Summary of the Outcomes of IMO MSC 111

ClassNK Technical Information

To whom it may concern

The 111th session of the Maritime Safety Committee (MSC 111) was held from 13 to 22 May 2026. Since the minutes, resolutions and circulars of the meeting were recently released from the IMO, a summary of the decisions taken at MSC 111 is provided below for your information.

1. Adopted mandatory requirements
   Mandatory requirements adopted at MSC 111 were as follows:
   (1) Amendments to SOLAS Chapters IV and V, and HSC Code
   Amendments to SOLAS Chapter IV and V, and HSC Code to allow the VHF Data Exchange System (VDES), which has function of VHF data exchange in addition to Automatic Identification System (AIS), to install ships as an alternative to AIS. In addition, the performance standards for shipborne VDES were adopted.
   Furthermore, amendments to regulation 18 of SOLAS chapter V extend the annual testing requirements previously applicable to AIS to both AIS and VDES.

   Applied: on or after 1 January 2028.

   (2) Amendments to 2011 ESP Code
   Amendments to 2011 ESP Code regarding Remote Inspection Technique (RIT). As a result of this amendment, in close-up surveys of the hull structure for ships subject to the ESP Code, the conditions for application of RIT and the associated limitations have been clarified. The use of RIT for surveys after the third renewal survey is subject to the agreement of the Flag Administration.
   In addition, the guidelines on the use of RIT for ESP Code surveys were also approved (see 3.2(1)).

   Applied: on or after 1 January 2028.

   (3) Amendments to IP Code
   Amendments to Part IV of IP Code to change the assumed mass of each industrial personnel from 75 kg to 90 kg in the ship stability calculation.

   Applied: ships that fall under the following:
   1. for which the building contract is placed on or after 1 January 2028;
   2. in the absence of a building contract, the keels of which are laid or which are at a similar stage of construction on or after 1 July 2028; or
   3. the delivery of which is on or after 1 January 2032.

(To be continued)

(4) Amendments to LSA Code

(i) Addition of design requirements for the arrangement to test the release system without launching the free-fall lifeboat into the water

MSC Resolution MSC.402(96), paragraph 6.2.7.1 requires that the arrangements for the test without launching the lifeboat, required by LSA Code 4.7.6.4, be engaged when conducting operational tests of the free-fall lifeboat release function. However, LSA Code 4.7.6.4 only specifies the functional requirement that a free-fall lifeboat's release system can be tested without launching the lifeboat, and it does not refer to the arrangement itself. Therefore, a new paragraph 4.7.7 has been introduced to specify the design requirements (such as safety factors, corrosion resistance, etc.) for such arrangements.

Applied: each free-fall lifeboat installed on or after 1 January 2031.

(ii) Clarification of the applicability of previous amendments

Previously, when the LSA Code was amended, the scope of application of the amendments was stated only in the main text of the resolutions. To improve usability, the scope of application of each amended provision has now been explicitly stated within the text of the LSA Code itself for past amendments.

There is no substantive change to the requirements in this regard.

Applied: on or after 1 January 2028.

(5) Amendments to the requirements for maintenance, thorough examination, operational testing, overhaul and repair of lifeboats and rescue boats, launching appliances and release gear (Resolution MSC.402(96))

Amendments to Resolution MSC.402(96) to add the required release system under load without launching the free-fall lifeboat into the water under LSA Code 4.7.7 mentioned above item (4) to the items for thorough examination.

Applied: each free-fall lifeboat installed on or after 1 January 2031.

(6) Amendments to 1988 Load Lines Protocol

Amendments to 1988 Load Lines Protocol regulation 25 to require having guard rails with 3 bars and openings not exceed 230 mm below the lowest course of the guard rails and 380 mm at the other courses for all exposed decks and all sea access holes same as for superstructure and freeboard decks. In addition, it was added that chains fitted in lieu of guard rails are to be tightened as much as reasonably practicable.

Applied: on or after 1 January 2028.

2. Approved mandatory requirements

The following draft amendments were approved at this session, and are expected to be adopted at MSC 112 to be held in December 2026.

(To be continued)

(1) Amendments to IGC Code
Amendments to Chapter 1 to 5, 8 to 13 and 15 to 19 of the IGC Code regarding the filling limit, requirements of using cargo other than LNG as a fuel, special requirements for carbon dioxide, etc. together with newly discussed application-date provisions based on three triggering dates, including the shipbuilding contract date.

3. Approval of unified interpretations, etc.
The following unified interpretations (UIs), guidelines and guidance etc. were approved during MSC 111.

3.1 Unified interpretations
(1) Unified interpretation of the IGC Code
Unified interpretation of chapter 4 of the IGC Code regarding the secondary barrier testing and effectiveness assessment.

3.2 Guidelines and guidance etc.
(1) Guidelines on the use of remote inspection techniques (RIT) for ESP Code surveys
Guidelines to provide technical guidance for the use of Remote Inspection Technologies (RIT) during the close-up survey required by the ESP Code, including requirements for certification of RIT service providers, approval of survey equipment, submission of inspection plan and pre-inspection verification.

(2) Interim guidelines for the safety of ships using hydrogen as fuel
Interim guidelines specifying provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using hydrogen as fuel in order to minimize the risk to the ship, persons on board and the environment.

(3) Interim guidelines for use of ammonia cargo as fuel
Interim guidelines specifying technical guidance to ensure a level of safety equivalent to that achieved when using natural gas cargo as fuel, in cases where ammonia cargo is used as fuel.

(4) Revised interim recommendations for carriage of liquefied hydrogen in bulk (resolution MSC.565(108))
Revised interim recommendations for carriage of liquefied hydrogen in bulk, including the addition of cargo containment systems of a membrane-type cargo tank maintaining the insulation spaces under vacuum.

4. Consideration of requirements for Maritime Autonomous Surface Ships (MASS)
In the recent development of MASS, it has been discussed at MSC on an international instrument of MASS (MASS Code). The non-mandatory MASS Code had been developed, including, for example, goal-based and functional requirements for areas such as safety, operation, and security.

(To be continued)

At this session, based on the report by the intersessional working group (ISWG-MASS 4) and the meeting outcome arranged by the related working group, the non-mandatory MASS Code was finalized and adopted. In the future, mandatory MASS Code will be considered with a view to entering into force on 2032 after reviewing the non-mandatory MASS Code at sub-committee and Experience-building phase (EBP). development of a framework for an EBP was commenced at this session. Specific instructions to the Sub-Committees and the framework for the EBP, including the data collection formats, is scheduled to be discussed at the next session.

The structure of the non-mandatory MASS Code is as follows.

Part 1: Introduction (purpose and application of the code)

Part 2: Main principles for MASS and remote operations centres (ROC) functions (certificate and survey, approval process, risk assessment, operational context, human element, etc.)

Part 3: Specific requirements (functional requirements and expected performance for each detailed item such as navigation and remote operations)

5. A safety regulatory framework to support the reduction of GHG emissions from ships using new technologies and alternative fuels

At MSC 107, identification and updating a list of new technologies and alternative fuels to reduce greenhouse gas (GHG) emissions and their technical assessment, as well as a review of safety obstacles and gaps in the current IMO instruments that may impede the use of the alternative fuel or new technology, were initiated.

At the previous session, based on the recommendations to address each of the identified barriers and gaps in current IMO instruments reported by the correspondence group, amendments to conventions or cords, development of guidelines, etc. were instructed to each sub-committee.
At this session, draft work plans were submitted by CCC and SDC sub-committee and approved.
For example:

- Develop safety requirements for onboard carbon capture and storage systems on ships: finalize development of interim guidelines at 2028 (CCC)
- Develop requirements for the Safety of Ships Using Lithium-ion Battery Installations: finalize amendments to SOLAS regulation II-1/41 to allow for batteries to be used as the main source of electrical power and lighting systems at 2027 (Transfer of work from SSE to SDC)
- Update the Code of Safety for Nuclear Merchant Ships (Resolution A.491(XII)): finalize the revised Nuclear Code and amendments to SOLAS chapter VIII at 2030 (SDC)
- Develop Interim guidelines for the Safety of Ships Using Wind Propulsion and Wind Assisted Power: finalize interim guidelines at 2029 (SDC)

6. Consideration of cybersecurity standards

At the previous session, it was discussed about newly develop cybersecurity standards for ships and port facilities, and agreed to develop a non-mandatory cybersecurity Code of which requirements are goal-based and include risk management. As the development of the Code would be subject to the approval of a future session of the committee, preliminary work on the Code would be undertaken by an informal group of experts.

(To be continued)

However, as MSC is faced with a large number of agenda items, the new work plan for this matter was submitted to, and approved by, the 50th session of the IMO Facilitation Committee (FAL 50) held in March this year, in order to ensure that consideration would commence.

At the present meeting, the results of the deliberations at FAL 50 were reported, and the road map including the holding of intersessional working groups (ISWG), was endorsed.

For any questions about the above, please contact:

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Attachment:

1. RESOLUTION MSC.583(111)
2. RESOLUTION MSC.584(111)
3. RESOLUTION MSC.585(111)
4. RESOLUTION MSC.586(111)
5. RESOLUTION MSC.587(111)
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10. RESOLUTION MSC.593(111)
11. RESOLUTION MSC.595(111)
12. RESOLUTION MSC.597(111)
13. DRAFT AMENDMENTS TO THE INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK (IGC CODE)
14. MSC.1/Circ.1700 Guidelines on the use of remote inspection techniques for ESP Code surveys
15. MSC.1/Circ.1701 Interim Guidelines for the safety of ships using hydrogen as fuel
16. MSC.1/Circ.1702 Interim Guidelines for use of ammonia cargo as fuel
17. MSC.1/Circ.1703 Unified interpretations of the IGC Code

ANNEX 3

RESOLUTION MSC.583(111)
(adopted on 21 May 2026)

AMENDMENTS TO CHAPTERS IV AND V, AND THE APPENDIX OF THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO article VIII(b) of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"), concerning the amendment procedure applicable to the annex to the Convention, other than to the provisions of chapter I,

HAVING CONSIDERED, at its 111th session, amendments to the Convention proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the Convention, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the said amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974

CHAPTER IV
RADIOCOMMUNICATIONS

Part B
Undertakings by Contracting Governments

Regulation 5
Provision of radiocommunication services

1 The following new paragraph is added after the existing paragraph 2:

"3 Each Contracting Government undertakes to use all operational recognized mobile satellite services in their area of responsibility when disseminating maritime safety information and search and rescue related information via the Enhanced Group Call service."

CHAPTER V
SAFETY OF NAVIGATION

Regulation 4
Navigational warnings

2 Regulation 4 is replaced by the following:

"Each Contracting Government shall take all steps necessary to ensure that, when intelligence of any danger is received from whatever reliable source, it shall be promptly brought to the knowledge of those concerned and communicated to other interested Governments, with due regard to regulation IV/5.3.*

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* Refer to the *Guidance on the IMO/IHO World-Wide Navigational Warning Service* (resolution A.706(17), as amended)."

Regulation 5
Meteorological services and warnings

3 The chapeau of paragraph 2 is replaced by the following:

"2 In particular, Contracting Governments undertake to carry out, in co-operation, the following meteorological arrangements, with due regard to regulation IV/5.3:"

Regulation 18
Approval, surveys and performance standards of navigational systems and equipment and voyage data recorder

4 In the footnote to paragraph 2, the following new entry is added:

"*Performance standards for shipborne VHF data exchange system (VDES)* (resolution MSC.593(111));"

5 Paragraph 9 is replaced by the following:

"9 The automatic identification system (AIS) or VHF data exchange system (VDES) shall be subjected to an annual test. The test shall be conducted by an approved surveyor or an approved testing or servicing facility. The test shall verify the correct programming of the ship static information, correct data exchange with connected sensors as well as verifying the radio performance by radio frequency measurement and on-air test using, e.g. a Vessel Traffic Service (VTS). A copy of the test report shall be retained on board the ship."

Regulation 19
Carriage requirements for shipborne navigational systems and equipment

1 Application and requirements

6 Paragraph 1.2.3 is replaced by the following:

"1.2 Ships constructed before 1 July 2002 shall:

.3 be fitted with the system as required in paragraph 2.4; and"

2 Shipborne navigational equipment and systems

7 Paragraph 2.4 is replaced by the following:

"2.4 All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with an automatic identification system (AIS) or VHF data exchange system (VDES), as follows:

.1 AIS or VDES shall:

.1 provide automatically to appropriately equipped shore stations, other ships and aircraft information, including the ship's identity, type, position, course, speed, navigational status and other safety-related information;

.2 receive automatically such information from similarly fitted ships;

.3 monitor and track ships; and

.4 exchange data with shore-based facilities;

.2 the requirements of paragraph 2.4.1 shall not be applied to cases where international agreements, rules or standards provide for the protection of navigational information; and

.3 AIS or VDES shall be operated taking into account the guidelines adopted by the Organization.* Ships fitted with AIS or VDES shall maintain AIS or VDES in operation at all times except where international agreements, rules or standards provide for the protection of navigational information.

* Refer to the *Revised guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS)* (resolution A.1106(29)) and *Guidelines for the onboard operational use of shipborne VHF data exchange system (VDES)* (MSC.1/Circ.1699)."

Regulation 19-1
Long-range identification and tracking of ships

8 Paragraph 4.2 is replaced by the following:

"4.2 Ships, irrespective of the date of construction, fitted with an automatic identification system (AIS) or VHF data exchange system (VDES), as defined in regulation 19.2.4, and operated exclusively within sea area A1, as defined in regulation IV/2.1.15, shall not be required to comply with the provisions of this regulation."

APPENDIX

CERTIFICATES

Record of equipment for passenger ship safety (Form P)

9 In the table for "Details of navigational systems and equipment", item 4.1 is replaced by the following:

"4.1 Automatic identification system (AIS) or VHF data exchange system (VDES)"

Record of equipment for cargo ship safety (Form E)

10 In the table for "Details of navigational systems and equipment", item 4.1 is replaced by the following:

"4.1 Automatic identification system (AIS) or VHF data exchange system (VDES)"

Record of equipment for cargo ship safety (Form C)

11 In the table for "Details of navigational systems and equipment", item 4.1 is replaced by the following:

"4.1 Automatic identification system (AIS) or VHF data exchange system (VDES)"

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ANNEX 4

RESOLUTION MSC.584(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE INTERNATIONAL CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF BULK CARRIERS AND OIL TANKERS, 2011 (2011 ESP CODE)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

NOTING resolution A.1049(27), by which the Assembly adopted the International Code on the Enhanced Programme of Inspections during Surveys of Bulk Carriers and Oil Tankers, 2011 ("the 2011 ESP Code"), which has become mandatory under chapter XI-1 of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"),

NOTING ALSO article VIII(b) and regulation XI-1/2 of the Convention concerning the procedure for amending the 2011 ESP Code,

HAVING CONSIDERED, at its 111th session, amendments to the 2011 ESP Code, proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the 2011 ESP Code, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the said amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE INTERNATIONAL CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF BULK CARRIERS AND OIL TANKERS, 2011 (2011 ESP CODE)

Contents

1 Under "ANNEX A", "Part A", existing "Annex 5" is renumbered as "Annex 5A" and the following new item is added after renumbered "Annex 5A":

"Annex 5B Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

2 Under "ANNEX A", "Part B", existing "Annex 5" is renumbered as "Annex 5A" and the following new item is added after renumbered "Annex 5A":

"Annex 5B Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

3 Under "ANNEX B", "Part A", existing "Annex 8" is renumbered as "Annex 8A" and the following new item is added after renumbered "Annex 8A":

"Annex 8B Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

4 Under "ANNEX B", "Part B", existing "Annex 7" is renumbered as "Annex 7A" and the following new item is added after renumbered "Annex 7A":

"Annex 7B Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

ANNEX A

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING THE SURVEYS OF BULK CARRIERS

PART A

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF BULK CARRIERS HAVING SINGLE-SIDE SKIN CONSTRUCTION

1 General

1.2 *Definitions*

5 Paragraph 1.2.21 is replaced by the following:

"1.2.21 *Administration* means the Administration or organization recognized by the Administration, unless defined otherwise in this Code."

6 The following new paragraph 1.2.22 is added after paragraph 1.2.21, together with the associated footnote:

"1.2.22 *Remote Inspection Technique (RIT)* is a means of survey of any parts of the structure without the need for direct physical access of the surveyor.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

1.5 ***Thickness measurements and close-up surveys***

7 Section 1.5 is replaced by the following:

"**1.5** ***Thickness measurements and close-up surveys***

1.5.1 In any kind of survey, i.e. renewal, intermediate, annual or other surveys having the scope of the foregoing ones, for structures in areas where close-up surveys are required, thickness measurements, when required by annex 2, shall be carried out simultaneously with close-up surveys.

1.5.2 For periodic surveys after the third renewal survey, the use of a RIT is subject to the agreement of the Administration, which may impose additional requirements or limitations; in this case the Administration means the Government of the State whose flag the ship is entitled to fly and not the recognized organization."

8 The following new section 1.6 is added after existing section 1.5, together with the associated footnote:

"**1.6** ***Remote inspection techniques***

1.6.1 RIT surveys shall be carried out in accordance with the requirements given herein and taking into account the guidelines developed by the Organization.*

1.6.2 Where a RIT for a close-up survey is not carried out by the Administration, it shall be conducted by a firm approved as a service supplier by the Administration according to the principles stated in annex 5B of part A of annex A and shall be carried out under the presence of the surveyor and their continuous direction and control of the RIT process.

1.6.3 If the RIT reveals damage or deterioration that the surveyor judges requires attention or further investigation, the surveyor shall require a traditional survey to be undertaken without the use of a RIT.

1.6.4 Random confirmatory surveys or close-up surveys shall be carried out at locations selected by the surveyor for the purpose of verifying the results of the RIT.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

2 Renewal survey

2.5 Extent of overall and close-up surveys

9 The following new paragraph 2.5.5 is added after existing paragraph 2.5.4:

"2.5.5 When using a RIT to assist the close-up survey, the following applies:

.1 the surveyor may use a RIT to assist the close-up survey when there are no permanent means of access provided;

.2 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.3 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.4 the RIT shall not be used to assist the surveyor during the close-up survey in areas which have a recorded significant history of structural failures (corrosion, cracks and buckling). See guidelines in annex 9, paragraph 3.1.1; and

.5 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey. Details of how this will be facilitated shall be included in the survey programme."

5 Preparations for survey

5.1 Survey programme

10 The following new paragraph 5.1.6 is added after existing paragraph 5.1.5:

"5.1.6 If it is proposed to use a RIT, the proposal shall be submitted before the survey as part of the survey programme detailed above, discussed and approved by the Administration. The following shall be taken into account when preparing the survey programme:

.1 the RIT limitations, if any, shall be detailed in the survey programme;

.2 details of the areas not fully accessed by the permanent means of access and proposed to be covered by a RIT shall be detailed in the survey programme;

.3 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.4 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.5 the RIT shall not be used to assist the surveyor during the close-up in areas which have a recorded significant history of structural failures, defects, damage or deterioration (corrosion, cracks and buckling). See guidelines in annex 9, paragraph 3.1.1; and

.6 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey, details of how this will be facilitated shall be included in the survey programme."

5.2 *Conditions for survey*

11 Paragraph 5.2.6 is replaced by the following:

"5.2.6 In preparation for survey (including for surveys making use of a RIT) and thickness measurements and to allow for a thorough examination, all spaces shall be cleaned including removal from surfaces of all loose accumulated corrosion scale. Spaces shall be sufficiently clean and free from water, scale, dirt, oil residues, etc., to reveal corrosion, deformation, fractures, damages or other structural deterioration as well as the condition of the coating. However, those areas of structure whose renewal has already been decided by the owner need only be cleaned and descaled to the extent necessary to determine the limits of the areas to be renewed."

5.4 *Equipment for survey*

12 The following new paragraph 5.4.6 is added after existing paragraph 5.4.5, together with the associated footnote:

"5.4.6 The surveyor shall be satisfied with the method of data presentation including pictorial representation, and a good two-way communication between the surveyor and RIT operator shall be provided. Prior to every survey onboard, the RIT shall be validated, taking into account the guidelines developed by the Organization* and the existing conditions (light, humidity, dust, etc.), to confirm that the expected results can be achieved.

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* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

5.7 *Survey planning meeting*

13 Paragraph 5.7.2 is replaced by the following:

"5.7.2 Prior to commencement of any part of the renewal or intermediate survey, a survey planning meeting shall be held between the attending surveyor(s), the owner's representative in attendance, the thickness measurement firm representative, the RIT firm representative, where involved, and the master of the ship or an appropriately qualified representative appointed by the master or company; for the purpose to ascertain that all the arrangements envisaged in the survey programme are in place, so as to ensure the safe and efficient conduct of the survey work to be carried out (see also 7.1.2)."

14 Paragraph 5.7.3 is replaced by the following:

"5.7.3 The following is an indicative list of items that shall be addressed in the meeting:

.1 schedule of the ship (i.e. the voyage, docking and undocking manoeuvres, periods alongside, cargo and ballast operations, etc.);

.2 provisions and arrangements for thickness measurements (i.e. access, cleaning/descaling, illumination, ventilation, personal safety);

.3 extent of the thickness measurements;

.4 acceptance criteria (refer to the list of minimum thicknesses);

.5 extent of close-up survey and thickness measurement considering the coating condition and suspect areas/areas of substantial corrosion;

.6 execution of thickness measurements;

.7 taking representative readings in general and where uneven corrosion/pitting is found;

.8 mapping of areas of substantial corrosion;

.9 communication between attending surveyor(s), the thickness measurement firm operator(s) and owner's representative(s) concerning findings;

.10 the RIT limitations, if any;

.11 details of the areas not fully accessed by permanent means of access and proposed to be covered by a RIT; and

.12 confirmatory surveys for RIT."

7 Procedures for thickness measurements

7.2 Certification of thickness measurement firm

15 Section 7.2 is replaced by the following:

"***7.2 Certification of thickness measurement firm***

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 5A."

Annex 4B

SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

16 Section 2 is replaced by the following:

"**2 Information on access provision for close-up surveys and thickness measurement**

The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a RIT, the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements shall be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as a result of the close-up survey. Note: A RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access (see 1.5 and 5.1.6).

Hold/Tank No.	Structure	Permanent means of access	Temporary staging	Rafts	Ladders	RIT	Direct access	Other means (please specify)
F.P.	Fore peak							
A.P.	Aft peak							
Cargo holds	Hatch side coamings							
	Topside sloping plate							
	Upper stool plating							
	Cross deck							
	Side shell, frames and brackets							
	Transverse bulkhead							
	Hopper tank plating							
	Lower stool							
	Tank top							
Topside tanks	Under-deck structure							
	Side shell and structure							
	Sloping plate and structure							
	Webs and bulkheads							
Hopper tanks	Hopper sloping plate and structure							
	Side shell and structure							
	Bottom structure							
	Webs and bulkheads							
	Double-bottom structure							
	Upper stool internal structure							
	Lower stool internal structure							

History of bulk cargoes of a corrosive nature (e.g. high sulphur content)

"

Annex 5

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES

17 Existing annex 5 is renumbered as "Annex 5A" and the following new annex 5B is inserted after renumbered annex 5A, together with the associated footnotes:

"Annex 5B

PROCEDURES FOR CERTIFICATION OF A FIRM ENGAGED IN CLOSE-UP SURVEY OF HULL STRUCTURES USING A REMOTE INSPECTION TECHNIQUE (RIT)

1 Application

This procedure applies to RIT firms providing visual livestreaming of video and images to support close-up surveys.

2 General requirements

Supervisor and operators

2.1 The firm shall designate a supervisor who shall be certified according to the recognized national requirements or an equivalent industrial standard and shall have a minimum of two years' experience in the inspection of ships' structures.

2.2 An operator of a RIT shall be certified according to the recognized national requirements or an equivalent industrial standard and have had at least one year's experience as an assistant carrying out inspections of ships' structures (including participation in a minimum of five different assignments). An operator of a RIT who, according to the international and national legislations, is required to be licensed for operation of a RIT shall hold valid documentation issued by the appropriate bodies (e.g. unmanned aerial vehicle (UAV) pilots shall be qualified and licensed in accordance with applicable national requirements).

Training and qualification of operators

2.3 The firm is responsible for the training and qualification of its operators. UAV pilots shall be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration.

2.4 The firm shall maintain a documented training plan for RIT equipment operators. The plan shall include requirements for training in the renewal survey requirements for the structure as specified in this Code, the identification of structural deterioration (including corrosion, buckling, cracking and deteriorated coatings) and the reporting requirements of this Code.

2.5 Knowledge of the following shall be documented:

.1 guidelines developed by the Organization;*

.2 marine and/or offshore nomenclatures;

.3 the structural configuration of relevant ship types, including internal structure;

.4 the remote inspection equipment and its operation; and

.5 survey plans for examination of hull spaces of various configurations, including appropriate flight plans if using a UAV.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

RIT equipment

2.6 As a minimum, the following equipment shall be available:

.1 remotely operated platform with data capture devices capable of operation within an enclosed space;

.2 means of powering the platforms with sufficient capacity to complete the required inspections, including spare batteries if applicable;

.3 data collection devices which may include cameras capable of capturing in high definition both video images and still images;

.4 illumination equipment;

.5 high-definition display screen with live high-definition feed from inspection cameras;

.6 means of communication, as applicable; and

.7 data recording devices.

2.7 The RIT equipment shall be approved taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Firm procedures and guidelines on the use of RITs

2.8 The firm shall have documented operational procedures and guidelines on the use of RITs for how to plan, carry out and report inspections; how to handle/operate the equipment; collection and storage of data. These shall take into account the guidelines developed by the Organization* and include:

.1 requirements for preparation of inspection plans;

.2 operation of the remotely operated platforms;

.3 operation of lighting;

.4 calibration of the data capture devices;

.5 operation of the data capture devices;

.6 two-way communication between the operator, platform, surveyor and other personnel, such as support staff and ships' crew;

.7 guidance for the operator on how to achieve complete coverage of the structure to be inspected;

.8 guidance for the maintenance of the remotely operated platforms, data capture and storage devices, and display screens, as applicable;

.9 requirements for the collection and validation of data;

.10 if data is to be stored, then requirements for location attribution, and, time and date attribution, as available, validation and storage of data;

.11 requirements for the reporting of inspections, including the recording of damages and defects found during inspection and repair work; and

.12 if capable of undertaking cleaning/surface preparation, then procedures for undertaking this work.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Documents and records

2.9 The firm shall maintain the following:

.1 training records;

.2 operators' statutory and regulatory certificates and licences;

.3 equipment register for RIT equipment, including delivery device (e.g. UAVs, robots), data capture devices, data analysis devices and any associated equipment necessary to perform inspections;

.4 equipment maintenance manuals and records/logbook;

.5 records of calibration; and

.6 RIT equipment operation logbook.

3 Procedures for certification

Submission of documents

3.1 The following documents shall be submitted to the Administration for approval, together with a list of the documents submitted:

.1 outline of the firm, e.g. organization and management structure;

.2 experience of the firm with close-up survey of hull structures of ships using the RIT;

.3 technicians' careers, i.e. experience of technicians as RIT operators, technical knowledge and experience of hull structure, etc.;

.4 equipment used, including capturing devices (i.e. drones, cameras, etc.), streaming devices (i.e. screens) and other supporting equipment (i.e. illumination), and their maintenance/calibration procedures;

.5 operational procedures and instructions on how to carry out the servicing of the equipment and/or system. These shall either contain or make reference to the manufacturer's servicing manuals, servicing bulletins, instructions and training manuals, as appropriate, and to relevant international requirements;

.6 training programmes for RIT operators; and

.7 report format taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

*Auditing of the firm**

3.2 Upon reviewing the documents submitted with satisfactory results, the firm shall be audited in order to ascertain that it is duly organized and managed in accordance with the documents submitted, and eventually is capable of conducting close-up surveys of the hull structure of ships using RIT.

3.3 Certification is conditional upon a demonstration (on board or in a test environment) of a close-up survey using the RIT, as well as satisfactory reporting.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

4 Certification

4.1 Upon satisfactory results of both the audit of the firm referred to in 3.2 and the demonstration tests referred to in 3.3, the Administration shall issue a certificate of approval stating that the firm's operation system has been found to be satisfactory and that the results of services performed in accordance with that system may be accepted and utilized by the Administration in making decisions affecting certification. The certificate shall clearly state the type and scope of services, type of equipment and/or names of manufacturers of equipment where these are limiting restraints and any limitations or restrictions imposed and include a statement that the RIT shall support the close-up survey for the areas which may not be fully accessed by use of the permanent means of access.

4.2 Renewal/endorsement of the certificate shall be made at intervals not exceeding three years by verification that original conditions are maintained.

5 Report of any alteration to the certified operation system of the RIT firm

In cases where any alteration to the certified RIT firm is made, such an alteration shall be immediately reported to the Administration. A re-audit shall be conducted where deemed necessary by the Administration.

6 Withdrawal of the certification

The certification may be withdrawn in the following cases:

.1 where the RIT was improperly used or the results were improperly reported;

.2 where the Administration found any deficiency in the operation systems of the RIT firm; and

.3 where the firm failed to report any alteration referred to in 5 above to the Administration as required."

Annex 6

SURVEY REPORTING PRINCIPLES

1 General

18 The following new paragraphs 1.4 and 1.5 are added after existing paragraph 1.3:

"1.4 When a RIT has been used then:

.1 the RIT report shall include all videos and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions; and

.2 the report shall include the details of: RIT firm, approval certificate, equipment used and operators.

1.5 The report shall provide evidence of having been reviewed and approved by the attending surveyor(s)."

3 Result of the survey

19 Paragraph 3.2.2 is replaced by the following:

> ".2 identification of compartments where no structural damages/defects have been found. The report may be supplemented by sketches/photographs/videos; and"

PART B

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF BULK CARRIERS HAVING DOUBLE-SIDE SKIN CONSTRUCTION

1 General

1.2 Definitions

20 Paragraph 1.2.21 is replaced by the following:

"1.2.21 *Administration* means the Administration or organization recognized by the Administration, unless defined otherwise in this Code."

21 The following new paragraph 1.2.22 is added after paragraph 1.2.21, together with the associated footnote:

"1.2.22 *Remote Inspection Technique (RIT)* is a means of survey of any parts of the structure without the need for direct physical access of the surveyor.*

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* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

1.5 Thickness measurements and close-up surveys

22 Section 1.5 is replaced by the following:

"**1.5** ***Thickness measurements and close-up surveys***

1.5.1 In any kind of survey, i.e. renewal, intermediate, annual or other surveys having the scope of the foregoing ones, for structures in areas where close-up surveys are required, thickness measurements, when required by annex 2, shall be carried out simultaneously with close-up surveys.

