PSSC).

This includes in addition to class related matters, the examination, testing, initial and periodical surveys of ships construction with respect to structural fire protection and evacuation, lifesaving appliances, radio and navigation equipment, and approval of stability documents.

Examination of intact and damage stability documentation benefits of the extensive computer program library of the Society.

Other recognitions cover other conventions and codes such as **Load Line, Tonnage, MARPOL, IAFS, COLREG, ILO/MLC, IGF Code, Polar Code...**etc.

B- NATIONAL REGULATIONS & CO-OPERATION WITH U.S.C.G

A number of coastal States have promulgated national legislation and impose controls on compliance to the adopted technical regulation.

Concerning the passenger vessels operating in **US waters**, the **USCG COMDTINST M16000.7 Vol II.Ch 7B June 2014 (Examinations procedures for Foreign Passenger Vessels)** specifies that **USCG** have to review safety drawings of the ship in order to be satisfied that this vessel complies with applicable requirements of SOLAS 1974 as amended, prior to inspection of vessels which are to operate for the first time from a US port.

Bureau Veritas has signed in December 1997 an **Outline Of Co-operation with USCG (O.O.C)** to facilitate the control verification examination process.

BV is acting during the examination phase as **single point of contact to the USCG**, and BV specialists are also present during USCG visits.

Registration of the ship under the O.O.C scheme is to be requested by Owners to BV who will inform USCG accordingly.

During design review, BV will advise Owners, Designers and Yards on relevant USCG interpretations, and will present the project, during a concept review meeting at USCG's Marine Safety Centre in Washington Headquarter, to discuss, new or unusual arrangements.

Certain drawings, approved by BV on behalf of the Flag Administration, are submitted to USCG Marine Safety Center together with relevant documentation and list of applicable regulations and interpretations.

Compliance with approved drawings and USCG comments are verified during the building phase by attending BV's surveyors.

BV is informing USCG in due time on proposed dates for their visit(s) at the shipyard, and is assisting building yard and Owners in preparation for and planning of the USCG examination until issuance of the **USCG's Certificate of Compliance (COC)** at the first US port call.

3 – THE SOLAS CONVENTION

A – INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA

For the international shipping community, the safety of passenger ships had always been a priority. Disasters such as the Titanic sinking of 1912 caused international concern and it is significant that the most important treaty dealing with shipping safety is called the **International Convention for the Safety of Life at Sea (SOLAS)**. The first version was adopted in 1914, the second in 1929 and the third in 1948.

The 1960 Convention was the first major task for the International Maritime Organization (IMO) after its creation and it represented a considerable step forward in modernizing regulations and in keeping pace with technical developments in the shipping industry.

The present version was adopted in 1974 with entry into force in 1980, and has since then been subject to several sets of amendments (see “**Regulations recently in force or coming in the future**” in Annex table n°1).

Technical provisions concerning passenger vessels are contained in:

Chapter II-1: Construction – subdivision and stability, machinery and electrical installations.

Parts A & B are covering structure, subdivision and stability requirements.

The subdivision of passenger ships into watertight compartments must be such that after assumed damage to the ship’s hull, the vessel will remain afloat in a stable position. Requirements for the watertight integrity and bilge pumping arrangements for passenger ships are also laid down.

The degree of subdivision varies with the ship’s length and the service in which it is engaged. The highest degree of subdivision applies to ships of the greatest length primarily engaged in the carriage of passengers.

In parts C & D, requirements for machinery and electrical installations are detailed to ensure that services which are essential for the safety of the ship, passengers and crew are maintained under various emergency conditions.

SOLAS Chapter II-1 parts A and B have been totally revised starting with MSC 80 and MSC 82, including the new probabilistic damage stability requirements to be applied for new passenger ships having their keel laying date on or after on 01st January 2009. The revision of SOLAS chapter II-1, part B, is intended to harmonize the provisions on subdivision and damage stability for passenger and cargo ships.