1.5.2 For periodic surveys after the third renewal survey, the use of a RIT is subject to the agreement of the Administration, which may impose additional requirements or limitations; in this case the Administration means the Government of the State whose flag the ship is entitled to fly and not the recognized organization."

23 The following new section 1.6 is added after existing section 1.5, together with the associated footnote:

"**1.6** ***Remote inspection techniques***

1.6.1 RIT surveys shall be carried out in accordance with the requirements given herein and taking into account the guidelines developed by the Organization.*

1.6.2 Where a RIT for close-up survey is not carried out by the Administration, it shall be conducted by a firm approved as a service supplier by the Administration according to the principles stated in annex 5B of part B of annex A and shall be carried out under the presence of the surveyor and their continuous direction and control of the RIT process.

1.6.3 If the RIT reveals damage or deterioration that the surveyor judges requires attention or further investigation, the surveyor shall require a traditional survey to be undertaken without the use of a RIT.

1.6.4 Random confirmatory surveys or close-up surveys shall be carried out at locations selected by the surveyor for the purpose of verifying the results of the RIT.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

2 Renewal survey

2.5 Extent of overall and close-up surveys

24 The following new paragraph 2.5.5 is added after existing paragraph 2.5.4:

"2.5.5 When using a RIT to assist the close-up survey, the following applies:

.1 the surveyor may use a RIT to assist the close-up survey when there are no permanent means of access provided;

.2 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.3 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.4 the RIT shall not be used to assist the surveyor during the close-up survey in areas which have a recorded significant history of structural failures (corrosion, cracks and buckling). See guidelines in annex 9, paragraph 3.1.1; and

.5 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey. Details of how this will be facilitated shall be included in the survey programme."

5 Preparations for survey

5.1 Survey programme

25 The following new paragraph 5.1.6 is added after existing paragraph 5.1.5:

"5.1.6 If it is proposed to use a RIT, the proposal shall be submitted before the survey as part of the survey programme detailed above, discussed and approved by the Administration. The following shall be taken into account when preparing the survey programme:

.1 the RIT limitations, if any, shall be detailed in the survey programme;

.2 details of the areas not fully accessed by the permanent means of access and proposed to be covered by a RIT shall be detailed in the survey programme;

.3 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.4 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.5 the RIT shall not be used to assist the surveyor during the close-up in areas which have a recorded significant history of structural failures, defects, damage or deterioration (corrosion, cracks and buckling). See guidelines in annex 9, paragraph 3.1.1; and

.6 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey, details of how this will be facilitated shall be included in the survey programme."

5.2 *Conditions for survey*

26 Paragraph 5.2.6 is replaced by the following:

"5.2.6 In preparation for survey (including for surveys making use of a RIT) and thickness measurements and to allow for a thorough examination, all spaces shall be cleaned including removal from surfaces of all loose accumulated corrosion scale. Spaces shall be sufficiently clean and free from water, scale, dirt, oil residues, etc., to reveal corrosion, deformation, fractures, damages or other structural deterioration as well as the condition of the coating. However, those areas of structure whose renewal has already been decided by the owner need only be cleaned and descaled to the extent necessary to determine the limits of the areas to be renewed."

5.4 *Equipment for survey*

27 The following new paragraph 5.4.6 is added after existing paragraph 5.4.5, together with the associated footnote:

"5.4.6 The surveyor shall be satisfied with the method of data presentation including pictorial representation, and a good two-way communication between the surveyor and RIT operator shall be provided. Prior to every survey onboard, the RIT shall be validated, taking into account the guidelines developed by the Organization* and the existing conditions (light, humidity, dust, etc.), to confirm that the expected results can be achieved.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

5.7 *Survey planning meeting*

28 Paragraph 5.7.2 is replaced by the following:

"5.7.2 Prior to commencement of any part of the renewal or intermediate survey, a survey planning meeting shall be held between the attending surveyor(s), the owner's representative in attendance, the thickness measurement firm representative, the RIT firm representative, where involved, and the master of the ship or an appropriately qualified representative appointed by the master or company; for the purpose to ascertain that all the arrangements envisaged in the survey programme are in place, so as to ensure the safe and efficient conduct of the survey work to be carried out (see also 7.1.2)."

29 Paragraph 5.7.3 is replaced by the following:

"5.7.3 The following is an indicative list of items that shall be addressed in the meeting:

.1 schedule of the ship (i.e. the voyage, docking and undocking manoeuvres, periods alongside, cargo and ballast operations, etc.);

.2 provisions and arrangements for thickness measurements (i.e. access, cleaning/descaling, illumination, ventilation, personal safety);

.3 extent of the thickness measurements;

.4 acceptance criteria (refer to the list of minimum thicknesses);

.5 extent of close-up survey and thickness measurement considering the coating condition and suspect areas/areas of substantial corrosion;

.6 execution of thickness measurements;

.7 taking representative readings in general and where uneven corrosion/pitting is found;

.8 mapping of areas of substantial corrosion;

.9 communication between attending surveyor(s), the thickness measurement firm operator(s) and owner’s representative(s) concerning findings;

.10 the RIT limitations, if any;

.11 details of the areas not fully accessed by permanent means of access and proposed to be covered by a RIT; and

.12 confirmatory surveys for RIT."

7 Procedures for thickness measurements

7.2 Certification of thickness measurement firm

30 Section 7.2 is replaced by the following:

"**7.2** ***Certification of thickness measurement firm***

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 5A."

Annex 4B

SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

31 Section 2 is replaced by the following:

"**2 Information on access provision for close-up surveys and thickness measurement**

The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a RIT, the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements shall be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as a result of the close-up survey. Note: A RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access (see 1.5 and 5.1.6).

Tank/Hold No.	Structure	Permanent means of access	Temporary staging	Rafts	Ladders	RIT	Direct access	Other means (please specify)
F.P.	Fore peak							
A.P.	Aft peak							
Cargo holds	Hatch side coamings							
	Topside sloping plate							
	Upper stool plating							
	Cross deck							
	Double-side tank plating							
	Transverse bulkhead							
	Hopper tank plating							
	Lower stool plating							
	Tank top							
Topside tanks	Under-deck structure							
	Side shell and structure							
	Sloping plate and structure							
	Webs and bulkheads							
Hopper tanks	Hopper sloping plate and structure							
	Side shell and structure							
	Bottom structure							
	Webs and bulkheads							
Double-side tanks	Side shell and structure							
	Inner skin and structure							
	Webs and bulkheads							
	Double-bottom structure							
	Upper stool internal structure							
	Lower stool internal structure							
Wing tanks of ore carriers	Underdeck and structure							
	Side shell and structure							
	Side shell vertical web and structure							
	Longitudinal bulkhead and structure							
	Longitudinal bulkhead web and structure							
	Bottom plating and structure							
	Cross ties/stringers							

History of bulk cargoes of a corrosive nature (e.g. high sulphur content)

"

Annex 5

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES

32 Existing annex 5 is renumbered as "Annex 5A" and the following new annex 5B is inserted after renumbered annex 5A, together with the associated footnotes:

"Annex 5B

PROCEDURES FOR CERTIFICATION OF A FIRM ENGAGED IN CLOSE-UP SURVEY OF HULL STRUCTURES USING A REMOTE INSPECTION TECHNIQUE (RIT)

1 Application

This procedure applies to RIT firms providing visual livestreaming of video and images to support close-up surveys.

2 General requirements

Supervisor and operators

2.1 The firm shall designate a supervisor who shall be certified according to the recognized national requirements or an equivalent industrial standard and shall have a minimum of two years' experience in the inspection of ships' structures.

2.2 An operator of a RIT shall be certified according to the recognized national requirements or an equivalent industrial standard and have had at least one year's experience as an assistant carrying out inspections of ships' structures (including participation in a minimum of five different assignments). An operator of a RIT who, according to the international and national legislations, is required to be licensed for operation of a RIT shall hold valid documentation issued by the appropriate bodies (e.g. unmanned aerial vehicles (UAV) pilots shall be qualified and licensed in accordance with applicable national requirements).

Training and qualification of operators

2.3 The firm is responsible for the training and qualification of its operators. UAV pilots shall be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration.

2.4 The firm shall maintain a documented training plan for RIT equipment operators. The plan shall include requirements for training in the renewal survey requirements for the structure as specified in this Code, the identification of structural deterioration (including corrosion, buckling, cracking and deteriorated coatings) and the reporting requirements of this Code.

2.5 Knowledge of the following shall be documented:

.1 guidelines developed by the Organization;*

.2 marine and/or offshore nomenclatures;

.3 the structural configuration of relevant ship types, including internal structure;

.4 the remote inspection equipment and its operation; and

.5 survey plans for examination of hull spaces of various configurations, including appropriate flight plans if using a UAV.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

RIT equipment

2.6 As a minimum, the following equipment shall be available:

.1 remotely operated platform with data capture devices capable of operation within an enclosed space;

.2 means of powering the platforms with sufficient capacity to complete the required inspections, including spare batteries if applicable;

.3 data collection devices which may include cameras capable of capturing in high definition both video images and still images;

.4 illumination equipment;

.5 high-definition display screen with live high-definition feed from inspection cameras;

.6 means of communication, as applicable; and

.7 data recording devices.

2.7 The RIT equipment shall be approved taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Firm procedures and guidelines on the use of RITs

2.8 The firm shall have documented operational procedures and guidelines on the use of RITs for how to plan, carry out and report inspections; how to handle/operate the equipment; collection and storage of data. These shall take into account the guidelines developed by the Organization* and include:

.1 requirements for preparation of inspection plans;

.2 operation of the remotely operated platforms;

.3 operation of lighting;

.4 calibration of the data capture devices;

.5 operation of the data capture devices;

.6 two-way communication between the operator, platform, surveyor and other personnel, such as support staff and ships' crew;

.7 guidance for the operator on how to achieve complete coverage of the structure to be inspected;

.8 guidance for the maintenance of the remotely operated platforms, data capture and storage devices, and display screens, as applicable;

.9 requirements for the collection and validation of data;

.10 if data is to be stored, then requirements for location attribution, and, time and date attribution, as available, validation and storage of data;

.11 requirements for the reporting of inspections, including the recording of damages and defects found during inspection and repair work; and

.12 if capable of undertaking cleaning/surface preparation, then procedures for undertaking this work.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Documents and records

2.9 The firm shall maintain the following:

.1 training records;

.2 operators' statutory and regulatory certificates and licences;

.3 equipment register for RIT equipment, including delivery device (e.g. UAVs, robots), data capture devices, data analysis devices and any associated equipment necessary to perform inspections;

.4 equipment maintenance manuals and records/logbook;

.5 records of calibration; and

.6 RIT equipment operation logbook.

3 Procedures for certification

Submission of documents

3.1 The following documents shall be submitted to the Administration for approval, together with a list of the documents submitted:

.1 outline of the firm, e.g. organization and management structure;

.2 experience of the firm with close-up survey of hull structures of ships using the RIT;

.3 technicians' careers, i.e. experience of technicians as RIT operators, technical knowledge and experience of hull structure, etc.;

.4 equipment used, including capturing devices (i.e. drones, cameras, etc.), streaming devices (i.e. screens) and other supporting equipment (i.e. illumination), and their maintenance/calibration procedures;

.5 operational procedures and instructions on how to carry out the servicing of the equipment and/or system. These shall either contain or make reference to the manufacturer's servicing manuals, servicing bulletins, instructions and training manuals, as appropriate, and to relevant international requirements;

.6 training programmes for RIT operators; and

.7 report format taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

*Auditing of the firm**

3.2 Upon reviewing the documents submitted with satisfactory results, the firm shall be audited in order to ascertain that it is duly organized and managed in accordance with the documents submitted, and eventually is capable of conducting close-up surveys of the hull structure of ships using RIT.

3.3 Certification is conditional upon a demonstration (on board or in a test environment) of a close-up survey using the RIT, as well as satisfactory reporting.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

4 Certification

4.1 Upon satisfactory results of both the audit of the firm referred to in 3.2 and the demonstration tests referred to in 3.3, the Administration shall issue a certificate of approval stating that the firm's operation system has been found to be satisfactory and that the results of services performed in accordance with that system may be accepted and utilized by the Administration in making decisions affecting certification. The certificate shall clearly state the type and scope of services, type of equipment and/or names of manufacturers of equipment where these are limiting restraints and any limitations or restrictions imposed and include a statement that the RIT shall support the close-up survey for the areas which may not be fully accessed by use of the permanent means of access.

4.2 Renewal/endorsement of the certificate shall be made at intervals not exceeding three years by verification that original conditions are maintained.

5 Report of any alteration to the certified operation system of the RIT firm

In cases where any alteration to the certified RIT firm is made, such an alteration shall be immediately reported to the Administration. A re-audit shall be conducted where deemed necessary by the Administration.

6 Withdrawal of the certification

The certification may be withdrawn in the following cases:

.1 where the RIT was improperly used or the results were improperly reported;

.2 where the Administration found any deficiency in the operation systems of the RIT firm; and

.3 where the firm failed to report any alteration referred to in 5 above to the Administration as required."

Annex 6

SURVEY REPORTING PRINCIPLES

1 General

33 The following new paragraphs 1.4 and 1.5 are added after existing paragraph 1.3:

"1.4 When a RIT has been used then:

.1 the RIT report shall include all videos and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions; and

.2 the report shall include the details of: RIT firm, approval certificate, equipment used and operators.

1.5 The report shall provide evidence of having been reviewed and approved by the attending surveyor(s)."

3 Result of the survey

34 Paragraph 3.2.2 is replaced by the following:

".2 identification of compartments where no structural damages/defects have been found. The report may be supplemented by sketches/photographs/videos; and"

ANNEX B

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF OIL TANKERS

PART A

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF DOUBLE-HULL OIL TANKERS

1 General

1.2 *Definitions*

35 Paragraph 1.2.20 is replaced by the following:

"1.2.20 *Administration* means the Administration or organization recognized by the Administration, unless defined otherwise in this Code."

36 The following new paragraph 1.2.21 is added after paragraph 1.2.20, together with the associated footnote:

"1.2.21 *Remote Inspection Technique (RIT)* is a means of survey of any parts of the structure without the need for direct physical access of the surveyor.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

1.5 *Thickness measurements and close-up surveys*

37 Section 1.5 is replaced by the following:

"**1.5** ***Thickness measurements and close-up surveys***

1.5.1 In any kind of survey, i.e. renewal, intermediate, annual or other surveys having the scope of the foregoing ones, for structures in areas where close-up surveys are required, thickness measurements, when required by annex 2, shall be carried out simultaneously with close-up surveys.

1.5.2 For periodic surveys after the third renewal survey, the use of a RIT is subject to the agreement of the Administration, which may impose additional requirements or limitations; in this case Administration means the Government of the State whose flag the ship is entitled to fly and not the recognized organization."

38 The following new section 1.6 is added after existing section 1.5, together with the associated footnote:

"**1.6** ***Remote inspection techniques***

1.6.1 RIT surveys shall be carried out in accordance with the requirements given herein and taking into account the guidelines developed by the Organization.*

1.6.2 Where a RIT for a close-up survey is not carried out by the Administration, it shall be conducted by a firm approved as a service supplier by the Administration according to the principles stated in annex 8B of part A of annex B and shall be carried out under the presence of the surveyor and their continuous direction and control of the RIT process.

1.6.3 If the RIT reveals damage or deterioration that the surveyor judges requires attention or further investigation, the surveyor shall require a traditional survey to be undertaken without the use of a RIT.

1.6.4 Random confirmatory surveys or close-up surveys shall be carried out at locations selected by the surveyor for the purpose of verifying the results of the RIT.

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* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

2 Renewal survey

2.4 Extent of overall and close-up surveys

39 The following new paragraph 2.4.5 is added after existing paragraph 2.4.4:

"2.4.5 When using a RIT to assist the close-up survey, the following applies:

.1 the surveyor may use a RIT to assist the close-up survey when there are no permanent means of access provided;

.2 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.3 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.4 the RIT shall not be used to assist the surveyor during the close-up survey in areas which have a recorded significant history of structural failures (corrosion, cracks and buckling). See guidelines in annex 12, paragraph 3.1.1; and

.5 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey. Details of how this will be facilitated shall be included in the survey programme."

2.6 ***Extent of tank pressure testing***

40 Paragraph 2.6.1.3 is replaced by the following:

".3 the tank testing is carried out within the renewal survey window and not more than three months prior to the date on which the overall or close-up survey is completed;"

5 Preparations for survey

5.1 ***Survey programme***

41 The following new paragraph 5.1.6 is added after existing paragraph 5.1.5:

"5.1.6 If it is proposed to use a RIT, the proposal shall be submitted before the survey as part of the survey programme detailed above, discussed and approved by the Administration. The following shall be taken into account when preparing the survey programme:

.1 the RIT limitations, if any, shall be detailed in the survey programme;

.2 details of the areas not fully accessed by the permanent means of access and proposed to be covered by a RIT shall be detailed in the survey programme;

.3 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.4 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.5 the RIT shall not be used to assist the surveyor during the close-up in areas which have a recorded significant history of structural failures, defects, damage or deterioration (corrosion, cracks and buckling). See guidelines in annex 12, paragraph 3.1.1; and

.6 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey, details of how this will be facilitated shall be included in the survey programme."

5.2 *Conditions for survey*

42 Paragraph 5.2.3 is replaced by the following:

"5.2.3 In preparation for survey (including for surveys making use of a RIT) and thickness measurements and to allow for a thorough examination, all spaces shall be cleaned including removal from surfaces of all loose accumulated corrosion scale. Spaces shall be sufficiently clean and free from water, scale, dirt, oil residues, etc., to reveal corrosion, deformation, fractures, damages or other structural deterioration as well as the condition of the coating. However, those areas of structure whose renewal has already been decided by the owner need only be cleaned and descaled to the extent necessary to determine the limits of the areas to be renewed."

5.4 *Equipment for survey*

43 The following new paragraph 5.4.6 is added after existing paragraph 5.4.5, together with the associated footnote:

"5.4.6 The surveyor shall be satisfied with the method of data presentation including pictorial representation, and a good two-way communication between the surveyor and RIT operator shall be provided. Prior to every survey onboard, the RIT shall be validated, taking into account the guidelines developed by the Organization* and the existing conditions (light, humidity, dust, etc.), to confirm that the expected results can be achieved.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

5.7 *Survey planning meeting*

44 Paragraph 5.7.2 is replaced by the following:

"5.7.2 Prior to commencement of any part of the renewal or intermediate survey, a survey planning meeting shall be held between the attending surveyor(s), the owner's representative in attendance, the thickness measurement firm representative, the RIT firm representative, where involved, and the master of the ship or an appropriately qualified representative appointed by the master or company; for the purpose to ascertain that all the arrangements envisaged in the survey programme are in place, so as to ensure the safe and efficient conduct of the survey work to be carried out (see also 7.1.2)."

45 Paragraph 5.7.3 is replaced by the following:

"5.7.3 The following is an indicative list of items that shall be addressed in the meeting:

.1 schedule of the ship (i.e. the voyage, docking and undocking manoeuvres, periods alongside, cargo and ballast operations, etc.);

.2 provisions and arrangements for thickness measurements (i.e. access, cleaning/descaling, illumination, ventilation, personal safety);

.3 extent of the thickness measurements;

.4 acceptance criteria (refer to the list of minimum thicknesses);

.5 extent of close-up survey and thickness measurement considering the coating condition and suspect areas/areas of substantial corrosion;

.6 execution of thickness measurements;

.7 taking representative readings in general and where uneven corrosion/pitting is found;

.8 mapping of areas of substantial corrosion;

.9 communication between attending surveyor(s), the thickness measurement firm operator(s) and owner's representative(s) concerning findings;

.10 the RIT limitations, if any;

.11 details of the areas not fully accessed by permanent means of access and proposed to be covered by a RIT; and

.12 confirmatory surveys for RIT."

7 Procedures for thickness measurements

7.2 Certification of thickness measurement firm

46 Section 7.2 is replaced by the following:

"**7.2** ***Certification of thickness measurement firm***

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 8A."

Annex 7B

SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

47 Section 2 is replaced by the following:

"The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a RIT, the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements shall be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as a result of the close-up survey. Note: A RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access (see 1.5 and 5.1.6).

Tank No.	Structure	C (Cargo)/ B (Ballast)	Permanent means of access	Temporary staging	Rafts	Ladders	RIT	Direct access	Other means (please specify)
F.P.	Fore peak								
A.P.	Aft peak								
Wing Tanks	Underdeck								
	Side shell								
	Bottom transverse								
	Longitudinal								
	Transverse								
Centre tanks	Under deck								
	Bottom transverse								
	Transverse								

History of cargo with H_2S content or heated cargo for the last three years together with indication as to whether cargo was heated and, where available, Material Safety Data Sheets (MSDS)*

* Refer to resolution MSC.150(77) on *Recommendation for material safety data sheets for MARPOL Annex I cargoes and marine fuel oils*."

Annex 8

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES

48 Existing annex 8 is renumbered as "Annex 8A" and the following new annex 8B is inserted after renumbered annex 8A, together with the associated footnotes:

"Annex 8B

PROCEDURES FOR CERTIFICATION OF A FIRM ENGAGED IN CLOSE-UP SURVEY OF HULL STRUCTURES USING A REMOTE INSPECTION TECHNIQUE (RIT)

1 Application

This procedure applies to RIT firms providing visual livestreaming of video and images to support close-up surveys.

2 General requirements

Supervisor and operators

2.1 The firm shall designate a supervisor who shall be certified according to the recognized national requirements or an equivalent industrial standard and shall have a minimum of two years' experience in the inspection of ships' structures.

2.2 An operator of a RIT shall be certified according to the recognized national requirements or an equivalent industrial standard and have had at least one year's experience as an assistant carrying out inspections of ships' structures (including participation in a minimum of five different assignments). An operator of a RIT who, according to the international and national legislations, is required to be licensed for operation of a RIT shall hold valid documentation issued by the appropriate bodies (e.g. unmanned aerial vehicle (UAV) pilots shall be qualified and licensed in accordance with applicable national requirements).

Training and qualification of operators

2.3 The firm is responsible for the training and qualification of its operators. UAV pilots shall be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration.

2.4 The firm shall maintain a documented training plan for RIT equipment operators. The plan shall include requirements for training in the renewal survey requirements for the structure as specified in this Code, the identification of structural deterioration (including corrosion, buckling, cracking and deteriorated coatings) and the reporting requirements of this Code.

2.5 Knowledge of the following shall be documented:

.1 guidelines developed by the Organization;*

.2 marine and/or offshore nomenclatures;

.3 the structural configuration of relevant ship types, including internal structure;

.4 the remote inspection equipment and its operation; and

.5 survey plans for examination of hull spaces of various configurations, including appropriate flight plans if using a UAV.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

RIT equipment

2.6 As a minimum, the following equipment shall be available:

.1 remotely operated platform with data capture devices capable of operation within an enclosed space;

.2 means of powering the platforms with sufficient capacity to complete the required inspections, including spare batteries if applicable;

.3 data collection devices which may include cameras capable of capturing in high definition both video images and still images;

.4 illumination equipment;

.5 high-definition display screen with live high-definition feed from inspection cameras;

.6 means of communication, as applicable; and

.7 data recording devices.

2.7 The RIT equipment shall be approved taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Firm procedures and guidelines on the use of RITs

2.8 The firm shall have documented operational procedures and guidelines on the use of RITs for how to plan, carry out and report inspections; how to handle/operate the equipment; collection and storage of data. These shall take into account the guidelines developed by the Organization* and include:

.1 requirements for preparation of inspection plans;

.2 operation of the remotely operated platforms;

.3 operation of lighting;

.4 calibration of the data capture devices;

.5 operation of the data capture devices;

.6 two-way communication between the operator, platform, surveyor and other personnel, such as support staff and ships' crew;

.7 guidance for the operator on how to achieve complete coverage of the structure to be inspected;

.8 guidance for the maintenance of the remotely operated platforms, data capture and storage devices and display screens, as applicable;

.9 requirements for the collection and validation of data;

.10 if data is to be stored, then requirements for location attribution, and, time and date attribution, as available, validation and storage of data;

.11 requirements for the reporting of inspections, including the recording of damages and defects found during inspection and repair work; and

.12 if capable of undertaking cleaning/surface preparation, then procedures for undertaking this work.

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* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Documents and records

2.9 The firm shall maintain the following:

.1 training records;

.2 operators' statutory and regulatory certificates and licences;

.3 equipment register for RIT equipment, including delivery device (e.g. UAVs, robots), data capture devices, data analysis devices and any associated equipment necessary to perform inspections;

.4 equipment maintenance manuals and records/logbook;

.5 records of calibration; and

.6 RIT equipment operation logbook.

3 Procedures for certification

Submission of documents

3.1 The following documents shall be submitted to the Administration for approval, together with a list of the documents submitted:

.1 outline of the firm, e.g. organization and management structure;

.2 experience of the firm with close-up survey of hull structures of ships using the RIT;

.3 technicians' careers, i.e. experience of technicians as RIT operators, technical knowledge and experience of hull structure, etc.;

.4 equipment used, including capturing devices (i.e. drones, cameras, etc.), streaming devices (i.e. screens) and other supporting equipment (i.e. illumination), and their maintenance/calibration procedures;

.5 operational procedures and instructions on how to carry out the servicing of the equipment and/or system. These shall either contain or make reference to the manufacturer's servicing manuals, servicing bulletins, instructions and training manuals, as appropriate, and to relevant international requirements;

.6 training programmes for RIT operators; and

.7 report format taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

*Auditing of the firm**

3.2 Upon reviewing the documents submitted with satisfactory results, the firm shall be audited in order to ascertain that it is duly organized and managed in accordance with the documents submitted, and eventually is capable of conducting close-up surveys of the hull structure of ships using RIT.

3.3 Certification is conditional upon a demonstration (on board or in a test environment) of a close-up survey using the RIT, as well as satisfactory reporting.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

4 Certification

4.1 Upon satisfactory results of both the audit of the firm referred to in 3.2 and the demonstration tests referred to in 3.3, the Administration shall issue a certificate of approval stating that the firm's operation system has been found to be satisfactory and that the results of services performed in accordance with that system may be accepted and utilized by the Administration in making decisions affecting certification. The certificate shall clearly state the type and scope of services, type of equipment and/or names of manufacturers of equipment where these are limiting restraints and any limitations or restrictions imposed and include a statement that the RIT shall support the close-up survey for the areas which may not be fully accessed by use of the permanent means of access.

4.2 Renewal/endorsement of the certificate shall be made at intervals not exceeding three years by verification that original conditions are maintained.

5 Report of any alteration to the certified operation system of the RIT firm

In cases where any alteration to the certified RIT firm is made, such an alteration shall be immediately reported to the Administration. A re-audit shall be conducted where deemed necessary by the Administration.

6 Withdrawal of the certification

The certification may be withdrawn in the following cases:

.1 where the RIT was improperly used or the results were improperly reported;

.2 where the Administration found any deficiency in the operation systems of the RIT firm; and

.3 where the firm failed to report any alteration referred to in 5 above to the Administration as required."

Annex 9

SURVEY REPORTING PRINCIPLES

1 General

49 The following new paragraphs 1.4 and 1.5 are added after existing paragraph 1.3:

"1.4 When a RIT has been used then:

.1 the RIT report shall include all videos and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions; and

.2 the report shall include the details of: RIT firm, approval certificate, equipment used and operators.

1.5 The report shall provide evidence of having been reviewed and approved by the attending surveyor(s)."

3 Result of the survey

50 Paragraph 3.2.2 is replaced by the following:

".2 identification of compartments where no structural damages/defects have been found. The report may be supplemented by sketches/photographs/videos;"

PART B

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF OIL TANKERS OTHER THAN DOUBLE-HULL OIL TANKERS

1 General

1.2 *Definitions*

51 Paragraph 1.2.17 is replaced by the following:

"1.2.17 *Administration* means the Administration or organization recognized by the Administration, unless defined otherwise in this Code."

52 The following new paragraph 1.2.18 is added after paragraph 1.2.17, together with the associated footnote:

"1.2.18 *Remote Inspection Technique (RIT)* is a means of survey of any parts of the structure without the need for direct physical access of the surveyor.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

1.5 *Thickness measurements and close-up surveys*

53 Section 1.5 is replaced by the following:

"**1.5** ***Thickness measurements and close-up surveys***

1.5.1 In any kind of survey, i.e. renewal, intermediate, annual or other surveys having the scope of the foregoing ones, for structures in areas where close-up surveys are required, thickness measurements, when required by annex 2, shall be carried out simultaneously with close-up surveys.

1.5.2 For periodic surveys after the third renewal survey, the use of a RIT is subject to the agreement of the Administration, which may impose additional requirements or limitations; in this case the Administration means the Government of the State whose flag the ship is entitled to fly and not the recognized organization."

54 The following new section 1.6 is added after existing section 1.5, together with the associated footnote:

"**1.6** ***Remote inspection techniques***

1.6.1 RIT surveys shall be carried out in accordance with the requirements given herein and taking into account the guidelines developed by the Organization.*

1.6.2 Where a RIT for close-up survey is not carried out by the Administration, it shall be conducted by a firm approved as a service supplier by the Administration according to the principles stated in annex 7B of part B of annex B and shall be carried out under the presence of the surveyor and their continuous direction and control of the RIT process.

1.6.3 If the RIT reveals damage or deterioration that the surveyor judges requires attention or further investigation, the surveyor shall require a traditional survey to be undertaken without the use of a RIT.

1.6.4 Random confirmatory surveys or close-up surveys shall be carried out at locations selected by the surveyor for the purpose of verifying the results of the RIT.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

2 Renewal survey

2.4 Extent of overall and close-up surveys

55 The following new paragraph 2.4.5 is added after existing paragraph 2.4.4:

"2.4.5 When using a RIT to assist the close-up survey, the following applies:

.1 the surveyor may use a RIT to assist the close-up survey when there are no permanent means of access provided;

.2 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.3 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.4 the RIT shall not be used to assist the surveyor during the close-up survey in areas which have a recorded significant history of structural failures (corrosion, cracks and buckling). See guidelines in annex 11, paragraph 3.1.1; and

.5 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey. Details of how this will be facilitated shall be included in the survey programme."

2.6 Extent of tank pressure testing

56 Paragraph 2.6.1.3 is replaced by the following:

".3 the tank testing is carried out within the renewal survey window and not more than three months prior to the date on which the overall or close-up survey is completed;"

5 Preparations for survey

5.1 *Survey programme*

57 The following new paragraph 5.1.6 is added after existing paragraph 5.1.5:

"5.1.6 If it is proposed to use a RIT, the proposal shall be submitted before the survey as part of the survey programme detailed above, discussed and approved by the Administration. The following shall be taken into account when preparing the survey programme:

.1 the RIT limitations, if any, shall be detailed in the survey programme;

.2 details of the areas not fully accessed by the permanent means of access and proposed to be covered by a RIT shall be detailed in the survey programme;

.3 the use of a RIT to assist the close-up survey shall not be permitted after the third renewal survey, unless agreed with the Administration (see 1.5.2);

.4 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.5 the RIT shall not be used to assist the surveyor during the close-up in areas which have a recorded significant history of structural failures, defects, damage or deterioration (corrosion, cracks and buckling). See guidelines in annex 12, paragraph 3.1.1; and

.6 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require thickness measurements, these shall be carried out simultaneously with the close-up survey, details of how this will be facilitated shall be included in the survey programme."

5.2 *Conditions for survey*

58 Paragraph 5.2.3 is replaced by the following:

"5.2.3 In preparation for survey (including for surveys making use of a RIT) and thickness measurements and to allow for a thorough examination, all spaces shall be cleaned including removal from surfaces of all loose accumulated corrosion scale. Spaces shall be sufficiently clean and free from water, scale, dirt, oil residues, etc., to reveal corrosion, deformation, fractures, damages or other structural deterioration as well as the condition of the coating. However, those areas of structure whose renewal has already been decided by the owner need only be cleaned and descaled to the extent necessary to determine the limits of the areas to be renewed."

5.4 *Equipment for survey*

59 The following new paragraph 5.4.6 is added after existing paragraph 5.4.5, together with the associated footnote:

"5.4.6 The surveyor shall be satisfied with the method of data presentation including pictorial representation, and a good two-way communication between the surveyor and RIT operator shall be provided. Prior to every survey onboard, the RIT shall be validated, taking into account the guidelines developed by the Organization* and the existing conditions (light, humidity, dust, etc.), to confirm that the expected results can be achieved.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700)."

5.7 *Survey planning meeting*

60 Paragraph 5.7.2 is replaced by the following:

"5.7.2 Prior to commencement of any part of the renewal or intermediate survey, a survey planning meeting shall be held between the attending surveyor(s), the owner's representative in attendance, the thickness measurement firm representative, the RIT firm representative, where involved, and the master of the ship or an appropriately qualified representative appointed by the master or company; for the purpose to ascertain that all the arrangements envisaged in the survey programme are in place, so as to ensure the safe and efficient conduct of the survey work to be carried out (see also 7.1.2)."

61 Paragraph 5.7.3 is replaced by the following:

"5.7.3 The following is an indicative list of items that shall be addressed in the meeting:

.1 schedule of the ship (i.e. the voyage, docking and undocking manoeuvres, periods alongside, cargo and ballast operations, etc.);

.2 provisions and arrangements for thickness measurements (i.e. access, cleaning/descaling, illumination, ventilation, personal safety);

.3 extent of the thickness measurements;

.4 acceptance criteria (refer to the list of minimum thicknesses);

.5 extent of close-up survey and thickness measurement considering the coating condition and suspect areas/areas of substantial corrosion;

.6 execution of thickness measurements;

.7 taking representative readings in general and where uneven corrosion/pitting is found;

.8 mapping of areas of substantial corrosion;

.9 communication between attending surveyor(s), the thickness measurement firm operator(s) and owner's representative(s) concerning findings;

.10 the RIT limitations, if any;

.11 details of the areas not fully accessed by permanent means of access and proposed to be covered by a RIT; and

.12 confirmatory surveys for RIT."

7 Procedures for thickness measurements

7.2 Certification of thickness measurement firm

62 Section 7.2 is replaced by the following:

"**7.2** ***Certification of thickness measurement firm***

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 7A."

Annex 6B

SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

63 Section 2 is replaced by the following:

"The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a RIT, the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements shall be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as a result of the close-up survey. Note: A RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access (see 1.5 and 5.1.6).

Tank No.	Structure	C (Cargo)/ B (Ballast)	Temporary staging	Rafts	Ladders	RIT	Direct access	Other means (please specify)
F.P.	Fore peak							
A.P.	Aft peak							
Wing tanks	Underdeck							
	Side shell							
	Bottom transverse							
	Longitudinal							
	Transverse							
Centre tanks	Under deck							
	Bottom transverse							
	Transverse							

History of cargo with H_2S content or heated cargo for the last three years together with indication as to whether cargo was heated and, where available, Material Safety Data Sheets (MSDS)*

* Refer to resolution MSC.150(77) on *Recommendation for material safety data sheets for MARPOL Annex I cargoes and marine fuel oils*."

Annex 7

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES

64 Existing annex 7 is renumbered as "Annex 7A" and the following new annex 7B is inserted after renumbered annex 7A, together with the associated footnotes:

"Annex 7B

PROCEDURES FOR CERTIFICATION OF A FIRM ENGAGED IN CLOSE-UP SURVEY OF HULL STRUCTURES USING A REMOTE INSPECTION TECHNIQUE (RIT)

1 Application

This procedure applies to RIT firms providing visual livestreaming of video and images to support close-up surveys.

2 General requirements

Supervisor and operators

2.1 The firm shall designate a supervisor who shall be certified according to the recognized national requirements or an equivalent industrial standard and shall have a minimum of two years' experience in the inspection of ships' structures.

2.2 An operator of a RIT shall be certified according to the recognized national requirements or an equivalent industrial standard and have had at least one year's experience as an assistant carrying out inspections of ships' structures (including participation in a minimum of five different assignments). An operator of a RIT who, according to the international and national legislations, is required to be licensed for operation of a RIT shall hold valid documentation issued by the appropriate bodies (e.g. unmanned aerial vehicle (UAV) pilots shall be qualified and licensed in accordance with applicable national requirements).

Training and qualification of operators

2.3 The firm is responsible for the training and qualification of its operators. UAV pilots shall be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration.

2.4 The firm shall maintain a documented training plan for RIT equipment operators. The plan shall include requirements for training in the renewal survey requirements for the structure as specified in this Code, the identification of structural deterioration (including corrosion, buckling, cracking and deteriorated coatings) and the reporting requirements of this Code.

2.5 Knowledge of the following shall be documented:

.1 guidelines developed by the Organization;*

.2 marine and/or offshore nomenclatures;

.3 the structural configuration of relevant ship types, including internal structure;

.4 the remote inspection equipment and its operation; and

.5 survey plans for examination of hull spaces of various configurations, including appropriate flight plans if using a UAV.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

RIT equipment

2.6 As a minimum, the following equipment shall be available:

.1 remotely operated platform with data capture devices capable of operation within an enclosed space;

.2 means of powering the platforms with sufficient capacity to complete the required inspections, including spare batteries if applicable;

.3 data collection devices which may include cameras capable of capturing in high definition both video images and still images;

.4 illumination equipment;

.5 high-definition display screen with live high-definition feed from inspection cameras;

.6 means of communication, as applicable; and

.7 data recording devices.

2.7 The RIT equipment shall be approved taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Firm procedures and guidelines on the use of RITs

2.8 The firm shall have documented operational procedures and guidelines on the use of RITs for how to plan, carry out and report inspections; how to handle/operate the equipment; collection and storage of data. These shall take into account the guidelines developed by the Organization* and include:

.1 requirements for preparation of inspection plans;

.2 operation of the remotely operated platforms;

.3 operation of lighting;

.4 calibration of the data capture devices;

.5 operation of the data capture devices;

.6 two-way communication between the operator, platform, surveyor and other personnel, such as support staff and ships' crew;

.7 guidance for the operator on how to achieve complete coverage of the structure to be inspected;

.8 guidance for the maintenance of the remotely operated platforms, data capture and storage devices and display screens, as applicable;

.9 requirements for the collection and validation of data;

.10 if data is to be stored, then requirements for location attribution, and, time and date attribution, as available, validation and storage of data;

.11 requirements for the reporting of inspections, including the recording of damages and defects found during inspection and repair work; and

.12 if capable of undertaking cleaning/surface preparation, then procedures for undertaking this work.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

Documents and records

2.9 The firm shall maintain the following:

.1 training records;

.2 operators' statutory and regulatory certificates and licences;

.3 equipment register for RIT equipment, including delivery device (e.g. UAVs, robots), data capture devices, data analysis devices and any associated equipment necessary to perform inspections;

.4 equipment maintenance manuals and records/logbook;

.5 records of calibration; and

.6 RIT equipment operation logbook.

3 Procedures for certification

Submission of documents

3.1 The following documents shall be submitted to the Administration for approval, together with a list of the documents submitted:

.1 outline of the firm, e.g. organization and management structure;

.2 experience of the firm with close-up survey of hull structures of ships using the RIT;

.3 technicians' careers, i.e. experience of technicians as RIT operators, technical knowledge and experience of hull structure, etc.;

.4 equipment used, including capturing devices (i.e. drones, cameras, etc.), streaming devices (i.e. screens) and other supporting equipment (i.e. illumination), and their maintenance/calibration procedures;

.5 operational procedures and instructions on how to carry out the servicing of the equipment and/or system. These shall either contain or make reference to the manufacturer's servicing manuals, servicing bulletins, instructions and training manuals, as appropriate, and to relevant international requirements;

.6 training programmes for RIT operators; and

.7 report format taking into account the guidelines developed by the Organization.*

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

*Auditing of the firm**

3.2 Upon reviewing the documents submitted with satisfactory results, the firm shall be audited in order to ascertain that it is duly organized and managed in accordance with the documents submitted, and eventually is capable of conducting close-up surveys of the hull structure of ships using RIT.

3.3 Certification is conditional upon a demonstration (on board or in a test environment) of a close-up survey using the RIT, as well as satisfactory reporting.

* Refer to the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700).

4 Certification

4.1 Upon satisfactory results of both the audit of the firm referred to in 3.2 and the demonstration tests referred to in 3.3, the Administration shall issue a certificate of approval stating that the firm's operation system has been found to be satisfactory and that the results of services performed in accordance with that system may be accepted and utilized by the Administration in making decisions affecting certification. The certificate shall clearly state the type and scope of services, type of equipment and/or names of manufacturers of equipment where these are limiting restraints and any limitations or restrictions imposed and include a statement that the RIT shall support the close-up survey for the areas which may not be fully accessed by use of the permanent means of access.

4.2 Renewal/endorsement of the certificate shall be made at intervals not exceeding three years by verification that original conditions are maintained.

5 Report of any alteration to the certified operation system of the RIT firm

In cases where any alteration to the certified RIT firm is made, such an alteration shall be immediately reported to the Administration. A re-audit shall be conducted where deemed necessary by the Administration.

6 Withdrawal of the certification

The certification may be withdrawn in the following cases:

.1 where the RIT was improperly used or the results were improperly reported;

.2 where the Administration found any deficiency in the operation systems of the RIT firm; and

.3 where the firm failed to report any alteration referred to in 5 above to the Administration as required."

Annex 8

SURVEY REPORTING PRINCIPLES

1 General

65 The following new paragraphs 1.4 and 1.5 are added after existing paragraph 1.3:

"1.4 When a RIT has been used then:

.1 the RIT report shall include all videos and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions; and

.2 the report shall include the details of: RIT firm, approval certificate, equipment used and operators.

1.5 The report shall provide evidence of having been reviewed and approved by the attending surveyor(s)."

3 Result of the survey

66 Paragraph 3.2.2 is replaced by the following:

".2 identification of compartments where no structural damages/defects have been found. The report may be supplemented by sketches/photographs/videos;"

***

ANNEX 5

RESOLUTION MSC.585(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE INTERNATIONAL CODE OF SAFETY FOR HIGH-SPEED CRAFT, 1994 (1994 HSC CODE)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

NOTING resolution MSC.36(63), by which it adopted the International Code of Safety for High-Speed Craft ("the 1994 HSC Code"), which has become mandatory under chapter X of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"),

NOTING ALSO article VIII(b) and regulation X/1.1 of the Convention concerning the procedure for amending the 1994 HSC Code,

HAVING CONSIDERED, at its 111th session, amendments to the 1994 HSC Code proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the 1994 HSC Code, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the said amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE INTERNATIONAL CODE OF SAFETY FOR HIGH-SPEED CRAFT, 1994 (1994 HSC CODE)

CHAPTER 13
SHIPBORNE NAVIGATIONAL SYSTEMS AND EQUIPMENT AND VOYAGE DATA RECORDER

13.15 Automatic identification system (AIS)

1 Paragraph 13.15 is replaced by the following:

"**13.15 Automatic identification system (AIS) and VHF data exchange system (VDES)**

13.15.1 Craft should be provided with automatic identification system (AIS) or VHF data exchange system (VDES).

13.15.2 AIS or VDES should:

.1 provide automatically to appropriately equipped shore stations, other vessels and aircraft information, including the craft's identity, type, position, course, speed, navigational status and other safety-related information;

.2 receive automatically such information from similarly fitted vessels and craft;

.3 monitor and track vessels; and

.4 exchange data with shore-based facilities.

13.15.3 The requirements of 13.15.2 should not be applied to cases where international agreements, rules or standards provide for the protection of navigational information.

13.15.4 AIS or VDES should be operated taking into account the guidelines developed by the Organization.*

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* Refer to the *Revised guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS)* (resolution A.1106(29)) and *Guidelines for the onboard operational use of shipborne VHF data exchange system (VDES)* (MSC.1/Circ.1699)."

Annex 1

FORM OF HIGH-SPEED CRAFT SAFETY CERTIFICATE

Record of Equipment for High-Speed Craft Safety Certificate

5 Details of navigational systems and equipment

2 In the table for "Details of navigational systems and equipment", item 13 is replaced by the following:

"13 Automatic identification system (AIS) or VHF data exchange system (VDES)"

***

ANNEX 6

RESOLUTION MSC.586(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE INTERNATIONAL CODE OF SAFETY FOR HIGH-SPEED CRAFT, 2000 (2000 HSC CODE)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

NOTING resolution MSC.97(73), by which it adopted the International Code of Safety for High-Speed Craft, 2000 ("the 2000 HSC Code"), which has become mandatory under chapter X of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"),

NOTING ALSO article VIII(b) and regulation X/1.2 of the Convention concerning the procedure for amending the 2000 HSC Code,

HAVING CONSIDERED, at its 111th session, amendments to the 2000 HSC Code proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the 2000 HSC Code, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the said amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE INTERNATIONAL CODE OF SAFETY FOR HIGH-SPEED CRAFT, 2000 (2000 HSC CODE)

CHAPTER 13
SHIPBORNE NAVIGATIONAL SYSTEM AND EQUIPMENT AND VOYAGE DATA RECORDERS

13.15 Automatic identification system

1 Paragraph 13.15 is replaced by the following:

"**13.15 Automatic identification system (AIS) and VHF data exchange system (VDES)**

13.15.1 Craft shall be provided with an automatic identification system (AIS) or VHF data exchange system (VDES).

13.15.2 AIS or VDES shall:

.1 provide automatically to appropriately equipped shore stations, other vessels and aircraft information, including the craft's identity, type, position, course, speed, navigational status and other safety-related information;

.2 receive automatically such information from similarly fitted vessels;

.3 monitor and track vessels; and

.4 exchange data with shore-based facilities.

13.15.3 The requirements of 13.15.2 shall not apply where international agreements, rules or standards provide for the protection of navigational information.

13.15.4 AIS or VDES shall be operated taking into account the guidelines adopted by the Organization.*

* Refer to the *Revised guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS)* (resolution A.1106(29)) and *Guidelines for the onboard operational use of shipborne VHF data exchange system (VDES)* (MSC.1/Circ.1699)."

Annex 1

FORM OF HIGH-SPEED CRAFT SAFETY CERTIFICATE

Record of Equipment for High-Speed Craft Safety Certificate

3 Details of navigational systems and equipment

2 In the table for "Details of navigational systems and equipment", item 15 is replaced by the following:

"15 Automatic identification system (AIS) or VHF data exchange system (VDES)"

***

ANNEX 7

RESOLUTION MSC.587(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE
INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG) CODE

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution MSC.122(75) by which it adopted the International Maritime Dangerous Goods Code (hereinafter referred to as "the IMDG Code"), which has become mandatory under chapter VII of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended (hereinafter referred to as "the Convention"),

RECALLING FURTHER article VIII(b) and regulation VII/1.1 of the Convention concerning the procedure for amending the IMDG Code,

HAVING CONSIDERED, at its 111th session, amendments to the IMDG Code, proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the IMDG Code, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that said amendments shall be deemed to have been accepted on 1 July 2027, unless prior to that date more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet, have notified their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 AGREES that Contracting Governments to the Convention may apply the aforementioned amendments in whole or in part on a voluntary basis from 1 January 2027;

5 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

6 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

DRAFT AMENDMENTS TO THE INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG) CODE (AMENDMENT 43-26)

PART 1
GENERAL PROVISIONS, DEFINITIONS AND TRAINING

Chapter 1.1
General provisions

1.1.3 Dangerous goods forbidden from transport

1.1.3.1 At the end of the paragraph, add the sentence "For vehicles which are prohibited from transport, see special provision SP980".

Chapter 1.2
Definitions, units of measurement and abbreviations

1.2.1 Definitions

Amend the existing definitions as indicated below:

In the definition for "*Bundles of cylinders*", at the end, add the words "The test pressure volume product taking into account the total water capacity of all pressure receptacles in the bundle shall not exceed 1.5 million bar L".

In the definition for "Cylinders", at the end, add the words "with a test pressure volume product not exceeding 1.5 million bar L".

In the definition for "Filling ratio", replace the words "a pressure receptacle" with the words "the means of containment".

In the definition for "*Large packagings*", in .2, replace the words "a volume" with the words "an internal volume".

In the definition for "*Large salvage packaging*", in .2, replace the words "a volume" with the words "an internal volume".

In the definition for "*Net explosive mass (NEM)*", after the word "*(NEQ)*", replace the comma with the word "*or*" and after the word "*(NEC)*", delete the words "*, or net explosive weight (NEW)*".

In the definition for "*Salvage pressure receptacle*", delete the words "with a water capacity not exceeding 3,000 L" and, after the words "pressure receptacle(s)", add the words "having a total test pressure volume product not exceeding 1.5 million bar L".

In the definition for "*Tube*", at the end, add the words "with a test pressure volume product not exceeding 1.5 million bar L".

In the definition for "Unit load", in paragraph ".2 placed in a protective outer enclosure, such as a pallet box;" insert the word "or", to read as follows: ".2 placed in a protective outer enclosure, such as a pallet box; or"

Insert the following new definitions in alphabetical order:

"*Usable water capacity* means the water capacity of salvage pressure receptacles remaining after the installation of equipment into a salvage pressure receptacle, which is necessary for, e.g. opening or drilling a stored pressure receptacle inside a closed salvage pressure receptacle. The usable water capacity may be lower than the water capacity originally approved and marked. It is expressed in litres".

"*Single packaging* means a packaging which does not require any inner packaging to perform its containment function during transport".

"*Pressure volume product (pV-product*) means the value resulting from multiplying the (usable) water capacity of a containment with its relevant maximum pressure during filling and usage (e.g. test pressure or charging pressure) as referenced for the relevant kind of containment. It is expressed in bar L".

1.2.2.1 In the table, in the second row for "Mass", in column "Acceptable alternative unit", replace the word "(ton)" with the words "(tonne (metric ton))".

In the table on round figures that are applicable for the conversion of the units into SI units:

Delete the sections for "Force" and "Stress".

In the section for "Pressure":

For "1 Pa", delete "= 1.02×10^{-5} kg/cm^2 = 0.75×10^{-2} torr".

For "1 bar", delete "= 1.02 kg/cm^2 = 750 torr".

Delete the lines for "1 kg/cm^2" and "1 torr".

In the section for "Energy, work, quantity of heat":

For "1 J", delete "= 0.102 kg·m".

For "1 kWh", delete "= 367×10^3 kg·m".

Delete the line for "1 kg·m".

For "1 kcal", delete "= 427 kg·m".

In the section for "Power":

For "1 W", delete "= 0.102 kg·m/s".

Delete the line for "1 kg·m/s^2".

For "1 kcal/h", delete "= 0.119 kg·m/s".

In the section for "Dynamic viscosity":

For "1 Pa·s", delete "= 0.102 kg·s/m²".

For "1 P", delete "= 1.02 × 10^{-2} kg·s/m²".

Delete the line for "1 kg·s/m²".

Chapter 1.5
General provisions concerning radioactive material

1.5.1.3 In the second sentence, after the words "in-transit storage", add the words ", shipment after storage".

PART 2
CLASSIFICATION

Chapter 2.0
Introduction

2.0.2 UN numbers and proper shipping names

In the third paragraph (entries in the Dangerous Goods List are of the following four types:), replace the following proper shipping names with upper-case text, to read as follows:

".1 single entries for well-defined substances or articles:

e.g.	UN 1090	ACETONE
	UN 1194	ETHYL NITRITE SOLUTION

.2 generic entries for well-defined groups of substances or articles:

e.g.	UN 1133	ADHESIVES
	UN 1266	PERFUMERY PRODUCT
	UN 2757	CARBAMATE PESTICIDE, SOLID, TOXIC
	UN 3101	ORGANIC PEROXIDE TYPE B, LIQUID

.3 specific N.O.S. entries covering a group of substances or articles of a particular chemical or technical nature:

e.g.	UN 1477	NITRATES, INORGANIC, N.O.S.
	UN 1987	ALCOHOLS, N.O.S.

.4 general N.O.S. entries covering a group of substances or articles meeting the criteria of one or more classes:

e.g.	UN 1325	FLAMMABLE SOLID, ORGANIC, N.O.S.
	UN 1993	FLAMMABLE LIQUID, N.O.S."

2.0.2.9 After the words "N.O.S. or generic entry", delete the words "and one or more substances" and at the end, add the words "or division".

2.0.4 Transport of samples

2.0.4.3 Samples of energetic materials for testing purposes

In **2.0.4.3**, add a new 2.0.4.3.2 and a new 2.0.4.3.3 to read as follows:

"2.0.4.3.2 Samples of organic substances carrying functional groups listed in tables A6.1 or A6.3 in appendix 6 of the *Manual of Tests and Criteria* may be assigned to one of the appropriate entries for self-reactive substances type C (UN Nos.3223, 3224, 3233 or 3234, as applicable) of division 4.1 and transported under the provisions of 2.4.2.3.2.4.2 for the transport in amounts of not more than 200 g per outer packaging provided that:

.1 they fulfil the criteria of 2.0.4.3.1.1 to .3; and

.2 their decomposition energy is:

.1 less than 1,500 J/g for salts or complexes of organic compounds;

.2 less than 2,000 J/g for other organic substances;

.3 1,500 J/g or more for salts or complexes of organic compounds, and in test C.1 the result is not "yes, rapidly" and in any one of test series F the result is not "not low"; or

.4 2,000 J/g or more for other organic substances, and in test C.1 the result is not "yes, rapidly" and in any one of test series F the result is not "not low".

The assessment in .2.3 and .2.4 may be based on a single test C.1 and a single test from test series F. If the criteria in .2 are fulfilled, it can be assumed that the sample is not more dangerous than self-reactive substances type B.

An appropriate method to determine temperature control requirements is described in section 20.3.4 of the *Manual of Tests and Criteria*.

Samples not passing the criteria in .2.3 or .2.4 may be transported by an approval issued by the competent authority of the country of origin. The approval shall be based on the available information and contain the classification and the relevant transport conditions. Alternatively, the sample may be dissolved or diluted with an inert compound to form a homogeneous mixture in agreement with the criteria in .2.1 or .2.2, as applicable.

2.0.4.3.3 A flow chart describing the classification of energetic samples is shown in figure 2.0.1.

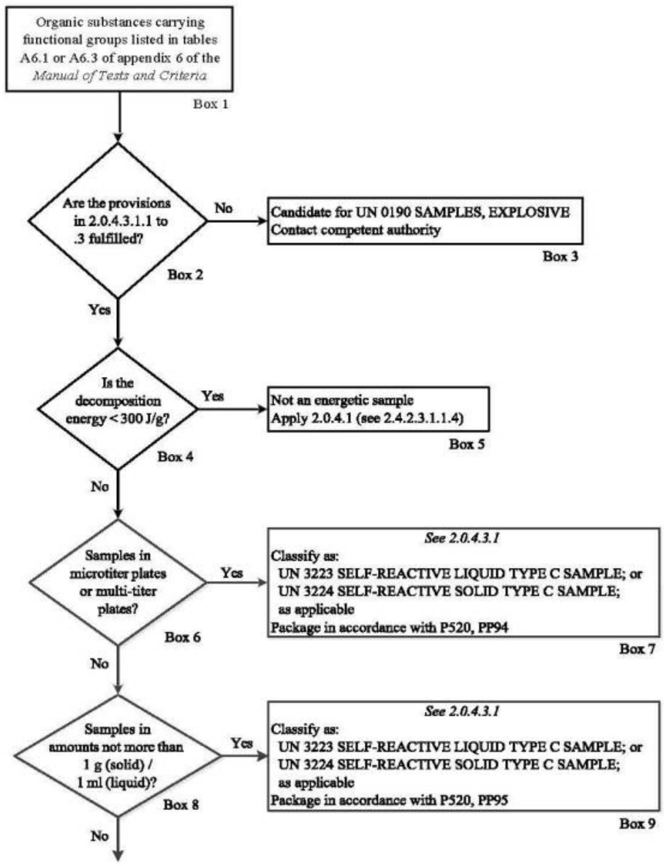

Figure 2.0.1 – Classification of energetic samples

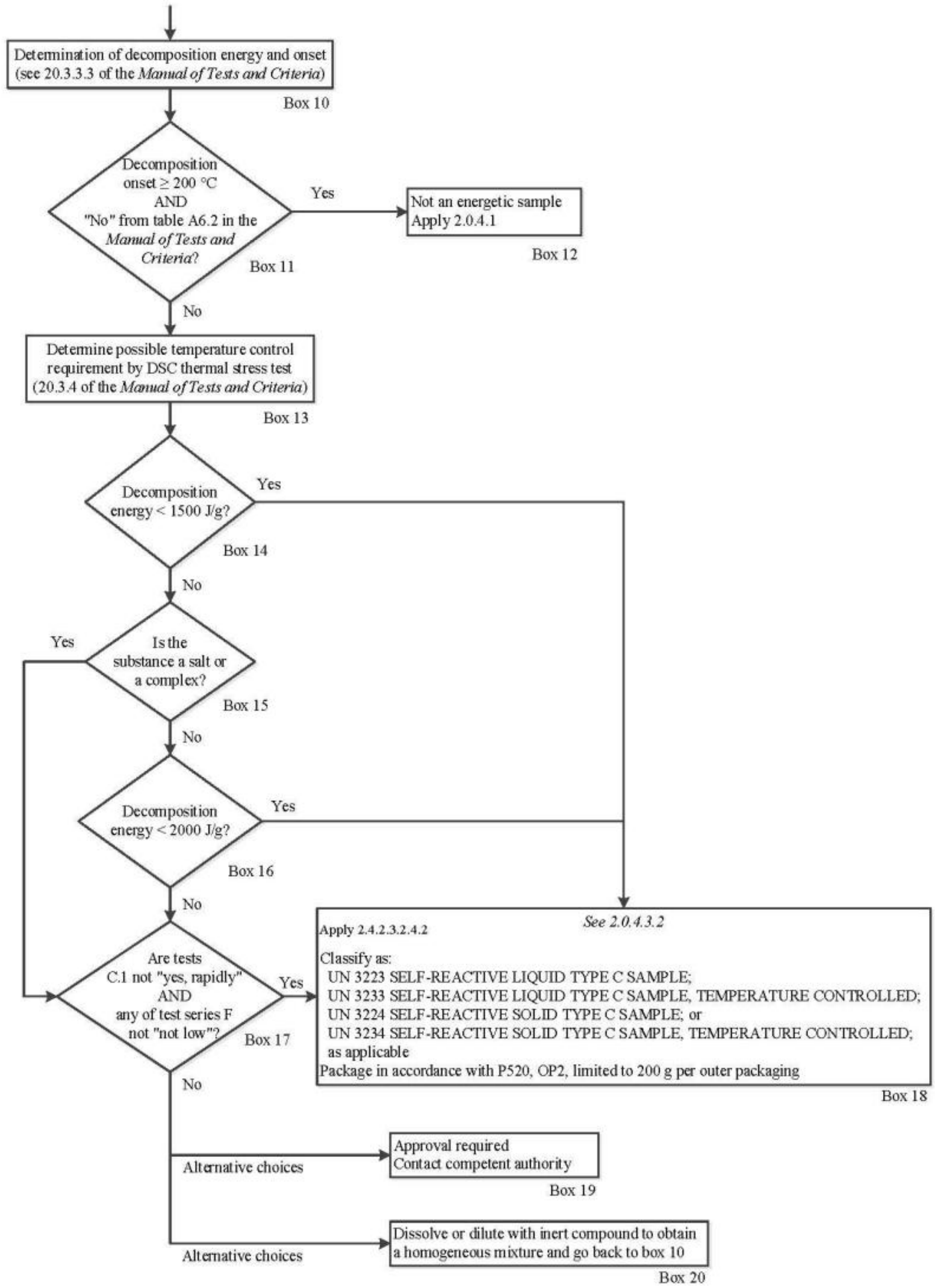

Figure 2.0.1 – Classification of energetic samples (continued)"

2.0.6 Classification of articles as articles containing dangerous goods, N.O.S.

2.0.6.2 In the second sentence, replace the words "Lithium cells and batteries" with the words "Lithium metal, lithium ion and sodium ion cells and batteries". In the third sentence, replace the words "lithium cells or batteries" with the words "lithium metal, lithium ion or sodium ion cells or batteries" (*twice*).

Chapter 2.1
Class 1 Explosives

2.1.1 Definitions and general provisions

2.1.1.1 In .2, after the word "except", add the words "those that are too dangerous to transport or".

2.1.1.3 Definitions

In .6, delete the words ", in the context of 2.1.1.1.3,".