The revised SOLAS chapter II-1, part B, contains the following parts:

Part B – Subdivision and Stability

Regulation 4

Part B-1- Stability

Regulations 5 to 8, with introduction of the new “Code on Intact Stability 2008” entered into force on 01st July 2010, and amended requirement on system capabilities and operational information after a flooding casualty on passenger ships.

Part B-2 – Subdivision, Watertightness and Weathertightness

Regulations 9 to 17-1

Part B-3 – Subdivision and Line Load Assignment for Passenger Ships

Regulation 18

Part B-4 – Stability Management

Regulations 19 to 23-3

In June 2015, the amendments adopted by the Committee introduced to SOLAS a new part G to Chapter II-1 (MSC.392(95)), and the Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels, **IGF Code** (resolution MSC.391(95)).

The mandatory provisions of the Code entered into force on 1st January 2017 and are applicable to new cargo ships ≥ 500 GT and passenger ships using natural gas as fuel:

- With a building contract placed on or after 1st January 2017; or
- In the absence of a building contract, the keel of which is laid or which is at a similar stage of construction on or after 1st July 2017; or
- Regardless of the building contract or keel laying date, the delivery is on or after 1st January 2021.

The IGF Code does not apply to gas carriers certified to the IGC Code which use their cargoes as fuel or use other low-flashpoint gaseous fuels provided that the fuel storage and distribution systems design and arrangements for such gaseous fuels comply with the requirements of the IGC Code for gas as a cargo.

Chapter II-1 has in 2017 been extensively revised (see IMO Res.MSC.421 (98)).

Regulation 4 – clarification of when probabilistic calculations are required

Regulation 5-1 – limiting curves to include trim

Regulation 6 – required subdivision index R modified

Regulation 7-2 – amending the calculation for s in the probability of survival

Regulation 9.3 – wells constructed in the double bottom

Regulation 19-1 – requirement to perform damage control drills

Regulation 22.3 – new requirements for opening of watertight doors during navigation (see revised MSC.1/Circ. 1564 – Guidance for watertight doors on Passenger ships which may be opened during navigation – new Annex: watertight doors will no longer be permitted to be left permanently open)

A list of further amendments and circulars can be found in the Annexes.

Chapter II-2: Construction – Fire protection, fire detection and fire extinction.

This chapter has been totally revised by the 2000 Amendments and contains separate provisions for the passenger ships. The revised chapter includes seven parts, each including requirements applicable to all or specified ship types, while the new Fire Safety Systems Code (FSS Code), which is made mandatory under the new chapter, includes detailed specifications for fire safety systems in 15 Chapters. New methodology, based

on modern fire prevention and fire-fighting techniques, and using fire load criteria and risk analysis methods, are now allowed, thus allowing new alternative designs as long as they are at least as safe as a design complying with the prescriptive SOLAS requirements.

Reference is also made in this chapter to the International Code for Application of Fire Test Procedures (FTP Code) in force since 01st July 1998 with a new edition adopted in December 2010 which entered into force on 01st July 2012 (2010 FTP Code).

Important changes have been made to Chapter II-2 with the Amendments adopted with MSC 82. Another important milestone was the introduction of the “safe return to port” concept (See Appendix 1).

In 2016 MSC 96 adopted amendments to SOLAS II-2/13.3.2 making evacuation analysis, to be performed early in design process, mandatory for passenger ships carrying more than 36 passengers keel laid on or after 1st January 2020. See also revised Guidelines for evacuation analysis (MSC.1/Circ. 1533).

A list of further amendments and circulars can be found in the Annexes.

Chapter III: Life-saving appliances and arrangements

Completely redrafted by the 96 Amendments, this chapter is divided in two parts, and contains specific requirements for passenger vessels.

This chapter refers to the International Life-Saving Appliance Code (LSA Code) entered into force on 01st July 1998 with the last edition dated September 2010.