2.1.3 Classification procedure

2.1.3.4 Exclusion from class 1

Renumber **2.1.3.4.2** as **2.1.3.4.4** and add the following new paragraphs:

> "**2.1.3.4.2** Where a substance provisionally accepted into class 1 is excluded from class 1 by performing test series 6 of section 16 of part I of the UN *Manual of Tests and Criteria* on a specific type and size of package, this substance, when meeting the classification criteria or definition for another class or division, shall be listed in the Dangerous Goods List of chapter 3.2 in that class or division with a special provision restricting it to the type and size of package tested.
>
> **2.1.3.4.3** Where a substance is assigned to class 1 but is diluted to be excluded from class 1 by test series 6 of section 16 of part I of the UN *Manual of Tests and Criteria*, this diluted substance (hereafter referred to as desensitized explosive) shall be listed in the Dangerous Goods List of chapter 3.2 with an indication of the highest concentration which excluded it from class 1 (see 2.3.1.4 and 2.4.2.4.1) and, if applicable, the concentration below which it is no longer deemed subject to this Code. New solid desensitized explosives subject to this Code shall be listed in class 4.1 and new liquid desensitized explosives shall be listed in class 3. When the desensitized explosive meets the criteria or definition for another class or division, the corresponding subsidiary hazard(s) shall be assigned to it."

Chapter 2.4
Class 4 – Flammable solids; substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases

2.4.3 Class 4.2 – Substances liable to spontaneous combustion

2.4.3.2 Classification of class 4.2 substances

2.4.3.2.3 ***Self-heating substances***

2.4.3.2.3.1 In .2 and .3, replace the word "a volume" with the words "an internal volume".

2.4.3.2.3.2 In .2 and .3, replace the word "a volume" with the words "an internal volume".

2.4.3.3.3 In .1 and .2, replace the word "a volume" with the words "an internal volume".

Chapter 2.5
Class 5 – Oxidizing substances and organic peroxides

2.5.3 Class 5.2 – Organic peroxides

2.5.3.2 Classification of organic peroxides

2.5.3.2.4 List of currently assigned organic peroxides in packagings

In the table, delete the entry for "([3R-(3R,5aS,6S,8aS,9R,10R,12S,12aR**)]-DECAHYDRO-10-METHOXY-3,6,9-TRIMETHYL-3,12-EPOXY-12H-PYRANO[4,3-j]-1,2-ENZODIOXEPIN)".

In the table, add the following new entries in proper order:

3115	*tert*-AMYL PEROXYPIVALATE	≤ 72	≥ 28				OP7	+10	+15	
3105	1,2,4,5,7,8-HEXOXONANE, 3,6,9-TRIMETHYL-3,6,9-tris (Ethyl and Propyl) derivatives	≤ 41	≥ 59				OP7			(35)
3106	ARTEETHER (including stereoisomers)	≤ 100					OP7			
3106	ARTEMETHER (including stereoisomers)	≤ 100					OP7			
3106	ARTEMISININ	≤ 100					OP7			
3106	ARTESUNATE (including stereoisomers)	≤ 100					OP7			
3106	DIHYDROARTEMISININ (including stereoisomers)	≤ 100					OP7			

In the list of "Remarks", add the following entry:

"(35) Available oxygen ≤ 7.3%".

Chapter 2.6
Class 6 – Toxic and infectious substances

2.6.2 Class 6.1 – Toxic substances

2.6.2.2 Assignment of packing groups to toxic substances

2.6.2.2.4.1 In the note, after the word "Substances", add the words "or mixtures".

2.6.3 Class 6.2 – Infectious substances

2.6.3.2 Classification of infectious substances

2.6.3.2.2 Replace the words "the following categories:" with the words "categories A and B".

2.6.3.2.2.1 Replace the text before the table to read as follows:

"**2.6.3.2.2.1** Category A

An infectious substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability, life-threatening or fatal disease in otherwise healthy humans or animals is assigned to category A. Indicative examples of substances that meet these criteria are given in the table in this paragraph.

Note: An exposure occurs when an infectious substance is released outside of the protective packaging, resulting in physical contact with humans or animals.

Infectious substances meeting these criteria which cause disease in humans or both in humans and animals shall be assigned to UN 2814 INFECTIOUS SUBSTANCE, AFFECTING HUMANS. Infectious substances which cause disease only in animals shall be assigned to UN 2900 INFECTIOUS SUBSTANCE, AFFECTING ANIMALS.

Assignment to UN Nos.2814 or 2900 shall be based on the known medical history and symptoms of the source human or animal, endemic local conditions, or professional judgement concerning individual circumstances of the source human or animal.

The following table is not exhaustive. Infectious substances, including new or emerging pathogens, which do not appear in the table but which meet the same criteria shall be assigned to category A. In addition, if there is doubt as to whether or not a substance meets the criteria, it shall be included in category A. To address emerging health situations, more up-to-date information on the applicable categories can be obtained from human and animal health intergovernmental organizations and national authorities."

In the table:

In the heading, delete "(2.6.3.2.2.1.1)" to read "Indicative examples of infectious substances included in category A in any form unless otherwise indicated".

In the heading of the second column, after the word "Microorganism" add the words "(bacteria and fungi are written in italics)".

In the first column, for UN 2900, at the end, delete the word "only".

2.6.3.2.2.2 Replace the text before the note to read as follows:

> "**2.6.3.2.2.2** Category B
>
> An infectious substance which does not meet the criteria for inclusion in category A is assigned to category B. Infectious substances in category B shall be assigned to UN 3373 BIOLOGICAL SUBSTANCE, CATEGORY B."

Delete the note.

2.6.3.2.3.9 In .3, at the end, add the words "other than lithium cells or batteries or sodium ion cells or batteries contained in or packed with equipment (UN Nos.3091, 3481 and 3552);".

At the end, add the following new paragraph:

> "When used medical devices contain or are packed with lithium cells or batteries or sodium ion cells or batteries, the relevant entry of the Dangerous Goods List in chapter 3.2 shall be used and all applicable provisions of this Code shall apply."

Chapter 2.8
Class 8 – Corrosive substances

2.8.2 General classification provisions

In 2.8.2.4, after the word "ingestion", replace the words "or dermal contact only in the range" with the words "and dermal contact in the range".

Chapter 2.9
Miscellaneous dangerous substances and articles (class 9) and environmentally hazardous substances

2.9.2 Assignment to class 9

2.9.2.2 Under "**Lithium batteries**":

In the line for "3536", after the word "LITHIUM", add the word "ION" and delete the lower-case text "lithium ion batteries or lithium metal batteries" at the end of the line.

After the line for "3536", add a new line to read as follows:

> "3563 LITHIUM METAL BATTERIES INSTALLED IN CARGO TRANSPORT UNIT"

Under "**Sodium ion batteries**":

After the lines for UN 3552, add a new entry to read as follows:

> "3564 SODIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT"

2.9.4 Lithium batteries

Replace the chapeau with the following text:

> "Cells and batteries, cells and batteries contained in articles, engines, equipment or vehicles or cells and batteries packed with equipment, containing lithium in any form may be transported under the appropriate entries if they meet the following provisions:"

In .1, renumber the existing note as "**Note 1**" and add a new note 2 to read as follows:

> "**Note 2:** A battery with a change resulting from treatment, such as repairing, refurbishing, or remanufacturing in accordance with 38.3.2.2 (c) of the *Manual of Tests and Criteria* may be considered to differ from a tested type."

In the note in .7, delete the words "for lithium cells or batteries or equipment with installed lithium cells or batteries".

Add a new .8 to read as follows:

> ".8 Hybrid batteries, containing both lithium ion cells and sodium ion cells (see special provision 410 of chapter 3.3), shall meet the following conditions:
>
> .1 the lithium ion cells and sodium ion cells are electrically connected;
>
> .2 the battery has been tested as a lithium ion battery in accordance with 2.9.4.1; and
>
> .3 each component lithium ion and sodium ion cell of the battery shall be of a type proved to meet the respective testing requirements of the *Manual of Tests and Criteria*, part III, subsection 38.3."

2.9.5 Sodium ion batteries

Replace the chapeau with the following text:

> "Cells and batteries, cells and batteries contained in articles, engines, equipment or vehicles, or cells and batteries packed with equipment containing sodium ion, which are a rechargeable electrochemical system where the positive and negative electrode are both intercalation or insertion compounds, constructed with no metallic sodium (or sodium alloy) in either electrode and with an organic non aqueous compound as electrolyte, may be transported under the appropriate entry if they meet the following provisions:"

Delete the sentence "They may be transported under these entries if they meet the following provisions:"

In .1, at the end, add the following new note:

> "**Note:** Batteries shall be of a type proved to meet the testing requirements of the *Manual of Tests and Criteria*, part III, subsection 38.3, irrespective of whether the cells of which they are composed are of a tested type."

In .6, at the end, add the following new note:

"**Note:** The term "make available" means that manufacturers and subsequent distributors ensure that the test summary is accessible so that the consignor or other persons in the supply chain can confirm compliance."

PART 3
DANGEROUS GOODS LIST, SPECIAL PROVISIONS AND EXCEPTIONS

Chapter 3.2
Dangerous Goods List

3.2.1 Structure of the Dangerous Goods List

With regard to "Column 17", replace the second paragraph to read as follows:

"**Note:** The following table provides examples of properties that may be included, as appropriate, in column 17 for the following specific classes:

All classes	• Physical state (i.e. solid, liquid, gas) • Form (e.g. flakes, powder, crystals, etc.) • Colour • Odour • Miscibility/solubility • Density • Human effect (e.g. irritating, drying, etc.) • Reactivity (e.g. with water, air, moisture, etc.) • Decomposition (e.g. with heat, fire or water) • Freezing/melting point • Vapour pressure
Class 1	• Stability (e.g. needs to be submerged in liquid)
Class 2	• Boiling point • Upper explosive or flammable limit (UEL/UFL) for class 2.1 • Lower explosive or flammable limit (LEL/LFL) for class 2.1 • Expansion ratio • Density in relation to air • "lighter than air" when the vapour density is down to half that of air; • "much lighter than air" when the vapour density is less than half that of air; • "heavier than air" when the vapour density is up to twice that of air; and • "much heavier than air" when the vapour density is more than twice that of air.
Class 3	• Boiling point • Initial boiling point

	• Flashpoint • Viscosity
Class 4	• None
Class 5	• None
Class 6	• Toxicity route for class 6.1 • Toxicity level for class 6.1 (LD_{50}, LC_{50}, saturated vapour concentration at 20℃)
Class 7	• None
Class 8	• Corrosivity to metal or skin or both • pH
Class 9	• Any of the above or other properties, as appropriate

The following are some examples of observations on substances and articles for inclusion in column 17 that would be useful to the crew:

.1 May form explosive mixtures with combustible material, powdered metals, or ammonium compounds.

.2 These mixtures are sensitive to friction and are liable to ignite.

.3 When involved in a fire, it evolves extremely toxic (e.g. phosgene) and corrosive (e.g. hydrogen chloride) fumes."

Dangerous Goods List

Amend the following existing entries as indicated below:

UN No.	Amendment
0012	In column 9, add "PP100" against "P130"
0014	In column 9, add "PP100" against "P130"
1040	In column 4, add "8"
1041	In column 4, add "8"
1075	In column 6, add "412"
1599 PG III	In column 14, replace "TP1" with "TP2"
1727	In column 4, add "6.1"
1761 PG III	In column 14, replace "TP1" with "TP2"
1897	In column 14, replace "TP1" with "TP2"
1965	In column 6, add "412"
2020	Replace column 2 to read "CHLOROPHENOLS, TOXIC, SOLID, N.O.S." and in column 6, add "274"
2021	Replace column 2 to read "CHLOROPHENOLS, TOXIC, LIQUID, N.O.S." and in column 6, add "274"
2029	In column 16(a), add "SW1", "SW11", "H2" and "H3". In column 9, replace "P001" with "PP98"
2046	In column 14, replace "TP1" with "TP2"
2052	In column 14, replace "TP1" with "TP2"
2203	In column 16a, replace the words "Category E" with the words "Category D"
2225 PG III	In column 16b, add "SG36" and "SG49"
2235	In column 14, replace "TP1" with "TP2"

UN No.	Amendment
2279	In column 14, replace "TP1" with "TP2"
2315	In column 14, replace "TP1" with "TP2"
2321	In column 14, replace "TP1" with "TP2"
2348 PG III	In column 17, replace the text to read "See entry above. Flashpoint: 23°C to 41°C c.c."
2372	In column 4, add "6.1" and "8". In column 13, replace "T4" with "T7". In column 14, add "TP28"
2433	In column 14, replace "TP1" with "TP2"
2504	In column 14, replace "TP1" with "TP2"
2514	In column 14, replace "TP1" with "TP2"
2515	In column 14, replace "TP1" with "TP2"
2518	In column 14, replace "TP1" with "TP2"
2735 PG II	In column 14, replace "TP1" with "TP2"
2857	In column 2, after the words "REFRIGERATING MACHINES", add the words "or HEATING MACHINES"
2862 PG III	In column 2, at the end, add the words ", containing less than 10% respirable particles". In column 17, replace the text to read "See entry above."
2941	Delete the entry
3028	In column 5, replace "III" with "-"
3082	In column 6, add "413" and in column 9, after "PP1", add "PP99"
3166	In column 6, add "980"
3171	In column 6, add "980"
3300	In column 4, add "8"
3358	In column 2, after the words "REFRIGERATING MACHINES", add the words "or HEATING MACHINES"
3408 PG II	In column 14, replace "TP1" with "TP2"
3408 PG III	In column 14, replace "TP1" with "TP2"
3480	In column 6, add "410"
3481	In column 6, add "410"
3536	In column 2, replace the existing text to read "LITHIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT". In column 6, add "410". In column 17, delete the words "lithium metal or"
3538	In column 6, add "411"
3551	In column 6, add "410"
3552	In column 6, add "410"
3556	In column 6, replace "405" by "980"
3557	In column 6, replace"405" by "980"
3558	In column 6, replace "405" by "980" and delete "404"

(1)	(2)	(3)	(4)	(5)	(6)	(7a)	(7b)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16a)	(16b)	(17)
2348	BUTYL ACRYLATES, STABILIZED	3	-	II	386	1 L	E2	P001	-	IBC02	-	-	T4	TP1	F-E, S-D	Category C SW1SW2	-	Colourless liquid with an unpleasant odour. Flashpoint: 14°C to < 23°C c.c. Explosive limits: 0.7% to 9.9%. Immiscible with water. Harmful by inhalation. Irritating to skin, eyes and mucous membranes.
2862	VANADIUM PENTOXIDE, non-fused form, containing not less than 10% respirable particles	6.1	-	II	-	500 g	E4	P002	-	IBC08	B2 B4	-	T3	TP33 TP43	F-A, S-A	Category A	-	Brownish powder. Slightly soluble in water. Toxic if swallowed, by skin contact or by inhalation.

Add the following entries:

(1)	(2)	(3)	(4)	(5)	(6)	(7a)	(7b)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16a)	(16b)	(17)
3561	CHLOROPHENOLS, CORROSIVE, TOXIC, SOLID, N.O.S.	8	6.1	II	274	1 kg	E2	P002	-	IBC08	B2 B4	-	T3	TP33	F-A, S-B	Category B SW2	-	Causes burns to skin, eyes and mucous membranes. Toxic if swallowed, by skin contact or by inhalation.
3562	CHLOROPHENOLS, CORROSIVE, SOLID, N.O.S.	8	-	II	-	1 kg	E2	P002	-	IBC08	B2 B4	-	T3	TP33	F-A, S-B	Category A	-	Causes burns to skin, eyes and mucous membranes.
3563	LITHIUM METAL BATTERIES INSTALLED IN CARGO TRANSPORT UNIT	9	-	-	389 410	0	E0	-	-	-	-	-	-	-	F-A, S-I	Category D SW1 SW2	-	Cargo transport unit containing lithium metal batteries which is designed to serve as a mobile power supply unit.
3564	SODIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT	9	-	-	389 410	0	E0	-	-	-	-	-	-	-	F-A, S-I	Category D SW1 SW2	-	Cargo transport unit containing sodium ion batteries which is designed to serve as a mobile power supply unit.

Chapter 3.3
Special provisions applicable to certain substances, materials or articles

Amend the following existing provision as indicated below:

SP63 Replace .6 and .7 to read as follows:

".6 The aerosol shall have a subsidiary hazard of division 6.1 or class 8 where the contents, other than the propellant of aerosol dispensers, are classified as:

.1 division 6.1, packing groups II or III; or

.2 class 8, packing groups II or III.

The aerosol shall be prohibited from transport where the contents are classified as:

.1 division 6.1, packing group I; or

.2 class 8, packing group I.

.7 The aerosol shall be prohibited from transport where the contents additionally meet the classification criteria of:

.1 class 1, explosives;

.2 liquid desensitized explosives of class 3;

.3 self-reactive substances and solid desensitized explosives of division 4.1;

.4 division 4.2, substances liable to spontaneous combustion;

.5 division 4.3, substances which, in contact with water, emit flammable gases;

.6 division 5.2, organic peroxides;

.7 division 6.2, infectious substances; or

.8 class 7, radioactive material;"

In the last paragraph, delete the second sentence and replace the last sentence to read: "The chemical heats of combustion shall be determined either by reference to published scientific literature, through calculation or by using suitable calorimetric test methods (e.g. ASTM D 240 and NFPA 30B)".

SP119 After the first sentence, add a new sentence to read: "Heating machines include machines or other appliances which have been designed for the specific purpose of heating".

In the now third sentence (previously second sentence), replace the words "Refrigerating machines and refrigerating machine components" by the words "Refrigerating or heating machines and their components".

At the end, add a new sentence to read: "Machines or other appliances that are used to perform heating and cooling functions may be transported either as "REFRIGERATING MACHINES" or "HEATING MACHINES".

SP145 Replace the words "of packing group III" with the words "with more than 24% but not more than 70% alcohol by volume".

SP172 In .3, replace the words "this (these) subsidiary hazard(s)" with the words "each subsidiary hazard".

In .4, before the words "subsidiary", replace the word "the" with the word "each".

SP188 In .3, replace the words "and 2.9.4.7" with ", 2.9.4.7 and 2.9.4.8 if applicable".

In .6:

in the first sentence, replace the words "with the appropriate lithium or sodium battery mark, as illustrated in" with the words "according to";

in the note, replace the words "(lithium battery mark)" with the words"(battery mark)";

in .2, at the end, add the following new sentence: "Where the equipment contains one or more button cells in addition to cells or batteries, the button cell or cells do not count toward package or consignment limits."

in the last paragraph, in the first sentence, replace the words "lithium or sodium battery mark" with the words "battery mark".

SP277 In the first sentence, after the word "value", add the words "for the purposes of exemptions in chapter 3.4".

SP280 In the second sentence, delete the words "described in special provision 296". At the end, add a new sentence to read: "However, this entry may be used for safety devices of class 9 transported for installation in life-saving appliances (UN 2990) in accordance with special provision 296".

SP291 In the first sentence, replace the words "refrigerating-machine components" with the words "refrigerating- or heating-machine components".

In the third sentence, replace the words "The refrigerating machines" with the words "Refrigerating or heating machines", and replace the words "refrigerating-machine components" with "their components".

In the fourth sentence, replace the words "Refrigerating machines and refrigerating-machine components" with the words "Refrigerating or heating machines and their components".

At the end, add a new sentence to read: "Machines that are used to perform heating and cooling functions may be transported either as "REFRIGERATING MACHINES" or "HEATING MACHINES".

SP296 In the first sentence, after the words "personal flotation devices", add the words ", self-inflating protective equipment".

Replace .2 to read as follows:

".2 for UN 2990 only:

.1 cartridges, power device of division 1.4, compatibility group S; or

.2 safety devices of class 9 (UN 3268),

installed for purposes of the self-inflating mechanism and provided that the quantity of explosives per appliance does not exceed 3.2 g;"

In .4, replace the words "lithium or sodium ion batteries" with the words "lithium batteries or sodium ion batteries".

SP301 After the third sentence, insert the following new sentence and sub-paragraphs:

"Such articles may in addition contain lithium cells or batteries or sodium ion cells or batteries, provided that the cells or batteries:

.1 provide electrical power for the operation of the article; and

.2 meet the requirements of special provision 188.1 to .3, .5 and .6."

In the fifth sentence (old fourth), after the first instance of the words "dangerous goods", add the words "other than cells or batteries". Insert a paragraph break after this sentence and replace the first sentence of this new paragraph to read: "If the articles contain more than one item of dangerous goods and these could react dangerously with one another during transport, each of the dangerous goods shall be enclosed separately (see 4.1.1.6)".

At the end, add the following new paragraph:

"Articles containing no other dangerous goods than cells or batteries shall be transported under UN Nos.3091, 3481 or 3552, as appropriate."

SP310 At the end of the first paragraph, replace the words "and 2.9.4.7" with the words ", 2.9.4.7, 2.9.4.8.2 if applicable and 2.9.4.8.3 if applicable for lithium cells or batteries, and shall meet the provisions of 2.9.5 with the exception of 2.9.5.1 and 2.9.4.5.7 (as referred to in 2.9.5.5) for sodium ion cells or batteries".

SP360 Before the last sentence, add the following new sentence: "Vehicles powered only by hybrid batteries containing both lithium ion cells and sodium ion cells in accordance with 2.9.4.8 shall be assigned to the entry UN 3556 VEHICLE, LITHIUM ION BATTERY POWERED".

Replace the last sentence to read: "Lithium batteries, sodium ion batteries or hybrid batteries containing both lithium ion cells and sodium ion cells in accordance with 2.9.4.8 installed in cargo transport units, designed only to provide power external to the transport unit shall be assigned to entries UN 3536 LITHIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT, UN 3563 LITHIUM METAL BATTERIES INSTALLED IN CARGO TRANSPORT UNIT or UN 3564 SODIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT, as applicable".

SP373 In the last sentence, replace the word "Category" with the word "category".

SP379 In .4.1, after "ISO 11114-1:2020", add "+ Amd 1:2023".

SP387 In the second sentence, replace the word "capacity" with the words "watt-hour rating".

SP388 In the second and third paragraphs, in the second sentence, replace the words "sodium batteries, lithium metal batteries or lithium ion batteries" with the words "nickel-metal hydride batteries, metallic sodium batteries, sodium alloy batteries, lithium metal batteries, lithium ion batteries, hybrid batteries containing both lithium ion cells and sodium ion cells in accordance with 2.9.4.8 or sodium ion batteries".

In the sixth paragraph, add a new second sentence to read "Vehicles powered only by hybrid batteries containing both lithium ion cells and sodium ion cells in accordance with 2.9.4.8 shall be assigned to the entry UN 3556 VEHICLE, LITHIUM ION BATTERY POWERED".

Replace the eighth paragraph to read as follows:

"Examples of equipment are lawnmowers, cleaning machines or model boats and model aircraft. Equipment powered by lithium metal batteries, lithium ion batteries or sodium ion batteries shall be assigned to the entries UN 3091 LITHIUM METAL BATTERIES CONTAINED IN EQUIPMENT or UN 3091 LITHIUM METAL BATTERIES PACKED WITH EQUIPMENT or UN 3481 LITHIUM ION BATTERIES CONTAINED IN EQUIPMENT or UN 3481 LITHIUM ION BATTERIES PACKED WITH EQUIPMENT or UN 3552 SODIUM ION BATTERIES CONTAINED IN EQUIPMENT or UN 3552 SODIUM ION BATTERIES PACKED WITH EQUIPMENT, as appropriate. Lithium ion batteries, lithium metal batteries, hybrid batteries containing both lithium ion cells and sodium ion cells in accordance with 2.9.4.8 or sodium ion batteries installed in a cargo transport unit and designed only to provide power external to the cargo transport unit shall be assigned to the entries UN 3536 LITHIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT, UN 3563 LITHIUM METAL BATTERIES INSTALLED IN CARGO TRANSPORT UNIT or UN 3564 SODIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT, as appropriate."

In the tenth paragraph, replace the words "and 2.9.4.7" with ", 2.9.4.7, 2.9.4.8.2 if applicable and 2.9.4.8.3 if applicable".

In the tenth paragraph, add a new last sentence to read: "Furthermore, sodium ion batteries shall meet the provisions of 2.9.5, except that 2.9.5.1, 2.9.5.5 and 2.9.5.6 do not apply when batteries of a production run of not more than 100 cells or batteries, or pre-production prototypes of cells or batteries when these prototypes are transported for testing, are installed in machinery or engines".

SP389 Replace the first paragraph to read:

"This entry only applies to lithium ion batteries, lithium metal batteries, sodium ion batteries or hybrid batteries containing both lithium ion cells and sodium ion cells in accordance with 2.9.4.8 installed in a cargo transport unit and designed only to provide power external to the cargo transport unit. Lithium batteries shall meet the requirements of 2.9.4.1 to .7. Hybrid batteries shall meet the requirements of 2.9.4.1 to .8. Sodium ion batteries shall meet the requirements of 2.9.5.1 to .6. All batteries shall contain the necessary systems to prevent overcharge and over discharge between the batteries."

SP393 At the end, add the words "to dry or unmodified nitrocellulose".

SP400 In .1, replace the words "shall be" with the word "is". In .3, replace the words "shall be" with the word "is". In .4, replace the words "shall be" with the word "is". In .5, first sentence, replace the words "shall be" with the word "are". In .5, second sentence, replace the words "shall be" with the word "is". In .6, replace the words "shall only contain" with the words "only contains".

SP401 In the last sentence, after the words "UN 2795", delete the words "BATTERIES, WET, FILLED WITH ALKALI, electric storage". At the end, add a new sentence to read: "Batteries containing metallic sodium or sodium alloy shall be transported as UN 3292".

SP403 In .2.1 and .2.2, replace the words "according to" with the words "in accordance with".

SP404 is deleted.

SP405 is deleted.

SP406 Replace the words "This entry" with the words "Substances under this entry".

SP407 In .2, replace the words "shall be" with the word "is".

In .3, replace the words "shall be" with the word "is" and the words "shall not" with the words "do not".

In .4, replace the words "shall be" with the word "is".

SP408 In .1 and .2, replace the word "must" with the word "shall".

SP961 The existing special provision, is replaced by the following:

"961 Vehicles which are not prohibited for transport in accordance with SP980 are not subject to the provisions of this Code, other than those in P912, SP388 and SP977 when applicable, if any of the following conditions are met:

.1 vehicles are stowed on the vehicle, special category and ro-ro spaces or on the weather deck of a ro-ro ship or a cargo space designated by the Administration (flag State) in accordance with SOLAS 74, chapter II-2, regulation 20 as specifically designed and approved for the carriage of vehicles, and there are no signs of leakage from the battery, engine, fuel cell, compressed gas cylinder or accumulator, or fuel system, or braking system when applicable. When packed in a cargo transport unit, the exception does not apply to container cargo spaces of a ro-ro ship;

.2 vehicles powered by a flammable liquid fuel with a flashpoint of 38°C or above, there are no leaks in any portion of the fuel system, the fuel tank(s) contains 450 L of fuel or less and installed batteries are electrically insulated to protect from short-circuit;

.3 vehicles powered by a flammable liquid fuel with a flashpoint less than 38°C, the fuel tank(s) are empty and installed batteries are electrically insulated to protect from short-circuit. Vehicles are considered to be empty of flammable liquid fuel when the fuel tank has been drained and the vehicles cannot be operated owing to a lack of fuel. Engine components such as fuel lines, fuel filters and injectors do not need to be cleaned, drained or purged to be considered empty. The fuel tank does not need to be cleaned or purged;

.4 vehicles powered by a flammable gas (liquefied or compressed), the fuel tank(s) are empty and the positive pressure in the tank does not exceed 2 bar, the fuel shut-off or isolation valve is closed and secured, and installed batteries are electrically insulated to protect from short-circuit;

.5 vehicles solely powered by a wet or dry electric storage battery or a sodium battery, and the battery is electrically insulated to protect from short-circuit; and

.6 vehicles solely powered by a sodium-ion battery, and the battery is short-circuited in a way that the battery does not contain electrical energy. The short circuiting shall be easily identifiable (e.g. busbar between terminals).

For vehicles powered by both a flammable liquid fuel and a flammable gas, all applicable conditions from .2 to .4 shall be met.

Sub-paragraphs .2 to .4 do not apply to hybrid electric vehicles as identified in special provision 388. Sub-paragraph .5 does not apply to vehicles powered by lithium batteries."

SP962 The existing special provision, is replaced by the following:

"962 Vehicles, which are not prohibited for transport in accordance with SP980 and do not meet the conditions of SP961 shall be assigned to class 9 and shall meet the following requirements:

.1 for flammable liquid-powered vehicles, the fuel tank(s) containing the flammable liquid shall not be more than one fourth full and, in any case, the flammable liquid shall not exceed 250 L unless otherwise approved by the competent authority;

.2 for flammable gas-powered vehicles, the fuel shut-off valve of the fuel tank(s) shall be securely closed; and

.3 installed batteries shall meet the provisions of SP388 or SP977, as applicable, and be protected from damage, accidental activation during transport, and electrically insulated to protect from short-circuit.

Unpackaged vehicles are not subject to the marking and labelling requirements of chapter 5.2.

Note: When transported in a cargo transport unit (CTU) the placarding requirements of chapter 5.3 apply, regardless of whether the vehicle is packaged or unpackaged."

Add the following new special provisions:

"410 Hybrid batteries in conformity with 2.9.4.8 containing both lithium ion cells and sodium ion cells shall be assigned to UN Nos.3480, 3481 or 3536, as appropriate. When such batteries are transported in accordance with special provision 188, the watt-hour rating shall not exceed 100 Wh and shall be marked on the outside case."

"411 Articles transported under this entry include magnetic resonance imaging (MRI) scanners containing non-flammable, non-toxic gas. The non-flammable, non-toxic gas shall be contained within the MRI scanner components. The MRI scanners shall be designed and constructed to contain the gas and preclude the risk of bursting or cracking of the gas retaining components during normal conditions of transport. MRI scanners are not subject to this Code if they contain less than 12 kg of gas in division 2.2."

"412 This entry may contain not more than 12% by mass of dimethyl ether."

"413 Liquid organic hydrogen carriers (LOHC) based on substances classified under this entry with physically dissolved hydrogen may only be transported under this entry when the content of physically dissolved hydrogen does not exceed the limit of 0.5 $L(H_2)/kg(LOHC)$."

"980 This Special Provision is not applicable to vehicles driven on board under their own power by a passenger, when carried on ro-ro passenger ships as defined in SOLAS regulation II-2/3.42.

The consignor shall assess the safety condition of the vehicle prior to offering for transport.

A vehicle shall not be offered for transport if it is forbidden in accordance with 1.1.3.1 or if it:

has, or shows signs of, leakage from the battery, engine, fuel cell, compressed gas cylinder or accumulator, fuel system, or braking system, when applicable; or

has, or shows signs of, damage to electric equipment (including but not limited to frayed or damaged cables); or

has, or shows signs of, damage to supplemental restraint systems (SRS) (e.g. airbags, seat belt tensioners); or

has been impacted by extreme events (e.g. flood, hurricane, tsunami, fire, submersion).

If any of the above condition(s) applies, the vehicle shall not be offered for transport unless corrective actions have been taken. Such corrective actions shall be evaluated regarding their effectiveness ensuring that the condition(s) no longer apply.

Batteries subject to Special Provision 376 shall be removed.

Vehicles transported as waste are also subject to the provisions of 2.0.5."

PART 4
PACKING AND TANK PROVISIONS

Chapter 4.1
Use of packagings, including intermediate bulk containers (IBCs) and large packagings

4.1.1 General provisions for the packing of dangerous goods in packagings, including IBCs and large packagings

4.1.1.2

In paragraph .1, delete the word "and" after the sentence "shall not be affected or significantly weakened by those dangerous goods;".

In paragraph .2 insert the word "and" after the sentence "shall not cause a dangerous effect, such as catalysing a reaction or reacting with the dangerous goods;".

4.1.1.19 Use of salvage pressure receptacles

4.1.1.19.3 In .3, first sentence, replace the words "and volume" with the words ", in usable water capacity and in pressure volume product".

4.1.3 General provisions concerning packing instructions

4.1.3.4 Replace the section for "Packagings" to read as follows:

"**Single packagings**

For substances of packing group I, unless approved for the transport of liquids of packing group I:

Drums: 1A2, 1B2, 1H2 and 1N2

Jerricans: 3A2, 3B2 and 3H2

For substances of packing groups I, II and III:

Drums: 1D and 1G

Boxes: 4A, 4B, 4C1, 4C2, 4D, 4F, 4G, 4H1, 4H2 and 4N

Bags: 5L1, 5L2, 5L3, 5H1, 5H2, 5H3, 5H4, 5M1 and 5M2

Composite packagings: 6HC, 6HD1, 6HD2, 6HG1, 6HG2, 6PC, 6PD1, 6PD2, 6PG1, 6PG2, 6PH1 and 6PH2"

4.1.3.6.5 In the first sentence, replace the words "level of filling" with the words "degree of filling".

4.1.4 List of packing instructions

4.1.4.1 Packing instructions concerning the use of packagings (except IBCs and large packagings)

P001 Add the following new special packing provisions:

"PP98 For UN 2029, when a pressure receptacle is used, the internal pressure at 65°C shall not exceed the test pressure.

PP99 For mixtures assigned to UN 3082 containing less than 1% of substances of highly toxic ingredients with an M factor of 10, 100, or 1000 (as described in 2.9.3.4.6.4), plastics drums with removable heads containing quantities of more than 5 litres and not more than 20 litres per packaging are not subject to the performance tests in chapter 6.1 for a transitional period until 31 December 2034, provided the packagings have successfully passed the stacking test in 6.1.5.6 for plastics drums intended for liquids and meet the general provisions of 4.1.1, except for 4.1.1.3, and 4.1.3."

P002 Delete table notes [4] and [5] and references to these notes.

After the row for "**Pressure receptacles**", provided that the general provisions of 4.1.3.6 are met." add a new row with the following text:

"***Additional requirement:***

Where the solid may become liquid during transport, see 4.1.3.4."

P006 In (5), first sentence, after the words "lithium cells or batteries", add the words "or sodium ion cells or batteries" (*twice*) and replace the words "have not met" with the words "has not met".

P130 Add the following new special packing provision:

"**PP100** For UN Nos.0012 and 0014, despite the requirements of 4.1.5.11, articles may be packed without internal cushioning, fittings, coating or liner in metal outer packagings."

P200 In (4) (d), replace the words "degree or pressure of filling" with the words "filling ratio or pressure of filling".

P410 Delete table note [3] and references to this note. Table note [4] becomes table note [3].

After the row for "**Pressure receptacles**", provided that the general provisions of 4.1.3.6 are met", add a new row with the following text:

"***Additional requirement:***

Where the solid may become liquid during transport, see 4.1.3.4."

P520 In special provision PP95, in .1, replace the word "consist" with the word "consists" and in .2, at the end, add the words "or 24 ± 2.4 g/L".

P903 In (2), at the beginning, replace the words "In addition" with the word "Alternatively,".

P907 At the end, add a new row with the following text:

"***Additional requirement:***

Cells and batteries shall be protected from damage and short circuit, and the article shall be equipped with an effective means of preventing accidental activation."

P911 In (2), first sentence, before the word "specified", add the word "approved or".

P912 In (c), at the beginning, replace the words "where the vehicles" with the words "where they".

4.1.4.2 Packing instructions concerning the use of IBCs

IBC04 and IBC05 After the second row, add a new row with the following text:

"***Additional requirement:***

Where the solid may become liquid during transport, see 4.1.3.4."

IBC520 For UN 3119, add a new entry to read as follows:

	tert-Butyl peroxy-2-ethylhexanoate, not more than 52%, in diluent type A	31HA1 31A	1,000 1,250	+30°C +30°C	+35°C +35°C

LP02 Before the row for "**Special packing provisions**", add a new row with the following text:

"***Additional requirement:***

Where the solid may become liquid during transport, see 4.1.3.4."

In table note [a], before the word "packagings", add the word "inner".

LP03 In (4), first sentence, after the words "lithium cells or batteries", add the words "or sodium ion cells or batteries" (*twice*).

LP906 In (2), first sentence, before the word "specified", add the words "approved or".

4.1.6 Special packing provisions for goods of class 2

4.1.6.1 General provisions

4.1.6.1.2 In the second sentence, after "ISO 11114-1:2020", add "+ Amd 1:2023".

4.1.6.1.8 In the paragraph after .5, third sentence, after "ISO 10297:2014 + Amd 1:2017", add the words "or clause 5.4.2 of ISO 10297:2024".

4.1.7 Special packing provisions for organic peroxides (class 5.2) and self-reactive substances of class 4.1

4.1.7.1 Use of packagings (except IBCs)

4.1.7.1.1 At the end of the paragraph add the following new sentence:

"To avoid the unnecessary confinement of liquids, metal packagings meeting the criteria of the internal pressure (hydraulic) test for packing group I shall not be used."

After the paragraph, add the following new note:

"**Note:** The consignor should consult with the packaging manufacturer to verify that the metal packaging does not meet the internal pressure (hydraulic) test criteria for packing group I."

Chapter 4.2
Use of portable tanks and multiple-element gas containers (MEGCs)

4.2.0 Transitional provisions

4.2.0.3 Insert new paragraphs at the end to read as follows:

"Portable tanks manufactured before 1 January 2027 which were marked in accordance with the requirements of 6.7.4.15.1 (i) (iv) applicable in Amendment 41-22 of this Code may continue to be used.

Portable tanks constructed before 1 January 2029 that do not conform to the requirements of 6.7.4.5.2 regarding the filling and discharge openings in the vapour phase may continue to be used."

4.2.1 General provisions for the use of portable tanks for the transport of substances of class 1 and classes 3 to 9

4.2.1.9 Degree of filling

4.2.1.9.2 Replace the words "The maximum degree of filling (in %) for general use is determined by the formula:" with the words "Except for liquids meeting any condition in 4.2.1.9.3, the maximum degree of filling (in %) for general use is determined by the formula:".

4.2.2 General provisions for the use of portable tanks for the transport of non-refrigerated liquefied gases and chemicals under pressure

4.2.2.8 In .1, replace the words "an ullage condition" with the words "a filling condition".

4.2.3 General provisions for the use of portable tanks for the transport of refrigerated liquefied gases of class 2

4.2.3.8 In .1, replace the words "an ullage condition" with the words "a filling condition".

4.2.5 Portable tank instructions and special provisions

4.2.5.3 Portable tank special provisions

Add the following new portable tank special provision:

"TP43 Portable tank instruction T1 may continue to be applied until 31 December 2028."

PART 5
CONSIGNMENT PROCEDURES

Chapter 5.2
Marking and labelling of packages including IBCs

5.2.1 Marking of packages including IBCs

5.2.1.10 Lithium or sodium ion battery mark

Replace the heading to read:

"5.2.1.10 Battery mark".

5.2.1.10.1 Replace the words "lithium or sodium ion cells or batteries" with the words "lithium cells or batteries or sodium ion cells or batteries" and replace the words "provision 188" with the words "provisions 188 or 400".

5.2.1.10.2 At the end of the first paragraph, add the following new sentence: "However, where equipment contains one or more button cells in addition to cells or batteries, there is no requirement for the UN number indicating the button cell or cells to be included on the mark."

In figure "Lithium or sodium ion battery mark", replace the words "Lithium or sodium ion battery mark" with the words "Battery mark".

5.2.1.10 Add a new 5.2.1.10.3 to read as follows:

"**5.2.1.10.3** When both the battery mark and labels in accordance with 5.2.2.2 other than model No.9A are required, the battery mark shall be located on the same surface as the labels if the package dimensions are adequate."

5.2.2 Labelling of packages including IBCs

5.2.2.1 Labelling provisions

5.2.2.1.13 ***Labels for articles containing dangerous goods transported as UN Nos.3537, 3538, 3539, 3540, 3541, 3542, 3543, 3544, 3545, 3546, 3547 and 3548***

In .1, in the second sentence, replace the words "lithium or sodium ion batteries" with the words "lithium batteries or sodium ion batteries" and replace the words "lithium or sodium ion battery mark" with the words "battery mark". In the third sentence, replace the words "lithium or sodium ion batteries" with the words "lithium batteries or sodium ion batteries".

5.2.2.2 Provisions for labels

5.2.2.2.2 ***Specimen labels***

Delete the word "Note:"

Chapter 5.4
Documentation

5.4.1.4.4 Examples of dangerous goods descriptions
Replace the text:

"UN 1092, Acrolein, stabilized, class 6.1 (3), PG I, (-24°C c.c.), MARINE POLLUTANT/ENVIRONMENTALLY HAZARDOUS

UN 1603, ETHYL BROMOACETATE 6.1 (3) II (58°C c.c.)

UN 1603, ETHYL BROMOACETATE, class 6.1, (class 3), PG II, (58°C c.c.)

UN 2761, Organochlorine pesticide, solid, toxic, (Aldrin 19%), class 6.1, PG III, MARINE POLLUTANT"

To be read as follows:

"UN 1092, ACROLEIN, STABILIZED, Class 6.1, (3), PG I, (-26°C c.c.), MARINE POLLUTANT, ENVIRONMENTALLY HAZARDOUS

UN 1603 ETHYL BROMOACETATE 6.1 (3) II (58°C c.c.)

UN 1603, ETHYL BROMOACETATE, Class 6.1, (Class 3), PG II, (58°C c.c.)

UN 2761 ORGANOCHLORINE PESTICIDE, SOLID, TOXIC (Aldrin 19%) Class 6.1 PG III MARINE POLLUTANT"

PART 6
CONSTRUCTION AND TESTING OF PACKAGINGS, INTERMEDIATE BULK CONTAINERS (IBCs), LARGE PACKAGINGS, PORTABLE TANKS, MULTIPLE-ELEMENT GAS CONTAINERS (MEGCs) AND ROAD TANK VEHICLES

Chapter 6.1
Provisions for the construction and testing of packagings (other than for class 6.2 substances)

6.1.4 Provisions for packagings

6.1.4.12 Fibreboard boxes (including corrugated fibreboard boxes)

6.1.4.12.1 In the second sentence, replace "ISO 535:2014" with "ISO 535:2023".

6.1.5 Test provisions for packagings

6.1.5.1 Performance and frequency of tests

6.1.5.1.3 Replace the word "Tests" with the words "Appropriate tests".

Chapter 6.2
Provisions for the construction and testing of pressure receptacles, aerosol dispensers, small receptacles containing gas (gas cartridges) and fuel cell cartridges containing liquefied flammable gas

6.2.1 General provisions

6.2.1.5 Initial inspection and test

6.2.1.5.1 In .7, before the words "technical code", add the word "recognized".

6.2.1.6 Periodic inspection and test

6.2.1.6.1 In .4, note 3, first sentence, after "Amd 1:2021", add "+ Amd 2:2024". After the second sentence, add the following new sentence: "For a transitional period until 31 December 2028, the standard ISO 18119:2018 + Amd 1:2021 may be used for this same purpose".

6.2.2 Provisions for UN pressure receptacles

6.2.2.1 Design, construction and initial inspection and test

6.2.2.1.1 In the table, in the row for ISO 4706:2008, in column "Applicable for manufacture", replace the words "Until further notice" by "Until 31 December 2030". Add a new row beneath this row as follows:

ISO 4706:2023	Gas cylinders – Refillable welded steel cylinders – Test pressure 60 bar and below	Until further notice

6.2.2.1.2 In the table, in the row for ISO 11515:2013 + Amd 1:2018, in column "Applicable for manufacture", replace the words "Until further notice" with the words "Until 31 December 2030". Add a new row beneath this row as follows:

ISO 11515:2022	Gas cylinders – Refillable composite reinforced tubes of water capacity between 450 l and 3000 l – Design, construction and testing	Until further notice

6.2.2.1.3 In the first table, in the row for ISO 4706:2008, in column "Applicable for manufacture", replace the words "Until further notice" with the words "Until 31 December 2030". Add a new row beneath this row as follows:

ISO 4706:2023	Gas cylinders – Refillable welded steel cylinders – Test pressure 60 bar and below	Until further notice

6.2.2.1.8 In the table, in the row for ISO 4706:2008, in column "Applicable for manufacture", replace the words "Until further notice" with the words "Until 31 December 2030". Add a new row beneath this row as follows:

ISO 4706:2023	Gas cylinders – Refillable welded steel cylinders – Test pressure 60 bar and below	Until further notice

6.2.2.2 Materials

In the table, in the row for ISO 11114-1:2020, in the first column, after "ISO 11114-1:2020", add "+ Amd 1:2023".

6.2.2.3 Closures and their protection

In the first table, in the row for ISO 10297:2014 + Amd 1:2017, in column "Applicable for manufacture", replace the words "Until further notice" with the words "Until 31 December 2028". Add a new row beneath this row as follows:

ISO 10297:2024	Gas cylinders – Cylinder valves – Specification and type testing	Until further notice

In the first table, in the row for ISO 14246:2014 + Amd 1:2017, in column "Applicable for manufacture", replace the words "Until further notice" with the words "Until 31 December 2030". Add a new row beneath this row as follows:

ISO 14246:2022	Gas cylinders – Cylinder valves – Manufacturing tests and examinations	Until further notice

6.2.2.4 Periodic inspection and test

In the first table, in the row for ISO 18119:2018 + Amd 1:2021, in column "Applicable", replace the words "Until further notice" with the words "Until 31 December 2028". Add a new row beneath this row as follows:

ISO 18119:2018 + Amd 1:2021 + Amd 2:2024	Gas cylinders – Seamless steel and seamless aluminium-alloy gas cylinders and tubes – Periodic inspection and testing	Until further notice

In the first table, in the row for ISO 11623:2015, in column "Applicable", replace the words "Until further notice" with the words "Until 31 December 2028". Add a new row beneath this row as follows:

ISO 11623:2023	Gas cylinders – Composite cylinders and tubes – Periodic inspection and testing **Note:** The pressure test shall not be replaced by a non-destructive examination (NDE) technique, though such techniques can be used for monitoring purposes.	Until further notice

In the first table, in the row for ISO 22434:2006, in column "Applicable", replace the words "Until further notice" with the words "Until 31 December 2028". Add a new row beneath this row as follows:

ISO 22434:2022	Gas cylinders – Inspection and maintenance of valves **Note:** These requirements may be met at times other than at the periodic inspection and test of UN cylinders.	Until further notice

6.2.2.7 Marking of refillable UN pressure receptacles

6.2.2.7.3 In (k) and (l), at the end, add the following new paragraph:

> "Acetylene cylinders constructed in accordance with Amendment 40-20 of this Code may continue to be used without the application of the marks detailed in (ii) and (iii) when the marking can neither be applied on the cylinder shoulder nor applied on any neck ring."

At the end, delete the note.

6.2.2.7.4 In (p), after "ISO 11114-1:2020", add "+ Amd 1:2023".

6.2.2.8 Marking of non-refillable UN cylinders

6.2.2.8.1 At the end, add a new paragraph to read as follows:

> "Non-refillable UN cylinders of seamless construction with a diameter of 40 mm or less may instead be permanently marked (e.g. stencilled, stamped, engraved or etched) on their side walls, provided no harmful stress concentration is created, and the minimum cylindrical shell wall thickness is maintained. The minimum size of the marks shall be 1.5 mm. The minimum size of the UN packaging symbol shall be 3 mm. The minimum size of the "DO NOT REFILL" mark shall be 3 mm."

6.2.2.9 Marking of UN metal hydride storage systems

6.2.2.9.2 In (j), after "ISO 11114-1:2020", add "+ Amd 1:2023".

6.2.3 Provisions for non-UN pressure receptacles

6.2.3.5 Salvage pressure receptacles

Replace the existing note with the following note:

> "**Note:** Salvage pressure receptacles with a water capacity of not more than 3,000 L may continue to be used without bearing the additional PVP mark until 31 December 2030."

In **6.2.3.5.2**, before the last sentence, add the following:

> "This indication of authorized pressure receptacles shall contain the following information:
>
> .1 the test pressure to which the salvage pressure receptacle can be loaded at maximum temperature, which limits the storage of pressure receptacles filled with liquified gases; and
>
> .2 the usable water capacity and the maximum pV-product authorized for stored pressure receptacles, which limits the storage of pressure receptacles filled with compressed gases. The value of this maximum pV-product is the lowest value of either of the following:

.1 the general limit of the pV-product of 1.5 million bar litres; or

.2 the pV-product of the salvage pressure receptacle based on the test pressure to which it is allowed to be loaded at maximum temperature and its usable water capacity."

The last sentence of **6.2.3.5.2** becomes a new **6.2.3.5.3**, and the following paragraphs are renumbered as **6.2.3.5.4** and **6.2.3.5.5**, respectively. At the end of the new **6.2.3.5.3**, add the words "in the approval certificate".

In the renumbered **6.2.3.5.5**, replace the last sentence to read as follows:

"The marking of the salvage pressure receptacle shall include the usable water capacity, the test pressure and the maximum pressure volume product. This mark shall start with the letters "PVP", followed by the pV-product and the units. The pV-product shall include a space in front of the last three digits of the value. The units "BAR" and "L" shall be separated by a dot. For harmonized readability and to avoid subsequent manipulation, the mark shall not contain more spaces. An example of the PVP mark is given below:

PVP1500 000BAR.L"

Chapter 6.3
Provisions for the construction and testing of packagings for class 6.2 infectious substances of category A (UN 2814 and UN 2900)

6.3.5 Test provisions for packagings

6.3.5.1 Performance and frequency of tests

6.3.5.1.3 Replace the words "Tests" with the words "Appropriate tests".

Chapter 6.4
Provisions for the construction, testing and approval of packages for radioactive material and for the approval of such material

6.4.11 Provisions for packages containing fissile material

6.4.11.2 In (d), second sentence, replace the word "weight" with the word "mass".

Chapter 6.5
Provisions for the construction and testing of intermediate bulk containers (IBCs)

6.5.2 Marking

6.5.2.1 Primary marking

6.5.2.1.1 In .7, first sentence, replace the words "stacking test load" with the words "superimposed stacking test mass".

6.5.2.1.3 In the first example, first sentence, replace the words "stacking test load" with the words "superimposed stacking test mass".

6.5.2.2 Additional marking

6.5.2.2.2 In the first sentence, replace the words "stacking load" with the words "superimposed stacking mass".

6.5.4 Testing, certification and inspection

6.5.4.4 Inspection and testing

6.5.4.4.2 At the end, add a new note to read as follows:

> "**Note:** The initial leakproofness test in accordance with (a) does not necessarily have to comply with the design type test in 6.5.6.7. However, samples of IBCs taken from the production shall meet the requirements for the leakproofness test according to 6.5.6.7. The periodic leakproofness test in accordance with (b) does not necessarily have to comply with the design type test in 6.5.6.7."

6.5.5 Specific provisions for IBCs

6.5.5.2 Specific provisions for flexible IBCs

6.5.5.2.2 After the first sentence, add the following new sentences: "No parts of IBC bodies recovered from previously used flexible IBCs shall be used in the manufacture of new IBC bodies, except as recycled material. For IBC bodies manufactured from recycled plastics material, only recycled plastics material as defined in 1.2.1 shall be used".

6.5.5.2.8 Delete the first two sentences. In the remaining sentence, replace the word "used" with the word "reused".

6.5.5.4 Specific provisions for composite IBCs with plastics inner receptacles

6.5.5.4.16 In the second sentence, replace "ISO 535:2014" with "ISO 535:2023".

6.5.5.5 Specific provisions for fibreboard IBCs

6.5.5.5.3 In the second sentence, replace "ISO 535:2014" with "ISO 535:2023".

6.5.6 Test provisions for IBCs

6.5.6.6 Stacking test

6.5.6.6.4 ***Calculation of superimposed test load***

Replace the words "load to be placed on the IBC" with the words "mass placed on the IBC surface to create the superimposed test load".

Chapter 6.6
Provisions for the construction and testing of large packagings

6.6.3 Marking

6.6.3.1 Primary marking

In (g), first sentence, replace the words "stacking test load" with the words "superimposed stacking test mass".

6.6.3.2 Examples of marking

In the first and second examples, replace the words "stacking load" with the words "superimposed stacking test mass".

6.6.3.3 In the first sentence, replace the words "stacking load" with the words "superimposed stacking mass".

6.6.4 Specific provisions for large packagings

6.6.4.4 Specific provisions for fibreboard large packagings

6.6.4.4.1 In the second sentence, replace "ISO 535:2014" with "ISO 535:2023".

6.6.5 Test provisions for large packagings

6.6.5.1 Performance and frequency of test

6.6.5.1.3 In the first sentence, replace the word "Tests" with the words "Appropriate tests".

6.6.5.3 Test provisions

6.6.5.3.3 ***Stacking test***

6.6.5.3.3.4 *Calculation of superimposed test load*

Replace the words "load to be placed on the large packaging" with the words "mass placed on the large packaging surface to create the superimposed test load".

Chapter 6.7
Provisions for the design, construction, inspection and testing of portable tanks and multiple-element gas containers (MEGCs)

6.7.2 Provisions for the design, construction, inspection and testing of portable tanks intended for the transport of substances of class 1 and classes 3 to 9

6.7.2.1 Definitions

In the definition of "*Portable tank*", in the last sentence, delete the words ", non-metallic tanks (except FRP portable tanks, see chapter 6.10)".

6.7.2.5 Service equipment

6.7.2.5.11 After the word "metals", add the words "or fibre reinforced plastic (FRP) in accordance with 6.10.3".

6.7.2.17 Portable tank supports, frameworks, lifting and tie-down attachments

6.7.2.17.5 In .4, replace "ISO 1496-3:1995" with the words "ISO 1496-3:2019. Design types conforming to ISO 1496-3:1995 approved before 1 January 2030 may continue to be used".

6.7.2.18 Design approval

6.7.2.18.2 In .1, replace "ISO 1496-3:1995;" with the words "ISO 1496-3:2019. Tests specified in ISO 1496-3:1995 may continue to be used until 31 December 2029".

6.7.3 Provisions for the design, construction, inspection and testing of portable tanks intended for the transport of non-refrigerated liquefied gases of class 2

6.7.3.13 Portable tank supports, frameworks, lifting and tie-down attachments

6.7.3.13.5 In .4, replace "ISO 1496-3:1995" with the words "ISO 1496-3:2019. Design types conforming to ISO 1496-3:1995 approved before 1 January 2030 may continue to be used".

6.7.3.14 Design approval

6.7.3.14.2 In .1, replace "ISO 1496-3:1995;" with the words "ISO 1496-3:2019. Tests specified in ISO 1496-3:1995 may continue to be used until 31 December 2029".

6.7.4 Provisions for the design, construction, inspection and testing of portable tanks intended for the transport of refrigerated liquefied gases of class 2

6.7.4.5 Service equipment

6.7.4.5.2 After the first sentence, add the following new sentence: "Filling and discharge openings also include the openings in the vapour phase of the portable tank that are used for vapour recovery".

6.7.4.12 Portable tank supports, frameworks, lifting and tie-down attachments

6.7.4.12.5 In .4, replace "ISO 1496-3:1995;" with the words "ISO 1496-3:2019. Design types conforming to ISO 1496-3:1995 approved before 1 January 2030 may continue to be used".

6.7.4.13 Design approval

6.7.4.13.2 In .1, replace "ISO 1496-3:1995;" with the words "ISO 1496-3:2019. Tests specified in ISO 1496-3:1995 may continue to be used until 31 December 2029".

6.7.5 Provisions for the design, construction, inspection and testing of multiple-element gas containers (MEGCs) intended for the transport of non-refrigerated gases

6.7.5.2 General design and construction provisions

6.7.5.2.4.1 After "ISO 11114-1:2020", add "+ Amd 1:2023".

6.7.5.10 MEGC supports, frameworks, lifting and tie-down attachments

6.7.5.10.4 In .4, replace "ISO 1496-3:1995" with the words "ISO 1496-3:2019. Design types conforming to ISO 1496-3:1995 approved before 1 January 2030 may continue to be used".

6.7.5.11 Design approval

6.7.5.11.2 In .1, replace "ISO 1496-3:1995;" with the words "ISO 1496-3:2019. Tests specified in ISO 1496-3:1995 may continue to be used until 31 December 2029".

Chapter 6.9
Provisions for the design, construction, inspection and testing of bulk containers

6.9.3 Provisions for the design, construction, inspection and testing of freight containers used as BK1 or BK2 bulk containers

6.9.3.1.1 Replace "ISO 1496-4:1991" with "ISO 1496-4:2023". At the end, add the following new sentence: "Bulk container types complying with ISO 1496-4:1991 may continue to be used until 31 December 2034".

6.9.3.1.2 Replace "ISO 1496-4:1991" with "ISO 1496-4:2023" and add the following new sentence: "The test requirement of ISO 1496-4:1991 may continue to be used until 31 December 2034".

6.9.5 Requirements for the design, construction, inspection and testing of flexible bulk containers BK3

6.9.5.5 Marking

6.9.5.5.1 In (g), replace the words "stacking test load" with the words "superimposed stacking test mass".

Chapter 6.10
Provisions for the design, construction, inspection and testing of portable tanks with shells made of fibre-reinforced plastics (FRP) materials

6.10.1 Application and general requirements

Add a new **6.10.1.5** to read as follows:

> "**6.10.1.5** The requirements of 6.10.3 are applied to FRP service equipment for portable tanks with shells made of metallic or FRP materials intended for the carriage of dangerous goods of classes or divisions 1, 3, 5.1, 6.1, 6.2, 8 and 9 by all modes of transport."

6.10.2 Provisions for the design, construction, inspection and testing of FRP portable tanks

6.10.2.1 Definitions

Replace the definition of "*FRP shell*" to read as follows:

> "*FRP shell* means the part of the portable tank constructed from FRP, which retains the substance intended for transport (tank proper), including openings and their closures, but does not include service equipment or external structural equipment. Openings and their closures may be manufactured from metallic materials or FRP."

Replace the definition of "*FRP tank*" with the following new definition:

> "*FRP portable tank* means a portable tank, as defined in 6.7.2.1, with an FRP shell."

6.10.2.2 General design and construction provisions

6.10.2.2.3 ***FRP Shells***

6.10.2.2.3.14 *Special provisions for the carriage of substances with a flashpoint of not more than 60°C*

6.10.2.2.3.14.1 Replace the words "FRP tanks" with the words "FRP portable tanks."

6.10.2.2.3.16 *Construction process for FRP shells*

6.10.2.2.3.16.2 In the first sentence, replace the word "weight" with the word "mass".

6.10.2.5 Equipment components for portable tanks with FRP shell

6.10.2.5 In the heading, replace the words "portable tanks with FRP shell" with the words "FRP portable tanks".

In the text under the heading, in the first sentence, delete the words "bottom openings, pressure relief devices, gauging devices," and replace the words "portable tanks" with the words "FRP portable tanks".

At the end, add a new sentence to read: "FRP service equipment in accordance with 6.10.3 may be used".

6.10.2.6 Design approval

6.10.2.6.4 Replace the word "tank" with the words "FRP portable tank".

6.10.2.7 Additional provisions applicable to FRP portable tanks

6.10.2.7.1 ***Material testing***

6.10.2.7.1.5 *Fire resistance test*

6.10.2.7.1.5.1 In the first sentence, replace the word "tank" with the words "FRP portable tank" and at the end, delete the words ", caused by an open heating oil pool fire or any other type of fire with the same effect".

In the second sentence, replace the word "tank" with the words "FRP shell".

After the third sentence, add the following new sentence: "These requirements shall be deemed to be met if the fire is caused by an open heating oil pool fire or any other type of fire with the same effect".

In the fifth sentence (old fourth), replace the first instance of the word "tank" with the words "FRP portable tank" and the second instance of the word "tank" with the words "FRP shell".

In the last sentence, replace the word "tank" with the words "FRP portable tank".

6.10.2.8 Inspection and testing

6.10.2.8.1 In the first sentence, replace the words "portable FRP tanks" with the words "FRP portable tanks".

6.10.2.8.3 Replace the word "tank" with the words "FRP portable tank".

6.10.2.8.4 Replace the word "shell" with the words "FRP shell" (*twice*).

6.10.2.9 Retention of samples

Replace the word "shell" with the words "FRP shell" (*twice*) and the word "tank" with the words "FRP portable tank".

6.10.2.10 Marking

6.10.2.10.2 Replace the word "Shell" with the words "FRP shell".

6.10.3 Requirements for design, construction, inspection and testing of FRP service equipment for portable tanks

Add a whole new section 6.10.3 with the following:

> "**6.10.3 Requirements for design, construction, inspection and testing of FRP service equipment for portable tanks**
>
> **6.10.3.1 Definitions**
>
> For the purposes of this section, the definitions in 6.7.2.1 and 6.10.2.1 apply except for definitions related to metal materials for the construction of the service equipment of portable tanks.
>
> Additionally, the following definitions apply to FRP service equipment:
>
> *FRP service equipment* means service equipment as defined in 6.7.2.1 made of FRP materials including parts fabricated from other materials, such as gate and seal assemblies, metallic parts, e.g. springs, fixings, applicable to both metallic and FRP shells of the portable tanks.
>
> *Injection moulding* means a process of melting plastic pellets (thermosetting/thermoplastic polymers) and mixing with reinforcement agents like chopped glass fibres. Then, the mixture is metered into a mould with the help of high-pressure pumps or injection cylinders, which fills and solidifies to produce the final product.