Current changes include the amendment of Regulation 30 (require damage control drills) and Regulation 37 (include damage control for flooding emergencies) – see IMO Res.MSC.421 (98).

A list of further amendments and circulars can be found in the Annexes.

Chapter IV: Radiotelegraphy and radiotelephony

This chapter contains all requirements for the Global Maritime Distress and Safety System (GMDSS) as set out in Nov 88 SOLAS Amendments, in force for every existing ships since 01st February 1999.

Chapter V: Safety of navigation

This chapter covers safety of navigation, includes requirements on navigation and emergency procedures, navigation equipment and documentation, and manning.

Regulation 23, in force since 01st July 1997, requires for all passenger ships a list of operational limitations and exemptions to be kept onboard. A new revised chapter V was adopted in December 2000, which entered into force on 1st July 2002. The new chapter makes mandatory the carriage of voyage data recorders (VDRs) and automatic ship identification systems (AIS) for certain ships.

The 2009 Amendments required passenger ships keel laid on or after 1st July 2011 be fitted with a bridge navigational watch alarm system (BNWAS). This applies as well to existing ships (Res. MSC.350 (92)).

Ships keel laid on or after 1st July 2012 shall be provided with an Electronic Chart Display and information system (ECDIS); applies to existing ships as well (first survey after 1st July 2014).

Chapter IX: Management of the safe operation of ships

This chapter has, after its entry into force on 1st July 1998, made the International Safety Management (ISM) Code mandatory.

Chapter X: Safety measures for High-Speed Craft.

This chapter has, after its entry into force on 1st January 1996, made the International Code of Safety for High Speed Craft (HSC Code) mandatory. Since then, several amendments were introduced.

Chapters XI-1 & XI-2: Enhanced maritime Safety and Security measures

This sub-chapters deal with measures to enhance maritime safety and maritime security, with the later one referring to the International Ship and Port Facility Security Code (ISPS Code) .

The ISPS Code is divided into two parts.

- Part A is made mandatory under SOLAS Chapter XI-2, as is the ISM Code under Chapter IX.

- Part B is a Guidance Note intended to clarify the provisions of SOLAS Chapter XI-2 and Part A of the ISPS Code. Most of major authorities, and among them USCG, ask for compliance with part A together with part B as applicable.

Chapter XIV: “Safety measures for ships operating in polar waters”.

IMO has adopted the International Code for Ships Operating in Polar Waters (Polar Code) and related amendments to make it mandatory under both the International Convention for the Safety of Life at Sea (MSC.385 (94) Nov 2014 Amendments to SOLAS) and the International Convention for the Prevention of Pollution from Ships (MEPC.264 (68) May 2015 with Amendments to MARPOL Annexes I, II, IV & V).

The SOLAS amendments came into force on 1st January 2017 applicable to new ships constructed on or after that date. Ships constructed before 1 January 2017 are required to meet the relevant requirements of the Polar Code by the first intermediate or renewal survey, whichever occurs first, after 1st January 2018.

The Polar Code covers the full range of design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships operating in the inhospitable waters surrounding the two poles.

The Polar Code includes mandatory measures covering safety (part I-A) and pollution prevention (part II-A) as well as recommendatory provisions for both (parts I-B and II-B). The Code will require ships intending to operate in the defined waters of the Antarctic and Arctic to apply for a Polar Ship Certificate, which would classify the vessel as:

- Category A ship – ships designed for operation in polar waters at least in medium first-year ice, which may include old ice inclusions;
- Category B ship – a ship not included in category A, designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions; or
- Category C ship – a ship designed to operate in open water or in ice conditions less severe than those included in Categories A and B.

The issuance of a certificate would require an assessment, taking into account the anticipated range of operating conditions in the polar waters, and it would include information on identified operational limitations, and plans or procedures or additional safety equipment necessary to mitigate incidents with potential safety or environmental consequences.