Compression moulding means a process for producing composite parts in a wide range of volumes typically employing a matched metal tool in a heated (normally hydraulic) press to consolidate sheet materials or moulding compounds under pressure.

Reinforced reaction injection moulding (RRIM) means a process of mixing of two or more resins together in the mixing chamber to form a thermosetting polymer under high pressure. Reinforcement agents like glass fibres are added to the mixture. Then, the resin mixture is metered into a mould with the help of high-pressure pumps or injection cylinders.
Coupon-sample means an FRP sample fabricated and tested in accordance with national or international standards to determine design allowables.

Inspection-sample means a sample cut out from the FRP service equipment to establish the conformity of the serial FRP device to the prototype.

FRP constituents means reinforcement fibres or particles, thermoset or thermoplastic polymer (matrix), adhesives, and additives.

6.10.3.2 General design and construction requirements

6.10.3.2.1 For the purposes of this section, the requirements of 6.7.2.2.11, 6.7.2.5.1 to 6.7.2.5.6, 6.7.2.5.10, 6.7.2.6.3, 6.7.2.8.2, 6.7.2.8.3, 6.7.2.9, 6.7.2.12, 6.7.2.14 and 6.7.2.15 shall be applied to FRP service equipment, including metallic parts (springs, fixings, etc.). FRP service equipment shall be designed and constructed in accordance with the requirements of a pressure vessel code and national and international standards, applicable to FRP materials and recognized by the competent authority.

6.10.3.2.2 ***Manufacturer's quality system***

6.10.3.2.2.1 FRP service equipment manufacturers shall have a documented quality system ensuring conformity of every item of the serial production of FRP service equipment to the approved prototype. The quality assurance programme shall be submitted to the competent authority for approval. All manufacturer's suppliers of material and components for FRP service equipment shall have a documented quality system. The quality system shall be developed in compliance with the general principles of international and national quality standards.

6.10.3.2.2.2 The applicable provisions of 6.10.2.2.2 shall apply to the FRP service equipment manufacturer's quality system.

6.10.3.2.3 ***FRP service equipment***

6.10.3.2.3.1 FRP service equipment shall have appropriate rigid joints to the portable tank shell. The connections shall cause no local stress concentrations exceeding the design allowables for all operating and test conditions.

6.10.3.2.3.2 FRP service equipment shall be made of suitable materials, capable of operating within a minimum design temperature range of -40°C to +50°C, unless temperature ranges are specified for specific more severe climatic or operating conditions (e.g. heating elements) by the competent authority of the country where the transport operation is being performed.

6.10.3.2.3.3 FRP service equipment shall be designed and manufactured to withstand a test pressure that is not less than 1.5 times MAWP. Stop valves, piping devices and pipefittings intended for filling or discharging shall be designed and manufactured to withstand a pressure that is not less than four times MAWP. Specific provisions are laid down for certain substances in the applicable portable tank instruction indicated in column 13 of the Dangerous Goods List and described in 4.2.5, or by the portable tank special provision indicated in column 14 of the Dangerous Goods List and described in 4.2.5.3.

6.10.3.2.3.4 FRP service equipment shall withstand vibration, service impacts, exposure to substance temperature and environmental effects.

6.10.3.2.3.5 Design calculations for FRP service equipment and its joints to the portable tank shell shall be performed by the finite element method or another method recognized by the competent authority.

6.10.3.2.3.6 FRP service equipment shall meet the same requirements as given in 6.10.2.2.3.14 for the carriage of substances with a flashpoint of not more than 60°C.

6.10.3.2.4 ***Materials***

6.10.3.2.4.1 *Resins*

The processing of the resin mixture shall be carried out in strict compliance with the recommendations of the supplier. This concerns mainly the use of hardeners, initiators and accelerators. The resins can be:

.1 unsaturated polyester resins;

.2 vinyl ester resins;

.3 epoxy resins;

.4 phenolic resins; or

.5 thermoplastic resins.

The heat distortion temperature (HDT) of the resin and FRP, determined in accordance with standard ISO 75-1:2020, shall be at least 20°C higher than the maximum service temperature of the tank, but shall, in any case, not be lower than 70°C.

6.10.3.2.4.2 *Additives*

Additives necessary for the treatment of the resin, such as catalysts, accelerators, hardeners and thixotropic substances, as well as materials used to improve the FRP service equipment, such as fillers, colours, pigments, etc., shall not cause weakening of the material, taking into account the lifetime and temperature expectancy of the design.

6.10.3.2.4.3 *Reinforcement fibres*

Reinforcement fibres shall be chopped or continuous fibres of several types.

6.10.3.2.4.4 FRP service equipment shall be manufactured by compression moulding, injection moulding, reinforced reaction injection moulding or hand lay-up. Other manufacturing technologies may be applied with the approval of the competent authority.

6.10.3.3 Design criteria

6.10.3.3.1 FRP service equipment shall be of a design capable of being stress-analysed mathematically or experimentally by resistance strain gauges, or by other methods approved by the competent authority.

6.10.3.3.2 FRP service equipment shall be designed and manufactured to withstand the test pressures specified in 6.10.3.2.3.3.

6.10.3.3.3 At the specified test pressure, the maximum tensile relative deformation measured in mm/mm in the FRP service equipment shall not result in the formation of microcracks, and therefore not be greater than the first measured point of elongation-based fracture or damage of the resin, measured during the tensile tests prescribed under 6.10.2.7.1.2.3 and 6.10.3.4.1.1.

6.10.3.3.4 For the internal test pressure specified in 6.10.3.2.3.3, the failure criterion (*FC*) shall not exceed the following value:

$$FC \leq \frac{1}{K}$$

where:

$$K = K_0 \times K_1 \times K_2 \times K_3 \times K_4 \times K_5$$

where:

K shall have a minimum value of 4;

K_0, K_1, K_2, K_3, K_4 are given in 6.10.2.3.4;

K_5 is a factor related to the deterioration in the material properties due to effects of salt fog spray and ultraviolet exposure. It shall be determined by the formula:

$$K_5 = \frac{\sigma_n}{\sigma_{eff}}$$

where:

σ_n is the nominal (under normal conditions) tensile strength of the FRP material and σ_{eff} is the tensile strength of the material after consecutive salt fog exposure in accordance with ISO 12944-2:2017, ISO 12944-6:2018, 168 hours at +(35 ± 2)°C and ultraviolet exposure in accordance with ISO 4892-2, 168 hours at +(23 ± 2)°C;

σ_{eff} is the minimum of (σ_{eff1}, σ_{eff2}, …, σ_{effk}), where 1, 2, ... k are identifiers of substances approved for transportation by the given portable tank. If a protective coating is used, the samples with the coating shall be fabricated and tested.

A design validation exercise using numerical analysis and a suitable composite failure criterion is to be undertaken to verify that stresses in the FRP service equipment are below the allowable. Suitable composite failure criteria include, but are not limited to strain invariant failure theory, maximum strain, or maximum stress. Other relations for the strength criterion are allowed upon agreement with the competent authority. The method, a proof of suitability for the chosen failure criterion with a list of relevant experiments for all parameters used in the chosen failure criterion, and results of this design validation exercise are to be submitted to the competent authority.

The parameters used in the chosen failure criterion are to be determined using the relevant experiments and the maximum strain in tension prescribed in 6.10.2.3.5, combined with factor of safety *K*. At least all experiments defined in 6.10.3.4.2 shall be performed.

6.10.3.3.5 Check calculations of the strength for FRP service equipment and its joints to the portable tank shell shall be performed by the finite element method. Treatment of singularities shall be undertaken using an appropriate method in accordance with the applicable pressure vessel code.

6.10.3.4 Material testing

6.10.3.4.1 *Resins*

Where neat resin specimens are used for the materials testing set out in 6.10.3.4.1.1 and 6.10.3.4.1.2, the resin shall be processed in the same manner as when it is used in a composite material, taking into account mix ratios, resin additives, post-cure, and any other parameters deemed relevant to cure.

6.10.3.4.1.1 Resin tensile elongation shall be tested in accordance with ISO 527-2:2012.

6.10.3.4.1.2 Heat distortion temperature shall be tested in accordance with ISO 75-1:2020.

6.10.3.4.2 *Coupon-samples*

Coupon-samples shall be manufactured by the same technology as the appropriate FRP service equipment.

6.10.3.4.2.1 Ultimate tensile strength and elongation shall be tested in accordance with ISO 527-4:2021 or ISO 527-5:2021 depending on the reinforcing fibres and layups used.

6.10.3.4.2.2 Determination of compressive properties shall be tested in the in-plane direction in accordance with ISO 14126:1999 + Cor 1:2001.

6.10.3.4.2.3 Determination of the in-plane shear stress/strain response and shear modulus shall be tested in accordance with ISO 20337:2018.

6.10.3.4.2.4 Mass density shall be tested in accordance with ISO 1183-1:2019.

6.10.3.4.2.5 Mass content and composition of the reinforcement fibres shall be tested in accordance with ISO 1172:1996 or ISO 14127:2008. The fibre mass content of the coupon-samples shall be between 90% and 100% of the minimum fibre mass content specified for the appropriate FRP service equipment and obtained from testing of the inspection-samples.

6.10.3.4.2.6 Heat distortion temperature shall be tested in accordance with ISO 75-1:2020, ISO 75-2:2013 or ISO 75-3:2004 depending on the reinforcing fibres and layups used.

6.10.3.4.2.7 Hardness shall be tested in accordance with ISO 868:2003.

6.10.3.4.2.8 Creep factor α shall be measured in accordance with the procedure prescribed by 6.10.2.7.1.2.5. The test samples shall be taken in accordance with ISO 14125:1998.

6.10.3.4.2.9 Ageing factor β shall be determined in accordance with the procedure prescribed by 6.10.2.7.1.2.6. The test samples shall be taken in accordance with ISO 14125:1998. This testing may be undertaken on either pristine samples or on samples pre-subjected to salt fog spray exposure conditioning as outlined in 6.10.3.2.4.10.

6.10.3.4.2.10 Salt fog exposure test shall be determined in accordance with ISO 12944-2:2017, ISO 12944-6:2018, 168 hours at 35 ± 2°C.

6.10.3.4.2.11 Ultraviolet exposure test shall be determined in accordance with ISO 4892-2:2013, 168 hours at 23 ± 2°C.

6.10.3.4.2.12 The chemical compatibility with the transported substances shall be tested in accordance with 6.10.2.7.1.3.

6.10.3.4.3 Additional material tests

The additional material tests shall be carried out for determination of material properties required for design calculation.

6.10.3.4.3.1 Flexural strength shall be measured in accordance with ISO 14125:1998.

6.10.3.4.3.2 Bearing test shall be determined in accordance with ISO 12815:2013.

6.10.3.4.4 ***Inspection-samples***

Prior to testing, all coatings shall be removed from the samples. The tests shall cover 6.10.3.4.2.1 to 6.10.3.4.2.8.

6.10.3.5 Design approval

6.10.3.5.1 The competent authority or its authorized body shall issue the type approval certificate for FRP service equipment. This certificate shall attest that the design has been surveyed by the authority and is suitable for its intended purpose and meets the requirements of this chapter. The certificate shall have a reference that prototype testing was carried out in accordance with 6.10.3.5.2, the information on the substances allowed for transportation, body and seal materials and certificate number.

6.10.3.5.2 The FRP service equipment prototype test report shall include at least the following:

.1 results of the material tests used for fabrication of FRP service equipment in accordance with 6.10.3.4.1 to 6.10.3.4.3;

.2 results of tests in accordance with ISO 4126-1:2013 for the appropriate relief devices;

.3 results of the pressure tests carried out in accordance with relevant ISO standards, where applicable, or in accordance with the procedure approved by the competent authority. The test pressure shall not be less than the pressure defined in 6.10.3.2.3.3;

.4 a representative prototype of FRP service equipment shall be subjected to the fire test prescribed in the *Manual of Tests and Criteria*, part IV, section 42;

.5 results of the electrical resistance tests in accordance with a procedure recognized by the competent authority; and

.6 results of the other tests prescribed in applicable pressure equipment standards or codes in agreement with the competent authority.

6.10.3.5.3 A service life inspection programme shall be established, which shall be a part of the operation manual, to monitor the condition of the FRP service equipment at periodic inspections. The service life inspection programme shall be approved by the competent authority.

6.10.3.6 Inspection and testing

6.10.3.6.1 FRP service equipment shall be inspected and tested before being put into service. The initial inspection and test after manufacture shall include a check of the design characteristics and an external examination of FRP service equipment with due regard to the substances to be transported, and a pressure test. Before putting the FRP service equipment into service, a leak proofness test and a test of the satisfactory operation shall also be performed. Relief valves shall be tested for opening/closing pressure before installation. The initial inspection and testing programme shall be approved by the competent authority.

6.10.3.6.2 Periodic inspection and testing of FRP service equipment shall be carried out during inspection of the portable tank in accordance with 6.7.2.19.2, 6.7.2.19.4, and 6.7.2.19.5 or 6.10.2.8.1 in accordance with the service life inspection programme approved by the competent authority.

6.10.3.6.3 The inspections and tests in 6.10.3.6.1 and 6.10.3.6.2 shall be performed or witnessed by an expert approved by the competent authority.

6.10.3.6.4 Repair work of FRP service equipment shall be limited to replacement of damaged components by components covered by the type approval of the service equipment.

6.10.3.7 Marking

6.10.3.7.1 ***Marking of relief devices***

Each relief device shall be marked as follows:

.1 name of the manufacturer and the serial number of the equipment;

.2 name of body and seal materials;

.3 type approval certificate number;

.4 the pressure at which the device is set to discharge (MPa or bar);

.5 the allowable tolerance at the discharge pressure for spring-loaded devices;

.6 the rated flow capacity of spring-loaded pressure relief devices under normal conditions (external pressure is 1 bar and ambient temperature is 0°C) in standard (normal) cubic metres of air per second, m^3/s (determined in accordance with 6.7.2.13.2);

.7 cross-sectional area of spring-loaded pressure relief devices, mm^2;

.8 MAWP, MPa or bar;

.9 external design pressure (if relevant), MPa or bar; and

.10 design temperature range.

6.10.3.7.2 ***Marking of stop valves***

Each stop valve shall be marked as follows:

.1 name of the manufacturer and the serial number of the equipment;

.2 name of body and seal materials;

.3 type approval certificate number;

.4 designation of the stop device;

.5 nominal diameter, mm;

.6 MAWP, MPa or bar;

.7 test pressure, MPa or bar;

.8 direction of medium flow; and

.9 design temperature range."

PART 7
PROVISIONS CONCERNING TRANSPORT OPERATIONS

Chapter 7.1
General stowage provisions

7.1.2 Definitions

After "Note 2: Cargo holds cannot be interpreted as closed cargo transport units.", in the definition of "Clear of living quarters", add the word "spaces" after the word "accommodation", to be read as "means that packages or cargo transport units shall be stowed a minimum distance of 3 m from accommodation spaces, air intakes, machinery spaces and other enclosed work areas."

7.1.4 Special stowage provisions

7.1.4.5 Stowage of goods of class 7

7.1.4.5.3.1 In the table for TI limits for freight containers and conveyances not under exclusive use, in the first column, delete twice "(closed containers)".

7.1.4.5.3.4 In the table for CSI limits for freight containers and conveyances containing fissile material, in the first column, delete twice "(closed containers)".

Table 7.1.4.5.18 – *CLASS 7 – Radioactive material*
Segregation table for persons

7.1.4.5.18 Replace the existing table with the following with the corresponding footnotes:
"

Sum of transport Indices (TI)	**Segregation distance of radioactive material from passengers and crew***		
	Containership[2] general cargo ship[2], ro-ro ship[2], barge-carrying ship[2]	**Ferry, etc.[3]**	**Offshore support vessel[4]**
≤ 10	At least 6 m	Stow at bow or stern furthest from living quarters and regularly occupied work areas	Stow at stern or at platform midpoint
10 < TI ≤ 20	At least 8 m	as above	as above
20 < TI ≤ 50	At least 13 m	as above	not applicable
50 < TI ≤ 100	At least 18 m	as above	not applicable
100 < TI ≤ 200	At least 26 m	as above	not applicable
200 < TI ≤ 400	At least 36 m	as above	not applicable

* The segregation distance is measured horizontally and projected vertically. This distance may be filled with cargo, but shall be according to the relevant segregation provisions of this Code.

² Containership, general cargo ship, ro-ro ship, and barge-carrying ship, all of 150 m minimum length.

3 Ferry or cross-channel, coastal and inter-island ship, all of 100 m minimum length.

4 Offshore support vessel of 50 m minimum length (in this case the practical maximum sum of TI's carried is 20)."

7.1.4.7 Stowage of stabilized dangerous goods

In the text "For substances, for which the word "STABILIZED" is added as part of the proper shipping name of the substances in accordance with 3.1.2.6, Stowage Category D and SW1 shall apply" replace the words "Stowage Category D and SW1 shall apply" with the words "stowage category D and SW1 shall apply".

7.1.5 Stowage codes

In the stowage codes given in column 16a of the Dangerous Goods List as specified in the table, replace the description as follows:

In SW14 Stowage category A only if the special stowage provisions of 7.4.1.4 and 7.6.2.8.4 are complied with.

In SW17 "Category E …" with the words "Stowage category E".

In SW18 "Category A…" with the words "Stowage category A".

In SW19 "For batteries transported in accordance with special provisions 376 or 377, category C, unless transported on a short international voyage" replace the words "category C" with the words "stowage category C".

In SW20 "… category D applies" replace the words "stowage, category D" with the words "stowage category D applies".

In SW21 "… category D applies" replace the words "stowage, category D" with the words "stowage category D applies".

In SW22 "For AEROSOLS with a maximum capacity of 1 L: category A. For AEROSOLS with a capacity above 1 L: category B. For WASTE AEROSOLS or WASTE GAS CARTRIDGES: category C, clear of living quarters." replace the text to be read as: "For AEROSOLS with a maximum capacity of 1 L: stowage category A. For AEROSOLS with a capacity above 1 L: stowage category B. For WASTE AEROSOLS or WASTE GAS CARTRIDGES: stowage category C, clear of living quarters."

In SW29 replace the word "Category" with the word "category".

Chapter 7.2
General segregation provisions

7.2.4 Segregation table

In the table, in the first column, replace the word "CLASS" by "CLASS/DIVISION".

7.2.7 Segregation of goods of class 1

7.2.7.1 Segregation between goods of class 1

7.2.7.1.5 In the second sentence ("where this is not permitted, closed cargo transport units shall be separated from one another"), replace the word "unit" with the word "units".

Chapter 7.3
Consigning operations concerning the packing and use of cargo transport units (CTUs) and related provisions

7.3.3 Packing of cargo transport units

7.3.3.7 Add a new second sentence to read "Unless otherwise indicated, packagings that have had a stacking test shall be loaded in the same orientation as when the samples were tested."

At the end, add the following new note:

> "**Note:** The stacking test is generally carried out on the top surface of the packaging. Packages, other than bags, should therefore be stacked on the top surface of the packages unless indicated otherwise."

7.3.7 Cargo transport units under temperature control

7.3.7.4 Methods of temperature control

7.3.7.4.3 In the third sentence, replace the words "using two measuring devices independent of each other" with the words "using two independently powered measuring devices".

Chapter 7.6
Stowage and segregation on general cargo ships

7.6.3 Segregation provisions

7.6.3.5.2 ***Segregation table***
In the table, in the first column, replace the words "Corrosive substance" with the words "Corrosive substances".

In the table, in the second column, replace the word "CLASS" with "CLASS/DIVISION".

Appendix A
List of generic and N.O.S. proper shipping names

In the table, for Division 6.1, under "Specific entries", add the following new entries:

6.1		2020	CHLOROPHENOLS, TOXIC, SOLID, N.O.S.
6.1		2021	CHLOROPHENOLS, TOXIC, LIQUID, N.O.S.

In the table, for class 8, under "Specific entries", add the following new entries:

8	6.1	3561	CHLOROPHENOLS, CORROSIVE, TOXIC, SOLID, N.O.S.
8		3562	CHLOROPHENOLS, CORROSIVE, SOLID, N.O.S.

INDEX

In the table, in the third column, replace the word "CLASS" by "CLASS/DIVISION".

Delete the entries for "Dichlorophenols, liquid, *see*", "Dichlorophenols, solid, *see*" and "Fluoric acid, *see*".

For "CHLOROPHENOLS, LIQUID", replace the entry in column "Substance, material or article" to read "CHLOROPHENOLS, TOXIC, LIQUID, N.O.S".

For "CHLOROPHENOLS, SOLID", replace the entry in column "Substance, material or article" to read "CHLOROPHENOLS, TOXIC, SOLID, N.O.S".

Delete the entry for "FLUOROANILINES".

For "2,4-Difluoroaniline, *see*", in column "UN No.", replace "2941" with "2810".

For "LITHIUM BATTERIES INSTALLED IN CARGO TRANSPORT UNIT lithium ion batteries or lithium metal batteries", replace the entry in column "Substance, material or article" to read "LITHIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT":

Add the following new entries in alphabetical order:

"

Substance, material or article	**MP**	**Class**	**UN. No.**
CHLOROPHENOLS, CORROSIVE, TOXIC, SOLID, N.O.S.		8	3561
CHLOROPHENOLS, CORROSIVE, SOLID, N.O.S.		8	3562
Heat pumps, *see*		2.2 2.1	2857 3358
HEATING MACHINES containing non-flammable, non-toxic, gases or ammonia solutions (UN 2672)		2.2	2857
HEATING MACHINES containing flammable, non-toxic, liquefied gas		2.1	3358
Magnetic resonance imaging (MRI) scanners containing non-flammable, non-toxic gas, *see*		2.2	3538
SODIUM ION BATTERIES INSTALLED IN CARGO TRANSPORT UNIT		9	3564
LITHIUM METAL BATTERIES INSTALLED IN CARGO TRANSPORT UNIT		9	3563

"

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ANNEX 8

RESOLUTION MSC.588(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE INTERNATIONAL CODE OF SAFETY FOR SHIPS CARRYING INDUSTRIAL PERSONNEL (IP CODE)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the function of the Committee,

NOTING resolution MSC.527(106), by which it adopted the International Code of Safety for Ships Carrying Industrial Personnel ("the IP Code"), which has become mandatory under chapter XV of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"),

NOTING ALSO article VIII(b) and regulation XV/1.2 of the Convention concerning the procedure for amending the IP Code,

HAVING CONSIDERED, at its 111th session, amendments to the IP Code, proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the IP Code, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the said amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE INTERNATIONAL CODE OF SAFETY FOR SHIPS CARRYING INDUSTRIAL PERSONNEL (IP CODE)

PART IV
ADDITIONAL REGULATIONS FOR SHIPS CERTIFIED IN ACCORDANCE WITH SOLAS CHAPTER I

Regulation 2
Subdivision and stability

1 The following new sub-paragraph .7 is added after existing paragraph 2.1.6:

".7 The mass of each industrial personnel shall be assumed to be 90 kg instead of 75 kg in the ship stability calculation, for ships:

.1 for which the building contract is placed on or after 1 January 2028; or

.2 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 1 January 2028 + 6 months; or

.3 the delivery of which is on or after 1 January 2028 + 4 years."

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ANNEX 9

RESOLUTION MSC.589(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE INTERNATIONAL LIFE-SAVING APPLIANCE (LSA) CODE

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution MSC.48(66), by which it adopted the International Life-Saving Appliance (LSA) Code ("the LSA Code"), which has become mandatory under chapter III of the International Convention for the Safety of Life at Sea (SOLAS), 1974 ("the Convention"),

RECALLING FURTHER article VIII(b) and regulation III/3.10 of the Convention concerning the procedure for amending the LSA Code,

HAVING NOTED, at its 108th session, that the application provisions in the amendments to the LSA Code adopted at that session and in some other previous amendments to the Code had been included in the text of the resolutions instead of the text of the requirements, which might hinder their effective implementation,

HAVING AGREED, at its 109th session, that a systematic approach be taken to ensure the insertion of relevant application provisions during the regulatory development and amendment processes,

HAVING CONSIDERED, at its 111th session, amendments to the LSA Code proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the LSA Code, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the amendments shall be deemed to have been accepted on 1 July 2027 unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, in conformity with article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE INTERNATIONAL LIFE-SAVING APPLIANCE CODE (LSA CODE)

Preamble

1 The preamble is replaced by the following:

"1 The purpose of this Code is to provide international standards for life-saving appliances required by chapter III of the International Convention for the Safety of Life at Sea (SOLAS), 1974.

2 The requirements of this Code are mandatory under the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, for ships constructed on or after 1 July 1998. Amendments to the Code are adopted and brought into force in accordance with the procedure laid down in article VIII of that Convention."

CHAPTER II
PERSONAL LIFE-SAVING APPLIANCES

2.2 Lifejackets

2.2.1 General requirements for lifejackets

2 Paragraph 2.2.1.6.2 is replaced by the following:

".2 for adult lifejackets provided on or after 1 January 2026, turn the body of unconscious, face-down persons in the water to a face-up position where the nose and mouth are clear of the water in an average time not exceeding that of the RTD plus 1 s;"

3 The following new paragraph 2.2.1.18 is added after existing paragraph 2.2.1.17:

"2.2.1.18 For the application of the requirement in paragraph 2.2.1.6.2, the expression "*lifejackets provided on or after 1 January 2026"* means lifejackets having a contractual delivery date to the ship on or after 1 January 2026 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2026."

CHAPTER IV
SURVIVAL CRAFT

4.4 General requirements for lifeboats

4.4.7 Lifeboat fittings

4 Paragraph 4.4.7.6.8 is replaced by the following:

".8 for those lifeboats installed on or after 1 January 2026, to prevent an accidental release during recovery of the boat, the hook shall not be able to support any load unless the hook is completely reset. In the case of a hook which is capable of releasing the lifeboat or rescue boat with a load on the hook when it is not fully waterborne, the handle or safety pins shall not be able to be returned to the reset (closed) position, and any indicators shall not indicate the release mechanism is reset, unless the hook is completely reset. Additional danger signs shall be posted at each hook station to alert crew members to the proper method of resetting;"

5 At the end of paragraph 4.4.7.6.16, the word "and" is deleted.

6 Paragraph 4.4.7.6.17 is replaced by the following:

".17 for those lifeboats installed on or after 1 January 2026, where a single fall and hook system is used for launching a lifeboat or rescue boat in combination with a suitable painter, the requirements of paragraphs 4.4.7.6.7 and 4.4.7.6.15 need not be applicable; provided that the single fall and hook system does not have the capability to release the lifeboat or rescue boat with a load on the hook when it is not fully waterborne; and"

7 The following new paragraph 4.4.7.6.18 is added after paragraph 4.4.7.6.17:

".18 for the application of the requirements in paragraphs 4.4.7.6.8 and 4.4.7.6.17, the expression "*lifeboats installed on or after 1 January 2026*" means lifeboats having a contractual delivery date to the ship on or after 1 January 2026 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2026."

4.6 Totally enclosed lifeboats

4.6.6 Ventilation means

8 The following new explanatory sentence is added after the title of paragraph 4.6.6:

"(For totally enclosed lifeboats installed on or after 1 January 2029, the following requirements apply)"

4.6.7 Openings of the ventilation system and their means of closing

9 The following new explanatory sentence is added after the title of paragraph 4.6.7:

"(For totally enclosed lifeboats installed on or after 1 January 2029, the following requirements apply.)"

10 The following new paragraph 4.6.8 is added after existing paragraph 4.6.7:

"4.6.8 For the application of the requirements in paragraphs 4.6.6 and 4.6.7, the expression "*totally enclosed lifeboats installed on or after 1 January 2029*" means totally enclosed lifeboats having a contractual delivery date to the ship on or after 1 January 2029 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2029."

4.7 Free-fall lifeboats

11 The following new paragraph 4.7.7 is inserted after existing paragraph 4.7.6, and existing paragraph 4.7.7 is renumbered as 4.7.8:

"4.7.7 Lifeboat release testing

4.7.7.1 For each free-fall lifeboat installed on or after 1 January 2031, the arrangement to test the release system under load without launching the lifeboat into the water, in accordance with paragraph 4.7.6.4, shall be designed with a safety factor of at least 6 on the basis of the calculated maximum working load with full complement of persons and equipment and the ultimate strength of the materials used for its construction considering static and relevant dynamic loads. Components of this arrangement that are exposed to the marine environment, other than falls and temporarily installed equipment, shall be constructed from materials that are corrosion resistant in the marine environment without the need for coatings or galvanizing.

4.7.7.2 For the application of the requirements in paragraph 4.7.7.1, the expression "*free-fall lifeboat installed on or after 1 January 2031*" means a free-fall lifeboat having a contractual delivery date to the ship on or after 1 January 2031 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2031."

CHAPTER VI
LAUNCHING AND EMBARKATION APPLIANCES

6.1 Launching and embarkation appliances

12 Paragraph 6.1.1.3 is replaced by the following:

"6.1.1.3 A launching appliance shall not depend on any means other than gravity or stored mechanical power which is independent of the ship's power supplies to launch the survival craft or rescue boat it serves in the fully loaded and equipped condition and also in the light condition.

Notwithstanding the above, for a rescue boat installed on or after 1 January 2024 on a cargo ship which is not one of the ship's survival craft, having a mass not more than 700 kg in fully equipped condition, with engine, but without the crew, the launching appliance of the boat does not need to be fitted with stored mechanical power provided that:

.1 manual hoisting from the stowed position and turning out to the embarkation position is possible by one person;

.2 the force on the crank handle does not exceed 160 N at the maximum crank radius of 350 mm; and

.3 means having sufficient strength such as a bowsing line is provided for bringing the rescue boat against the ship's side and holding it alongside so that persons can be safely embarked."

13 The following new text is added at the end of existing paragraph 6.1.1.3:

"6.1.1.3.1.1 For the application of the requirements in this paragraph, the expression "*rescue boat installed on or after 1 January 2024*" means a rescue boat having a contractual delivery date to the ship on or after 1 January 2024 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2024."

6.1.2 Launching appliances using falls and a winch

14 Paragraph 6.1.2.8 is replaced by the following:

"6.1.2.8 For launching appliances installed on or after 1 January 2026, the speed at which the fully loaded survival craft or rescue boat is lowered to the water shall not be less than that obtained from the formula:

$S = 0.4 + 0.02 \cdot H$ or 1.0, whichever is less

where:

S is the lowering speed in metres per second and

H is the height in metres from the davit head to the waterline with the ship at the lightest seagoing condition."

15 Paragraph 6.1.2.10 is replaced by the following:

"6.1.2.10 For launching appliances installed on or after 1 January 2026, the maximum lowering speed of a fully loaded survival craft or rescue boat shall be 1.3 m/s. The Administration may accept a maximum lowering speed other than 1.3 m/s, having regard to the design of the survival craft or rescue boat, the protection of its occupants from excessive forces, and the strength of the launching arrangements taking into account inertia forces during an emergency stop. Means shall be incorporated in the appliance to ensure that this speed is not exceeded."

16 The following new paragraph 6.1.2.14 is added after existing paragraph 6.1.2.13:

"6.1.2.14 For the application of the requirements in paragraphs 6.1.2.8 and 6.1.2.10, the expression "*launching appliances installed on or after 1 January 2026*" means launching appliances having a contractual delivery date to the ship on or after 1 January 2026 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2026."

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ANNEX 10

RESOLUTION MSC.590(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE REQUIREMENTS FOR MAINTENANCE, THOROUGH EXAMINATION, OPERATIONAL TESTING, OVERHAUL AND REPAIR OF LIFEBOATS AND RESCUE BOATS, LAUNCHING APPLIANCES AND RELEASE GEAR (RESOLUTION MSC.402(96))

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution MSC.402(96), by which it adopted the Requirements for maintenance, thorough examination, operational testing, overhaul and repair of lifeboats and rescue boats, launching appliances and release gear ("the Requirements"), which has become mandatory under chapter III of the International Convention for the Safety of Life at Sea (SOLAS), 1974 ("the Convention"), as amended by resolution MSC.404(96),

RECALLING FURTHER article VIII(b) and regulation III/3.25 of the Convention concerning the procedure for amending the Requirements,

TAKING INTO ACCOUNT the amendments to the LSA Code adopted by resolution MSC.589(111), with respect to the arrangements to test the release system under load without launching the lifeboat into the water,

RECOGNIZING the need to keep the Requirements up to date with regard to annual thorough examination and operational testing of the arrangements to test the release system under load without launching the free-fall lifeboat into the water,

HAVING CONSIDERED, at its 111th session, amendments to the Requirements, proposed and circulated in accordance with VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the Requirements for maintenance, thorough examination, operational testing, overhaul and repair of lifeboats and rescue boats, launching appliances and release gear, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES SOLAS Contracting Governments to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 ALSO INVITES Contracting Governments to note that the provisions in the annex are to be applied to free-fall lifeboats installed on or after 1 January 2031, or having a contractual delivery date to the ship on or after 1 January 2031 or, in the absence of a contractual delivery date to the ship, actually delivered to the ship on or after 1 January 2031;

5 REQUESTS the Secretary-General, in conformity with article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

6 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

AMENDMENTS TO THE REQUIREMENTS FOR MAINTENANCE, THOROUGH EXAMINATION, OPERATIONAL TESTING, OVERHAUL AND REPAIR OF LIFEBOATS AND RESCUE BOATS, LAUNCHING APPLIANCES AND RELEASE GEAR (RESOLUTION MSC.402(96))

6 SPECIFIC PROCEDURES FOR INSPECTION, MAINTENANCE, THOROUGH EXAMINATION, OPERATIONAL TESTING, OVERHAUL AND REPAIR

6.2 Annual thorough examination and operational test

1 Paragraph 6.2.3 is replaced by the following:

"6.2.3 For lifeboats (including free-fall lifeboats), rescue boats and fast rescue boats, the following items shall be thoroughly examined and checked for satisfactory condition and operation:

.1 condition of the boat structure, including fixed and loose equipment (including a visual examination of the external boundaries of the void spaces, as far as practicable);

.2 engine and propulsion system;

.3 sprinkler system, where fitted;

.4 air supply system, where fitted;

.5 manoeuvring system;

.6 power supply system;

.7 bailing system;

.8 fender/skate arrangements;

.9 rescue boat righting system, where fitted;

.10 ventilation system, where fitted; and

.11 arrangement to test the release system under load without launching the lifeboat into the water (free-fall lifeboats only)."

2 Paragraph 6.2.7 is replaced by the following:

"6.2.7 The operational test of the free-fall lifeboat release function shall be carried out as follows:

.1 engage the arrangements for the test without launching the lifeboat, required by paragraphs 4.7.6.4 and 4.7.7 of the LSA Code, as specified in the manufacturer's operating instructions;

.2 if required to be on board, ensure that the operator is properly seated and secured in the seat location from which the release mechanism is to be operated;

.3 operate the release mechanism to release the lifeboat;

.4 reset the lifeboat in the stowed configuration;

.5 repeat the procedures referred to in .2 to .4 above, using the back-up release mechanism, if applicable;

.6 remove the arrangements for the test without launching the lifeboat, required by paragraphs 4.7.6.4 and 4.7.7 of the LSA Code; and

.7 verify that the lifeboat is in the ready-to-launch stowed configuration."

***

ANNEX 11

RESOLUTION MSC.591(111)
(adopted on 21 May 2026)

AMENDMENTS TO THE PROTOCOL OF 1988 RELATING TO THE INTERNATIONAL CONVENTION ON LOAD LINES, 1966 (1988 LOAD LINES PROTOCOL)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO article VI of the Protocol of 1988 relating to the International Convention on Load Lines, 1966 ("1988 Load Lines Protocol") concerning amendment procedures,

HAVING CONSIDERED, at its 111th session, amendments to the 1988 Load Lines Protocol proposed and circulated in accordance with article VI(2)(a) thereof,

1 ADOPTS, in accordance with article VI(2)(d) of the 1988 Load Lines Protocol, amendments to the 1988 Load Lines Protocol, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VI(2)(f)(ii)(bb) of the 1988 Load Lines Protocol, that the said amendments shall be deemed to have been accepted on 1 July 2027, unless, prior to that date, more than one third of the Parties to the 1988 Load Lines Protocol, or Parties the combined merchant fleets of which constitute not less than 50% of the gross tonnage of all the merchant fleets of all Parties, have notified their objections to the amendments;

3 INVITES the Parties concerned to note that, in accordance with article VI(2)(g)(ii) of the 1988 Load Lines Protocol, the amendments shall enter into force on 1 January 2028 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, in conformity with article VI(2)(e) of the 1988 Load Lines Protocol, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Parties to the 1988 Load Lines Protocol;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Parties to the 1988 Load Lines Protocol.

ANNEX

DRAFT AMENDMENTS TO THE PROTOCOL OF 1988 RELATING TO THE INTERNATIONAL CONVENTION ON LOAD LINES, 1966 (1988 LOAD LINES PROTOCOL)

Annex B
ANNEXES TO THE CONVENTION AS MODIFIED BY THE PROTOCOL OF 1988 RELATING THERETO

Annex I
Regulations for determining load lines

Chapter II
Conditions of assignment of freeboard

Regulation 25
Protection of the crew

1 The following application provision is inserted before paragraph (1):

"This regulation, as amended by resolution MSC.591(111), shall apply to ships the keels of which are laid, or which are at a similar stage of construction on or after 1 January 2028."

2 Paragraph (2) is replaced by the following:

"(2) Guard rails or bulwarks shall be fitted around all exposed decks and all exposed sea access holes (such as edges of moonpools) accessible to the crew during navigation. The height of the bulwarks or guard rails shall be at least 1 m from the deck. Where this height interferes with the normal operation of the ship, a lesser height providing adequate protection may be approved by the Administration."

3 The chapeau of paragraph (3) is replaced by the following:

"(3) Guard rails referred to in paragraph (2) shall have at least three courses. The opening below the lowest course of the guard rails shall not exceed 230 mm. The other courses shall be not more than 380 mm apart. In the case of ships with rounded gunwales the guard rail supports shall be placed on the flat of the deck. Guard rails shall comply with the following provisions:"

4 Sub-paragraph (3)(d) is replaced by the following:

"(d) where necessary for the normal operation of the ship, chains fitted between two fixed stanchions and/or bulwarks are acceptable in lieu of guard rails, provided that the chains are tightened as much as reasonably practicable and are detachable."

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ANNEX 14

RESOLUTION MSC.593(111)
(adopted on 21 May 2026)

PERFORMANCE STANDARDS FOR
SHIPBORNE VHF DATA EXCHANGE SYSTEM (VDES)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution A.886(21), by which the Assembly resolved that the functions of adopting performance standards and technical specifications, as well as amendments thereto, shall be performed by the Maritime Safety Committee on behalf of the Organization,

RECALLING FURTHER resolution MSC.570(109), by which the Committee adopted revised *Performance standards for a universal shipborne automatic identification system (AIS)* to improve the safety of navigation,

TAKING INTO ACCOUNT resolution MSC.583(111) by which the Committee adopted amendments to chapter V of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"), introducing a VHF data exchange system (VDES) as an alternative shipborne navigational equipment and system to comply with the existing requirements of the automatic identification system (AIS),

TAKING ALSO INTO ACCOUNT MSC.1/Circ.1699 on *Guidelines for the onboard operational use of shipborne VHF data exchange system (VDES)*,

RECOGNIZING that AIS is one of the four components of VDES, which allows the existing AIS to coexist with VDES,

HAVING CONSIDERED, at its 111th session, the recommendation made by the Sub-Committee on Navigation, Communications and Search and Rescue at its twelfth session,

1 ADOPTS *Performance standards for a shipborne VHF data exchange system (VDES)*, set out in the annex to the present resolution;

2 RECOMMENDS that Governments ensure that shipborne VDES equipment conforms to performance standards not inferior to those specified in the present resolution.

ANNEX

**PERFORMANCE STANDARDS FOR
SHIPBORNE VHF DATA EXCHANGE SYSTEM (VDES)**

1 Scope

1.1 These performance standards specify the requirements for the shipborne VHF data exchange system (VDES) for the use of VDES equipment on board vessels.

1.2 The VDES equipment integrates four components and their functions. These components are the automatic identification system (AIS) component, the application-specific messages (ASM) component, the terrestrial component of VHF data exchange (VDE-TER) and the satellite component of VHF data exchange (VDE-SAT).

1.3 VDES should be capable of providing information exchange between ships, ships and shore authorities and services, automatically with minimal involvement of the ship's personnel and with a high level of availability and security.[1]

1.4 VDES should be capable of providing the following functions:

.1 exchanging data to improve safety, security and efficiency of navigation and protection of the marine environment;

.2 means for coastal States to request and obtain information about a ship and its cargo and/or passengers;

.3 means for providing Maritime Services in the context of e-navigation; and

.4 means for standardized and automated reporting in accordance with MSC.1/Circ.1595[2] and MSC.1/Circ.1610,[3] as amended.

1.5 The installations, in addition to meeting the requirements of the Radio Regulations, applicable ITU-R Recommendations and the general requirements set out in resolutions A.694(17)[4] and MSC.191(79),[5] as amended, should comply with these performance standards.

2 Equipment functionalities

2.1 The general functions of VDES equipment (see figure 1) are as follows:

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1 High level of security can be achieved by implementing authentication of data and encryption where necessary.

2 *E-navigation Strategy Implementation Plan – Update 1.*

3 *Descriptions of Maritime Services in the context of e-navigation.*

4 *Recommendation on general requirements for shipborne radio equipment forming part of the Global Maritime Distress and Safety System (GMDSS) and for electronic navigational aids.*

5 *Recommendation on performance standards for the presentation of navigation-related information on shipborne navigational displays.*

.1 The AIS component should not be interfered with by other communication means within the VDES, ensuring accurate AIS position reporting and the provision of safety-related information;

.2 VDES should allow the flexibility to prioritize some applications and, consequently, adapt some parameters of the transmission (robustness or capacity) while minimizing system complexity;

.3 VDES should give its highest priority to AIS position reporting and safety-related information, followed by second priority to ASM, third priority to VDE-TER and then to VDE-SAT;

.4 The AIS component of VDES should be capable of providing all modes of operation as described in Recommendation ITU-R M.1371;

.5 VDES should be capable of exchanging data between ship-to-ship, ship-to-shore, shore-to-ship, ship-to-satellite and satellite-to-ship;

.6 VDES should be capable of implementing software/firmware updates;

.7 VDES should be capable of separately disabling VDE-SAT, VDE-TER, or ASM;

.8 VDES should be capable of changing its transmission power from the default setting to a low setting (1 W) or stopping transmission except for the AIS component when operations such as loading or discharging dangerous cargo require it; and

.9 VDES should be capable of temporarily disabling VDE-SAT transmission when receiving a message from an AIS or VDES shore station within its coverage area.

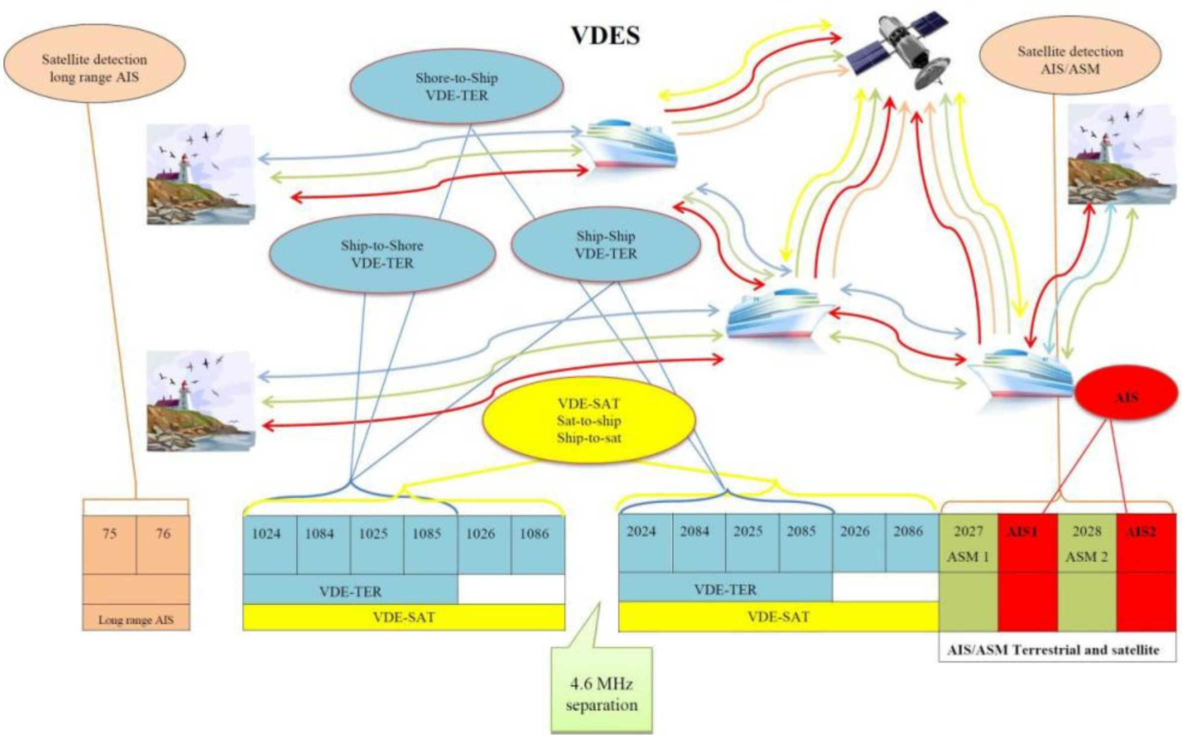

Figure 1: VDES functions

2.2 The AIS component of VDES should comply with the requirements set out in resolution MSC.570(109) and Recommendation ITU-R M.1371.

2.3 The ASM component of VDES should provide a robust and efficient terrestrial data transfer link, enabling the transmission of a wide variety of messages, including application-specific messages currently transmitted by AIS.[6] These messages should be encoded in accordance with Recommendation ITU-R M.1371 annexes on *Application-specific messages* and *Automatic identification system messages,* as well as Recommendation ITU-R M.2092 annex on *Common technical elements of VDES* and the technical characteristics should meet the requirements specified in Recommendation ITU-R M.2092 annex on *Technical characteristics of the application-specific message channels for the VDES in the VHF maritime band*.

2.4 The VDE-TER function of VDES should provide an efficient terrestrial data transfer link. The technical characteristics should comply with Recommendation ITU-R M.2092 annex on *Common technical elements of VDES* and with the annex on *Technical characteristics of VHF data exchange-terrestrial in the maritime mobile band*.

2.5 The VDE-SAT function of VDES should provide an efficient satellite data transfer link. The technical characteristics should meet the requirements specified in Recommendation ITU-R M.2092 annex on *Common technical elements of VDES* and in the annex on *Technical characteristics of VHF data exchange-satellite operating in the VHF maritime mobile satellite band*.

3 Capability

3.1 VDES should support the functions of ASM, VDE-TER and VDE-SAT specified in this performance standard in addition to the AIS functions specified in resolution MSC.570(109).

3.2 In addition, VDES should be capable of:

- .1 selecting the communication component which is controlled through the user interface;
- .2 receiving digital data according to Recommendation ITU-R M.2092 and output through the user interface;
- .3 transmitting digital data according to Recommendation ITU-R M.2092 as input via the user interface; and
- .4 operating continuously under all modes of operation.

4 User interface

4.1 The human-machine interface should include a keyboard and display for configuration, monitoring and control.

4.2 To enable a user to access, select and display the information on a separate system, the VDES should be provided with at least one interface conforming to an appropriate international marine interface standard.[7]

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6 See SN.1/Circ.289 and those identified by IALA List of reference for ASM.

7 IEC 61162 series, as applicable.

5 Identification

Shipborne VDES stations should be uniquely identified with a unique numerical identifier as defined by the most recent version of Recommendation ITU-R M.585 on *Assignment and use of identities in the maritime mobile services*.

6 Information

6.1 VDES information consists of AIS, ASM and other information.

6.2 AIS information is defined by resolution MSC.570(109) and should be exchanged by the AIS component of VDES.

6.3 Other information is information other than AIS and ASM, and should be exchanged by VDE-TER and VDE-SAT components of VDES.[8]

7 Security

7.1 Cybersecurity

Since VDES is networked with other navigational/communication equipment or systems on board, appropriate cybersecurity measures conforming to international standards such as IEC 61162-460 and IEC 63154 should be provided.

7.2 Integrity and authentication

.1 VDES should be capable of verifying a digital signature to ensure the integrity of the data and the identity of the sender; and

.2 VDES should be capable of providing authentication of AIS messages.

8 Operational readiness time

VDES should be operational within two minutes of being switched on by the user.

9 Power supply

VDES and associated equipment should be powered by the ship's main and emergency sources of electrical energy. In addition, it should be possible to operate VDES and associated equipment from a reserve source of electrical energy.

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8 *Guidelines for the onboard operational use of shipborne VHF data exchange system (VDES)* (MSC.1/Circ.1699).

ANNEX 16

RESOLUTION MSC.595(111)

**INTERNATIONAL CODE OF SAFETY FOR
MARITIME AUTONOMOUS SURFACE SHIPS (MASS CODE)**

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the function of the Committee,

RECOGNIZING rapid developments in technological innovation within the maritime industry that will lead to the commercial use of maritime autonomous surface ships (MASS), whether they are operated remotely or autonomously,

RECOGNIZING ALSO that instruments of the Organization currently do not adequately or fully address the safe operation of MASS, warranting the need for guidance for administrations, shipbuilders, owners, operators, insurers and other stakeholders to design, build and operate MASS safely, in particular when they are operating jointly with conventional ships,

HAVING CONSIDERED, at its 111th session, the text of the proposed Code,

1 ADOPTS the International Code of Safety for Maritime Autonomous Surface Ships (MASS Code), the text of which is set out in the annex to the present resolution;

2 INVITES all Governments concerned to take appropriate steps to give effect to the MASS Code set out in the annex, on 1 July 2026;

3 ALSO INVITES all Governments concerned to apply the MASS Code, as far as practicable, to MASS of less than 500 gross tonnage;

4 RECOMMENDS that all Governments concerned bring the MASS Code to the attention of shipowners, ship operators, ship designers, shipbuilders, ship repairers, equipment manufacturers and installers, insurers and all other parties concerned with the operation of MASS;

5 URGES Governments to facilitate the safe operation of MASS, provided that the Governments concerned are satisfied that the MASS in question comply with the provisions of this Code, together with any additional measures necessary to ensure the safe operation of such ships within their respective jurisdictions; and

6 REQUESTS the Secretary-General to bring this resolution and its annex to the attention of all stakeholders concerned.

ANNEX

**INTERNATIONAL CODE OF SAFETY
FOR MARITIME AUTONOMOUS SURFACE SHIPS
(MASS CODE)**

Contents

CHAPTER 8 – OPERATIONAL CONTEXT

CHAPTER 9 – SYSTEM DESIGN

CHAPTER 10 – SOFTWARE PRINCIPLES

CHAPTER 11 – MANAGEMENT OF SAFE OPERATIONS

CHAPTER 12 – SPECIAL MEASURES TO ENHANCE MARITIME SECURITY

PREAMBLE

1 Existing IMO instruments have historically been developed on the basis that the ship will have at least a required minimum level of manning on board to carry out the various tasks required to ensure safe, secure, and environmentally sound ship operations.

2 The ever increasing use of automation in the operation of ships, along with the anticipated increase in the use of autonomous and remote operation of key functions, will require a different approach and, therefore, some adjustment to the accepted norms regarding onboard manual intervention and control as reflected within the International Convention for the Safety of Life at Sea (SOLAS), 1974, and other IMO instruments.

3 Notwithstanding the above, enhanced automation does not qualify a ship as a MASS. The qualifier to distinguish a MASS from a conventional ship is the introduction of autonomous or remotely-operated technology augmenting or replacing functions otherwise performed by onboard crew involved in conducting or controlling these ship functions.

4 In facing these challenges, it is recognized that some aspects associated with MASS are not adequately or fully addressed in SOLAS or other IMO instruments and that additional guidance is required on the design and operation of MASS to ensure a level of safety and security and environmental protection that is expected of a conventional ship.

5 This Code is intended to be supplementary to other IMO instruments, such as SOLAS, and provides a regulatory framework for autonomous and remote operation of key functions.

6 This Code, and the use of MASS, are required to conform to the relevant rules of international law, including the United Nations Convention on the Law of the Sea (UNCLOS), and generally accepted international regulations, procedures and practices developed by IMO as the competent international organization for global shipping.

7 The safety principles and objectives of this Code reflect changes in the operational risks which may result from the introduction of autonomous and remote operation of key functions. This Code addresses the management and reduction of these risks through mitigation measures and controls. This includes the human element issues which may result from the anticipated increase in human-machine interaction, cooperation or collaboration.

8 This Code has been developed based on the *Principles to be considered when drafting IMO instruments* (resolution A.1103(29)), and on the *Generic guidelines for developing IMO goal-based standards* (MSC.1/Circ.1394/Rev.2) for Part III.

9 The provisions of this Code should be implemented for individual autonomous or remote functions even where persons are on board to handle other functions.

10 This Code takes into account that certain operational functions may be controlled from a location remote from the MASS and addresses necessary aspects of such Remote Operations Centres (ROCs).

PART I

INTRODUCTION

CHAPTER 1 – PURPOSE, PRINCIPLES AND OBJECTIVES

1.1 Purpose

The purpose of this Code is to provide an international regulatory framework to address autonomous or remote operation of key functions and systems, and ensure safe, secure, and environmentally sound operation of Maritime Autonomous Surface Ships (MASS). The Code further aims to support the adoption and integration of new technology for ship operations, and provide for a consistent approach to the design, build and operation of MASS.

1.2 Principles

This Code is developed on the principles that it be:

.1 supplementary to any other applied instruments, and only addressing MASS operations and functions as far as they are not adequately or fully addressed in the other applied instruments;

.2 holistic to ensure the objectives, aims and principles of the other applied instruments are maintained while also enabling the MASS operations and functions to be addressed across all instruments;

.3 goal-based and addressing matters at the functional level;

.4 non-mandatory although developed in such a way as to facilitate future transition to mandatory status; and

.5 technology neutral, acknowledging industry practices and experience in the deployment of new technologies.

1.3 Objectives

In achieving its purpose, this Code is intended to:

.1 ensure standards of an acceptable level for design, construction, and operation of MASS in order to achieve levels of safety and security expected of a conventional ship;

.2 enable all ships to safely coexist without impeding or negatively impacting each other, regardless of whether MASS operations or functions are autonomous or remotely-operated;

.3 allow for the application of solutions that are demonstrably safe, secure, and environmentally sound in performing the designated MASS operations or functions under all defined conditions;

.4 avoid the unintended placement of regulatory barriers to new or novel application of autonomous or remotely-operated technology on ships;

.5 require human oversight and control of MASS operations or functions while ensuring effective collaboration between human operators and autonomous systems; and

.6 address responsibility for the operation, and human oversight, of a MASS.

CHAPTER 2 – APPLICATION

2.1 This Code applies to cargo ships to which SOLAS chapter I applies, including any associated Remote Operations Centre(s) (ROC(s)), which have systems and functions that enable autonomous or remote operations, when the Administration deems that compliance with other applicable instruments is impracticable or insufficient. This Code does not apply to:

.1 cargo high-speed craft to which SOLAS chapter X applies; and

.2 warships, naval auxiliaries, and other ships owned or operated by a Contracting Government and used only on Government non-commercial service.

2.2 Where in this Code reference is made to a "MASS", this means a ship to which this Code applies.

2.3 The provisions of this Code should be implemented for individual autonomous or remotely-operated functions even where persons are on board to handle other functions.

CHAPTER 3 – CODE STRUCTURE

The structure and intent of the parts of this Code are:

Part I: Introduction covering overarching matters to be considered in the application of the Code.

Part II: Principles applicable in all cases when applying the Code. These principles and the resulting provisions should be met as part of any MASS approval and certification process.

Part III: Goals, functional requirements, and expected performances applicable to specific MASS operations and functions. Depending on the modes of operation and functionality being certified, not all chapters of part III may be applicable.

CHAPTER 4 – DEFINITIONS

For the purposes of the Code, unless expressly provided otherwise, terms used have the meanings defined in the following paragraphs. For terms used, but not defined in this Code, the definitions as given in SOLAS, should apply.

4.1 *Agent* means a human or software (computer or computer system(s)) responsible for performing or supervising control actions.

4.2 *Autonomous* means processes or equipment in a MASS system which are designed and verified to, under specified conditions, determine control action(s) without human intervention.

4.3 *Autonomous Navigation System* (ANS) means a system which, under specified conditions, is capable of the navigation of a MASS without human intervention.

4.4 *Concept of Operations* (ConOps) means a document describing the characteristics of a MASS.

4.5 *Connectivity* means capabilities that allow appropriate and applicable MASS systems and the Remote Operations Centre(s) (ROC(s)), to connect to a communication network.

4.6 *Control* is purposeful action on or in a process, to meet specified objectives.

4.7 *Control action* means the acquisition of information, analysis of information, decision-making, or implementation of actions.

4.8 *Control station* means a single or multiple position(s), including all equipment, such as computers and communication terminals and furniture, from which functions or operations of a MASS can be controlled or monitored.

4.9 *Degraded state* means a deviation in the normal operation or condition of the MASS which can potentially result in a fallback state.

4.10 *Failure* means the loss of the ability of an item to perform the specified function.

4.11 *Fallback response* means the actions and procedures to enter into, safely stay within, and eventually recover from, a predefined fallback state.

4.12 *Fallback state* means a predefined state entered when it is not possible for the MASS to stay within the Operational Envelope (OE).

4.13 *Fault* means an abnormal condition that can cause an element or an item to fail.

4.14 *Fault tolerant* means the ability of a functional unit to perform a required function in the presence of faults or errors.

4.15 *Hazards* are situations having the potential to threaten human life, health, property or the environment.

4.16 *Human-centred design* is an approach to system design and development that aims to make interactive systems more usable by focusing on the use of the system; applying human factors, ergonomics and usability knowledge and techniques.

4.17 *Human-Machine Interface* (HMI) means the part of a system with which an operator interacts. The interface is the aggregate of means by which the users interact with a machine, device, and system. The interface provides means for input, allowing the users to control the system and output, allowing the system to inform the users.

4.18 *Intolerable risk* means a level of risk that would neither be negligible nor tolerable.

4.19 *Maritime Autonomous Surface Ship* (MASS) means a ship which, to a varying degree, can operate independently of human interaction.

4.20 *MASS function* means a task or group of tasks, duties and responsibilities, as specified in the Code, necessary for the operation of the MASS.

4.21 *Mitigation* means a measure implemented to prevent unsafe conditions or modes from resulting in losses.

4.22 *Modes of operation* means the condition(s) under which the functions of a MASS are operated, i.e. autonomous or remotely-operated, with or without persons on board.

4.23 *Monitoring* means the use of measurements and analytical methods to understand the condition and any changes in the state of MASS including its systems and components.

4.24 *Normal operation* means operations within the Operational Envelope of a MASS.

4.25 *Onboard crew* means a master, officers or operational staff physically on board.

4.26 *Operational Design Domain* (ODD) refers to the design range in which a system can operate as intended. It includes both internal events, such as component or subsystem failure or degradation; and relevant external factors, such as available resources, geographical, or environmental situations.

4.27 *Operational Envelope* (OE) means the description of the MASS's operational capabilities and limitations.

4.28 *Override* means to take over control of functions or systems that are under autonomous or remote operation.

4.29 *Quality of service* is a network's ability to maintain acceptable connectivity in the intended Operational Envelope, achieve maximum bandwidth, and deal with other network performance elements.

4.30 *Remote operation* is when functions and systems are operated from outside the MASS.

4.31 *Remote Operations Centre* (ROC) means a location remote from the MASS and from which some or all of the functions of the MASS can be operated.

4.32 *Remote operator* means a qualified person who is employed or engaged to operate some or all of the functions of a MASS from a ROC.

4.33 *Situational awareness* means the perception of surroundings and environmental elements in different modes of operation, the condition of all relevant systems and events with respect to time and space, the comprehension of their meaning, and the projection of their future status.

4.34 *Submitter* is an entity seeking approval of a MASS from the Administration, and responsible for communicating with the Administration for the submission and follow up of the approval process.

4.35 *System* means the combination of interacting elements organized to achieve one or more stated purpose.

4.36 *Systematic failure* means an event that is the consequence of inadequate work processes and may occur at any stage in the systems' lifecycle.

4.37 *Systemic failure* means an event which occurs not only by the malfunctions of a distinct component in the system but due to inherent deficiencies, flaws or oversights in the system's structure, including unforeseen interactions or dependencies among other various constitutive elements of the system.

4.38 *Task* means a set of actions taken to enable functions and the performance of operations.

4.39 *Task station* means a multifunction display with dedicated controls providing the possibility to display and operate any tasks. A task station is part of a control station.

4.40 *Third parties* means persons or entities that are not involved in the operations of the MASS or an associated ROC but are engaging with it (e.g. vessel traffic services (VTS), ports, pilots or other persons on board or in the ROC for maintenance reasons, persons in distress, etc.).

4.41 *Unsafe state* means when a system is operating outside its Operational Envelope but not within a fallback state owing to degraded performance (e.g. faults or failures), or is exceeding capabilities which, if left uncorrected or unmitigated, has the potential to directly cause an accident.

4.42 *Validation* means the testing and evaluation to prove that a MASS and its systems, including hardware and software components, are effective, dependable and safe during real-world operations and satisfy all the technical requirements representative of normal, abnormal and adverse operating conditions.

4.43 *Verification* means the testing and evaluation to prove MASS and its systems, including hardware and software components meet the technical requirements at a particular stage of their development.

4.44 *Voyage phase* means the parts of the voyage typically characterized by a recognizable shift in where the MASS is located in terms of geographical surroundings, or the start and end of one or more operations.

PART II

PRINCIPLES FOR MASS AND MASS FUNCTIONS

GENERAL

Each chapter in this part consists of the principles applicable in all cases when applying the Code. These principles and the resulting provisions should be met as part of any MASS approval and certification process.

CHAPTER 5 – SURVEYS AND CERTIFICATES

5.1 MASS Safety Certificate

5.1.1 Every MASS should have on board a valid MASS Safety Certificate, issued after an initial or renewal survey confirming compliance with the relevant requirements of this Code.

5.1.2 The MASS Safety Certificate should be issued either by the Administration or an organization recognized by it, in accordance with SOLAS regulation XI-1/1.

5.1.3 The MASS Safety Certificate should be accompanied by a MASS Record, containing the following:

.1 description of the Concept of Operations (ConOps);

.2 survey requirements associated with the systems to which this Code applies;

.3 task allocation summary;

.4 regulatory gap analysis; and

.5 list of any Remote Operations Centre(s) (ROC(s)) approved for the MASS.

5.1.4 The MASS Safety Certificate and MASS Record should be drawn up in a form corresponding to the models given in the appendix. If the language used is neither English, nor French nor Spanish, the text should include a translation into one of these languages.

5.1.5 The MASS Safety Certificate and the MASS Record should be issued in addition to other relevant certificates required in SOLAS regulation I/12.

5.1.6 Where compliance with any of the requirements of SOLAS is achieved through application of this Code, resulting exemptions or equivalent arrangements should be reflected on the appropriate SOLAS certificates.

5.2 MASS surveys

5.2.1 The MASS Safety Certificate validity, survey dates and endorsements should be harmonized with the relevant SOLAS certificates in accordance with the principles of *Survey guidelines under the harmonized system of survey and certification (HSSC), 2025* (resolution A.1207(34), as amended), and SOLAS.

5.2.2 MASS surveys should be carried out as follows:

.1 an initial survey that should include complete inspection, verification and testing of the MASS functionality and connectivity with any associated ROCs intended to be certified, to ensure compliance with the requirements of this Code;

.2 a renewal survey that should consist of an inspection, with tests, of the MASS functionality and connectivity with any associated ROCs, to ensure compliance with the requirements of this Code, that they are in satisfactory condition, and are fit for the service for which the MASS is intended;

.3 intermediate and annual surveys that should include, as appropriate, general inspection, verification and testing of the MASS functionality, including inspection of operational records of related systems, to ensure that they comply with the requirements of this Code, are in satisfactory condition, and are fit for the service for which the MASS is intended; and

.4 additional surveys after repairs resulting from investigations prescribed in SOLAS regulation I/11, or after any major repairs, renewals or modifications of equipment, or systems related to autonomous or remotely-operated functions, to ensure that the MASS complies with the relevant requirements of this Code. Such major repairs, renewals or modifications of equipment and/or systems may include, inter alia, the following:

  .1 replacements or updates that may affect the compatibility, security and stability of any software system;

  .2 modifications to the ConOps and verification that the functionality of MASS systems and functions continues to comply;

  .3 repairs after serious failure or defects of equipment and/or systems; and

  .4 any change to the list of ROCs associated with the MASS.

5.2.3 The MASS Safety Certificate should be endorsed after intermediate and annual surveys referred to in II/5.2.2.

5.3 MASS ROC Certificate

5.3.1 Every ROC should, for each MASS it operates, have a valid MASS ROC Certificate issued after an initial or renewal survey.

5.3.2 The MASS ROC Certificate should be issued either by the Administration or an organization recognized by it, in accordance with SOLAS regulation XI-1/1.

5.3.3 The MASS ROC Certificate should be accompanied by a MASS ROC Record, containing the following:

.1 a description of the ConOps;

.2 all operational restrictions on the ROC; and

.3 the infrastructure for connectivity, and its performance and quality of service as accepted by the Administration.

5.3.4 A copy of the MASS Safety Certificate and MASS Record should accompany the MASS ROC Certificate.

5.3.5 The MASS ROC Certificate and MASS ROC Record should be drawn up in a form corresponding to the models given in the appendix. If the language used is neither English, nor French nor Spanish, the text should include a translation into one of these languages.

5.4 MASS ROC surveys

5.4.1 MASS ROC Certificate validity, survey dates and endorsements should be harmonized with the relevant SOLAS certificates in accordance with the principles of *Survey guidelines under the harmonized system of survey and certification (HSSC), 2025* (resolution A.1207(34), as amended), and SOLAS.

5.4.2 MASS ROC surveys should be carried out, as follows:

.1 an initial survey that should include a complete inspection, verification and testing of the ROC and the remote operation functionality, to ensure compatibility between the MASS and ROC and that they comply with the requirements of this Code;

.2 a renewal survey that should consist of an inspection, with tests, of the ROC and the remote operation functionality, to ensure compatibility between the MASS and ROC and that they comply with the requirements of this Code, are in satisfactory condition, and are fit for the service for which the MASS and ROC are intended;

.3 intermediate and annual surveys that should, as considered appropriate, include general inspection, verification and testing of the ROC and the remote operation functionality, to ensure compatibility between the MASS and ROC and that they comply with the requirements of this Code, are in satisfactory condition, and are fit for the service for which the MASS and ROC are intended; and

.4 additional surveys of equipment and/or systems related to autonomous or remotely-operated functions should be made after repairs resulting from investigations prescribed in SOLAS regulation I/11, or other major repairs, renewals or modifications, to ensure that the ROC complies with the requirements of this Code. Such major repairs, renewals or modifications of equipment and/or systems may include, inter alia, the following:

.1 replacements or updates that may affect the compatibility, security and stability of any software system;

.2 modifications to the ConOps, and verification that the ROC and MASS functionality continues to comply; and

.3 repairs after serious failure or defects of equipment and/or systems.

5.4.3 The MASS ROC Certificate should be endorsed after intermediate and annual surveys referred to in II/5.4.2.

5.5 Provisional Certificates

5.5.1 Provisional MASS Safety and MASS ROC Certificates may be issued to a MASS and ROC that will enable initiation of operations while they are undergoing testing during step 3 of the approval process, as described in II/6.1.

5.5.2 Provisional MASS Safety and MASS ROC Certificate(s) may be issued before performing the full-scale test of the MASS and ROC, provided that individual MASS systems have been tested and verified and results of simulation (if applicable) are reviewed and accepted, in accordance with the verification and validation plan approved at step 2 of the approval process, and all the design documents have been updated accordingly and approved according to the simulation and system testing results.

5.5.3 Provisional MASS Safety and MASS ROC Certificate(s) should be issued by the Administration to a MASS and ROC for a period and area of testing specified by the Administration, based on the arrangements proposed by the Submitter in the verification and validation plan.

5.5.4 In addition to surveys covered by the verification and validation plan, MASS and ROCs issued with Provisional MASS Safety and MASS ROC Certificate(s) should be subject to the surveys listed in II/5.2 and II/5.4, as appropriate.

5.6 Validity of certificates

5.6.1 A certificate issued under II/5.1, II/5.3 or II/5.5 should cease to be valid in any of the following cases:

.1 if the relevant surveys and inspections are not completed within the periods specified under II/5.2 or II/5.4;

.2 if the certificate is not endorsed in accordance with the present requirements; or

.3 upon transfer of the MASS to the flag of another State. A new certificate should only be issued when the Administration issuing the new certificate is fully satisfied that the MASS is in compliance with the requirements of this Code.

5.6.2 Where a MASS ROC Certificate is withdrawn or ceases to be valid, the Administration should review the effect on the associated MASS Safety Certificate as well as on other MASS ROC Certificates issued for this ROC by that Administration.

5.7 Safety management certification

5.7.1 Every International Safety Management (ISM) Company intending to operate a MASS should, in accordance with chapter 11 of this Code, develop its Safety Management System (SMS) to address autonomous and/or remote operations, as applicable.

5.7.2 The Company should ensure that the SMS is implemented and maintained on the MASS and at any ROC(s) involved in its operation. The Company should clearly identify and document the subdivision of tasks and relationship between the Company and any associated ROCs and MASS.

5.7.3 Any operational procedures specified by this Code for the autonomous or remote operations, including watchkeeping arrangements, should be included in the SMS of the MASS and ROC respectively.

5.7.4 The operation of the ROC, including the remote operation of the MASS, should be included in the ISM verification and certification process for a Company to the satisfaction of the Administration.

5.7.5 Where the alternative management described in II/11.3 is used for the operation of a ROC(s), certification should follow a similar approach as the ISM Code with:

.1 a ROC Safety Management System (ROCSMS);

.2 a Document of Compliance for the Remote Operation Management Company (ROM DoC); and

.3 a ROC Management Certificate (RMC) for each ROC.

5.8 International Ship and Port Facility Security certification

A MASS and any ROC operating a MASS should be subject to the International Ship and Port Facility Security (ISPS) Code, as supplemented by this Code.

5.9 Minimum safe manning documents

5.9.1 A MASS or ROC operating a MASS should be sufficiently, effectively and efficiently manned in accordance with the principles of minimum safe manning as set out in *Principles of minimum safe manning* (resolution A.1047(27), as amended), and as supplemented by this Code.

5.9.2 A MASS should be issued with a minimum safe manning document (MSMD) according to resolution A.1047(27), as amended, and to the satisfaction of the Administration.

5.9.3 A ROC operating a MASS should be issued with a MSMD for operation of that MASS, based on the principles of resolution A.1047(27), as amended, and to the satisfaction of the Administration.

5.9.4 A ROC operating several MASS should be issued with one MSMD per MASS. For such ROCs, a MASS ROC Master Plan (MRMP) for watchkeeping and other tasks should be developed and approved by each Administration who has issued MSMDs covered by the MRMP.

5.9.5 The Company should be able to demonstrate compliance with the MSMD(s), through issuing and maintaining appropriate records.

5.9.6 The determination of safe manning should consider the specific personnel qualifications (see chapter 14), operational policy and procedures (see chapter 11), and the infrastructure/technology necessary to perform operational functions (see chapter 8). This determination should consider normal operation (including degraded states), fallback states and emergency situations.

CHAPTER 6 – APPROVAL PROCESS

6.1 Process description

6.1.1 A structured approval process should take place to enable the MASS to obtain the required approval including the necessary certificates related to requirements for the intended operation. By following this process, a Submitter and the Administration would be working in cooperation to ensure that all aspects of safety, security and environmental protection are adequately assessed. This process is intended for the MASS as a whole, while individual systems are covered in the verification and validation step.

6.1.2 The approval process for MASS should be based on and follow the main principles of the *Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments* (MSC.1/Circ.1455), taking into consideration parts II and III. The level of detail should be proportional to the complexity, level of novelty and associated risk of the MASS and on whether the Submitter is applying for preliminary or final approval. The necessary documentation may vary accordingly.

6.1.3 The Concept of Operations (ConOps) (as described in II/8.2) should be a base document in the approval process and should be the basis for the assessment in each step.

6.1.4 The steps and documentation required in this chapter (and annex 1) provide the general basis of the approval process, without prejudice to other information or documentation that may be requested by the Administration, or to an alternative process which may be followed to the satisfaction of the Administration.

6.1.5 Sufficient information should be supplied to enable the Administration to fully assess the features of the MASS. After appropriate identification of relevant stakeholders by the Submitter, discussions should commence at the earliest possible stage, so that the Administration may fully evaluate the level of safety of the MASS.

6.1.6 The following steps should be observed in the approval process:

.1 preliminary design development;

.2 preliminary design approval;

.3 testing, simulation, and other verification and validation methods;

.4 final approval; and

.5 operation.

6.1.7 Table 1 in annex 1 provides additional guidance in relation to the approval steps that require relevant documentation.

6.2 Evaluation criteria

The basic principle for the evaluation criteria should be to ensure a level of safety, security and environmental protection that is expected of a conventional ship. The evaluation criteria should be developed through compliance with the principles of part II and goals and functional requirements of the applicable chapters of part III in combination with a risk assessment (as described in II/7.2). The evaluation criteria and an assessment plan thereof should be agreed with the Administration.

6.3 Design and documentation requirements

For each approval step, information and supporting documentation required by the Administration should be produced and submitted. The various documents required in the approval process steps are expected to be reviewed according to any possible design or operational changes and added details. The approval steps do not need to be sequential, meaning that they may also run at the same time.

6.4 Operation

6.4.1 Conditions for maintaining the safety level agreed during the design approval may be imposed on MASS operations. Any operational conditions should be determined during the approval process, and they should be clearly documented and communicated to relevant parties.

6.4.2 If, during the operational phase, the initial assumptions, systems and equipment are changed, resulting in any change in the ConOps, the part of the risk assessment with the respective changes should be repeated. The extent of work needed will be dependent on the risk-based features and the changes and the operation of the MASS, and may be decided by the Administration. For example, in the case of a Remote Operations Centre (ROC) with remote operators approved for the control of one MASS, it may be necessary to review the approval assumptions if a second MASS is added to the same ROC.

6.4.3 A MASS may initiate operations while it is being tested. During such tests, the certification of the MASS should follow the process for provisional MASS certification described in II/5.5. In addition, further mitigation layers to the system being tested should be foreseen such as different modes of operation from the ones of the final design.

CHAPTER 7 – RISK ASSESSMENT

7.1 A risk assessment should be conducted to ensure that risks arising from the use of MASS functions, including relevant functions in Remote Operations Centres (ROCs), affecting persons on board, the environment, and the safety of the MASS are addressed, taking into account identified goals and functional requirements, ensuring a level of safety expected of a conventional ship.

7.2 The risk assessment can be conducted on MASS as a whole, and/or on the MASS functions. It should also consider the Operational Envelope (OE) or Concept of Operations (ConOps) of the MASS, and address relevant mitigation measures.

7.3 Should the risk assessment be carried out on specific MASS functions, the consequences on other functions should be considered and mitigated.

7.4 Appropriate risk assessment methodologies[1] should be used for the different steps of the approval process as required in chapter 6 (Approval process). Such risk assessments, inter alia, might include:

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1 Refer to:
- MSC.1/Circ.1455 on *Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments*
- IEC/ISO 31010:2019 – Risk management — Risk assessment techniques
- IEC 61508 on *Functional safety of electrical/electronic/programmable electronic safety-related systems* - Parts 1 to 7
- STPA: http://psas.scripts.mit.edu/home/get_file.php?name=STPA_handbook.pdf
- RBAT: https://www.emsa.europa.eu/mass/rbat.html

.1 MASS (including ROC(s)) and system design; and

.2 alteration or modification of any major characteristic of the MASS or of the OE or ConOps of MASS that may impact MASS functions.

7.5 A risk assessment should be carried out by personnel with relevant expertise as required by the Administration (*Revised guidelines on alternative design and arrangements for SOLAS chapters II-1 and III* (MSC.1/Circ.1212/Rev.2), section 4 (Design team)).

7.6 The output format should be justified by the Submitter and be agreed between the Submitter and the Administration.

7.7 The risk assessment should include a comprehensive description of autonomous and remotely-operated function utilization, effectiveness and reliability by performing a hazard and mitigation analysis, evaluating the identified risks, and implementing effective risk control measures.

7.8 The risk assessment should analyze and address hazards associated with the intended OE of the MASS including any associated ROCs, as described in the ConOps. Apart from the hazards such as loss of function, cyber incidents, software application failure, component damage, fire, explosion and electric shock, it should also consider the random, systematic, and systemic hazards involved within the OE.

7.9 The adopted mitigation measures should take into consideration single failure events, but also foreseeable events within the OE of the MASS that may influence the performance of more than one system at the same time. Such features should consist mainly of independent mitigation layers, including predefined fallback states. The number of such mitigation layers should be proportional to the risk.

7.10 The assessment should ensure that hazards are eliminated wherever possible through inherently safe design and hazards that cannot be eliminated should be mitigated as needed. The effectiveness of the mitigation measures considered in the risk assessment should be verified according to the verification and validation plan stipulated in paragraph 2.7 of annex 1.

CHAPTER 8 – OPERATIONAL CONTEXT

8.1 General

8.1.1 The operational context for a MASS should, within the applicable regulatory framework, and on the understanding that it does not have any privilege over conventional ships, consider all aspects of the MASS operation and describe the autonomous or remotely-operated function(s) and the external environment that influences its operation.

8.1.2 The operational context encompasses the Concept of Operations (ConOps), the Operational Envelope (OE), the system-specific Operational Design Domain (ODD), fallback states, the modes of operation and the human control and supervision, all of which should be considered as part of the certification. Figure 1 in annex 2 illustrates the relationship between the OE, ODD, fallback state and contingency plans.

8.2 Concept of Operations

8.2.1 The ConOps should be drafted to ensure the safe, secure and environmentally sound operation of the MASS.

8.2.2 The ConOps may be drawn up in a form corresponding to the model given in annex 2, or an alternative acceptable to the Administration.

8.2.3 Risk assessments for the MASS and Remote Operations Centre (ROC) should take the ConOps into consideration. The ConOps and the associated risk assessment should ensure that all relevant risks are addressed.

8.2.4 The ConOps should include consideration of the OE and the technical design of the MASS and of the ROC(s), if applicable, including connectivity and communication lines. The ConOps should address the control, monitoring, and intervention on board the MASS and at the ROC, if applicable, together with the integration of humans in the operation.

8.2.5 The ConOps should be re-evaluated when there are hardware, software, operational or management changes to the MASS or ROC.

8.3 Operational Envelope and Operational Design Domain

A MASS should have a clearly defined OE for the MASS as an integrated system, which also includes the ODDs of all relevant systems or functions.

8.3.1 *Operational Envelope*

8.3.1.1 The OE of the MASS should encompass the operational capabilities and limitations of the autonomous or remote operation, and ship-specific capabilities and limitations to indicate the condition in which a MASS can operate safely in all operating conditions, including all reasonably foreseeable degraded states.

8.3.1.2 The OE should, inter alia, contain:

.1 definition of the MASS functions and states, and its use case(s);

.2 geographic area of operations, including coverage/connectivity and traffic conditions;

.3 description of the environmental limitations;

.4 description of operational limitations for different modes of operation during a single voyage;

.5 the use and management of the modes of operation, including the division of functions and allocation of tasks between humans and systems which enable autonomous or remote operations; and

.6 any other factors that have a significant impact on MASS operations.

8.3.2 *Operational Design Domain*

8.3.2.1 The ODD of individual autonomous or remotely-operated functions or systems should be based on the results of a risk assessment. The relevant design documents should include:

.1 conditions and limitations under which any relevant individual system or function operates safely;

.2 reasonably foreseeable system or equipment malfunctions including corresponding degraded states;

.3 extent of human interaction;

.4 capabilities and limitations to be accomplished before activation of the individual system or function; and

.5 descriptions of the external and internal conditions, such as geographical boundaries within which the MASS is to operate, the maximum wind speed and wave heights, etc.

8.3.2.2 An autonomous or remotely-operated system and related equipment should operate within its ODD and should be able to detect whether its current state of operation meets the ODD.

8.3.3 *Degraded state*

A single autonomous or remotely-operated system or function deviating from its ODD should not necessarily result in the MASS deviating from its OE. As long as the MASS, as an integrated system, can continue to be operated within its OE the deviation of an autonomous or remotely-operated system or function from its ODD should be considered as a degraded state.

8.4 Fallback state

8.4.1 In case of deviating from its OE, a MASS should enter a predefined fallback state, offering an additional mitigation layer. There may be more than one predefined fallback state, to address failures or conditions identified at the design stage that might lead to a MASS deviating from its OE.

8.4.2 The conditions, actions and procedure to enter into, and recover from, a fallback state should be considered as the fallback response and should be predefined and able to be tested.

8.4.3 When a MASS enters a fallback state, the predefined fallback response should avoid harm to human life, other ships, infrastructure, and the marine environment while the MASS returns into its OE and normal operation is restored.

8.4.4 Fallback states should be risk-assessed and demonstrate effectiveness in avoiding further deterioration in the status of the MASS or increases in the threat to human life, marine environment, other ships or infrastructure. Depending on the result of the risk assessment, more than one independent fallback state should be available at any time during normal operations. Being in a fallback state should not result in an intolerable risk.

8.4.5 The MASS should be capable of notifying its onboard crew and remote operators when transitioning to, and operating in, a fallback state.

8.5 Contingency plans

A deviation from an OE beyond a predefined fallback state should lead to the activation of contingency plan(s).

8.6 Mode(s) of operation

8.6.1 The mode of operation of a MASS may be changed for different phases of a voyage, and procedures to change from one mode of operation to another, along with the criteria for any such change, should be described in the ConOps.

8.6.2 The description of mode(s) of operation should also identify:

.1 which functions are autonomous or remotely-operated;

.2 how autonomous or remotely-operated functions are allocated to different agents (human or software);

.3 how the affected functions are supervised, and by which agents;

.4 where the different agents are located (on board or remote); and

.5 which other systems and other roles (personnel) are involved in performing the control action.

8.7 Human oversight and control

8.7.1 All onboard crew and remote operators responsible for managing MASS operations should be able to exercise human oversight and control for operation of the MASS, including the ability to:

.1 understand and interpret system outputs;

.2 supervise the system, and verify system-initiated decisions, as appropriate; and

.3 intervene and/or override the system, if required.

8.7.2 The allocation of functions as per II/8.6.2.2 should be based on the understanding that the operation of a MASS without any human interaction has limitations. Therefore, any onboard crew and remote operators responsible for managing MASS operations should always be able and prepared to take over the responsibilities of autonomous functions without risk to the outcome of the task.

8.7.3 There should be a human master responsible for a MASS, regardless of the mode of operation and the master should have the means to intervene when necessary.

8.7.4 The onboard crew or remote operator should be provided with ample time and sufficient information to be able to establish situational awareness, assume responsibility and exercise direct or supervisory control of all functions according to the ConOps (see II/10.7).

CHAPTER 9 – SYSTEM DESIGN

In addition to complying with relevant rules, regulations, and standards, systems related to MASS functions should comply with the following high-level principles.

9.1 Safety-centric design

Systems should be designed to minimize threat to the MASS, human life, marine environment, other ships and infrastructure by incorporating inherently safe design principles. All systems used for MASS operations should include fail-safe mechanisms and emergency protocols to ensure comprehensive safety and effective risk management. Hazards should be eliminated wherever possible, and those that cannot be eliminated should be mitigated as needed by using a risk assessment as described in chapter 7 (Risk assessment).

9.2 Human-centred design

Systems should be designed, and further developed throughout their life-cycle, using a human-centred approach, which takes into account the characteristics and competence of expected users, including their tasks and working environment.

9.3 Robustness

Systems should be robust and should be able to operate effectively under adverse conditions, including diverse maritime environments and operational challenges.

9.4 Reliability

It should be ensured that the systems perform their required functions effectively during the operational period specified by the manufacturer, up to predetermined maintenance intervals.

9.5 Adaptability

Systems should have the ability to adapt to changing environments, tasks, and user requirements, and allow for updates and modifications to accommodate necessary technical and regulatory updates, and future needs.

9.6 Redundancy and fault tolerance

9.6.1 Redundant sub-systems should be implemented to maintain functionality in case of component failures including systemic or systematic failures.

9.6.2 Systems should be designed to handle and recover from failures and continue operating at a reduced performance level (fallback state).

9.7 Scalability

It should be ensured that system designs are scalable, allowing for expansion or updates as technology advances or operational needs change.

9.8 Security and cybersecurity

Measures to mitigate security risks and cyber risks should be incorporated in the systems of the MASS and the Remote Operations Centre (ROC), including prevention of unauthorized access.

9.9 Data management and quality

Data management systems should be incorporated that ensure data accuracy, integrity, and quality.

9.10 Proper record keeping (data logging)

9.10.1 Systems should support data logging for performance, failure and incident analysis.[2]

9.10.2 Data should be electronically stored for a predetermined period, not less than 30 days, and be made available in an appropriate format.[3]

9.10.3 For data stored on board, means should be available to protect data during, and retrieve data following, an incident.

9.10.4 Logged data should contain appropriate detail to restore a complete record of the MASS operations, including, where applicable, remote operations and automated decision-making processes.

9.10.5 Logged data should be made available to the Administration and other marine investigation authorities upon request.

9.10.6 The requirements of SOLAS regulation V/20 (Voyage Data Recorders) should apply to all MASS.

9.11 Interoperability

Compatibility and interoperability with systems, devices, applications, and technologies should be ensured.

9.12 Testing and validation

9.12.1 Systems should undergo comprehensive testing and validation to ensure compliance with design specifications and operational requirements. This process includes a structured procedure comprising detailed simulation, component testing, integration testing, and system testing.

9.12.2 Remote operators should be actively involved in the system validation phase in real-case scenarios to ensure practical usability and operational soundness meeting all regulatory requirements, before obtaining the necessary certifications.

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2 Refer to resolution MSC.333(90) on *Adoption of revised performance standards for shipborne Voyage Data Recorder (VDRs);* IEC 61996-1:2013+A1:2021 *Maritime navigation and radiocommunication equipment and systems - Shipborne voyage data recorder (VDR) - Part 1: Performance requirements, methods of testing and required test results*.

3 Refer to MSC.1/Circ.1024 on *Guidelines on voyage data recorder (VDR) ownership and recovery*.

9.13 Transparency

Transparency should be maintained in the system design for systems operations and decision-making processes.

CHAPTER 10 – SOFTWARE PRINCIPLES

The principles in this chapter should be implemented to ensure that software on MASS or supporting MASS functions is reliable, trustworthy, safe and secure. They should be used within the context of complying with this Code, including the use of autonomous and remotely-operated functions, and should be considered as part of the approval process, and this may be done using software quality assurance standards.[4]

10.1 Proportionality

Software should have an explicit and well-defined Operational Design Domain (ODD). The use of software should not go beyond what is provided for in the Concept of Operations (ConOps). Risk assessment(s) should be used to identify and manage hazards from the software.

10.2 Reliability

The continued effectiveness of software capabilities should be subject to testing and assurance across their entire lifecycles.

10.3 Safety and security

Unwanted harm (safety risks) as well as vulnerabilities to external factors (security risks) should be avoided and addressed, as described in chapter 7 (Risk assessment). Safety and security (including cybersecurity) risks should be identified, addressed, and mitigated throughout the software's operational life to prevent and/or limit, any potential or actual harm to shipping, human life, or the marine environment.

10.4 Transparency and explainability

Software should be transparent and explainable at all stages of its operational life, and for all decision-making processes. The transparency and explainability should ensure relevant personnel possess an appropriate understanding of the technology, development processes, and operational methods applicable to autonomous capabilities, including with transparent and auditable methodologies, data sources, and design procedures and documentation.

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4 Refer to:
- MSC.1/Circ.1512 on *Guidelines on software quality assurance and human-centred design for e-Navigation*
- IEC 61508 on *Functional safety of safety-related electrical/electronic/programmable electronic safety-related systems* — Parts 1 to 7
- IEC 61924-2:2021 on *Maritime navigation and radiocommunication equipment and systems – Integrated navigation systems (INS) – Part 2: Modular structure for INS – Operational and performance requirements, methods of testing and required test results*
- IEC 61162 series of standards on *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*
- IACS UR E22 on *Computer-based systems* Rev.3 (June 2023)
- ISO/IEC/IEEE 90003:2018 on *Software engineering – Guidelines for the application of ISO 9001 to computer software*
- ISO/IEC 25000:2014 on *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) – Guide to SQuaRE*
- MSC-FAL.1/Circ.3/Rev.3 on *Guidelines on maritime cyber risk management*

10.5 Accountability

Entities developing, deploying, or operating software should implement mechanisms to ensure accountability and proper operation of their software. Software should be auditable and traceable to such entities. There should be governance mechanisms in place for oversight, impact assessment, audit, and due diligence to ensure accountability for the software's performance and reliability throughout its operational life.

10.6 Robustness

Safe and secure software should be enabled through robust frameworks. Software should perform consistently with intended objectives, in a stable and resilient manner in a variety of circumstances. The robustness of such software should be tested and assured across its entire life cycle within that domain of use.

10.7 Controllability

Software should be designed and developed to ensure that any onboard crew and remote operators responsible for managing MASS operations can exercise human oversight and control, including the means to:

.1 interpret appropriate context by delivering accurate, timely, sufficient and unambiguous information to operators and other systems;

.2 verify system behaviour with respect to the accuracy of system output and effectiveness of system performance at any time during operations by providing timely indicators of task status;

.3 take over control, and adjust or override system behaviour in a time frame that minimizes risk and disruption to ongoing operations; and

.4 provide timely input and direction as required to prevent or minimize risks to MASS operations by enabling performance of all required operator actions, providing accurate, understandable and relevant feedback and confirmation where necessary.

10.8 Unintended bias

Software should be designed and developed to prevent unintended bias.

CHAPTER 11 – MANAGEMENT OF SAFE OPERATIONS

11.1 Purpose

The purpose of this chapter is to ensure adequate management for safe operations.

11.2 Safety Management System provisions for MASS operations

11.2.1 The MASS, the Company and the Remote Operations Centre (ROC) should follow the provisions of this chapter, which are supplementary to the requirements for the management of the safe operation of ships in SOLAS and the ISM Code.

11.2.2 The Safety Management System (SMS) of the Company should provide for safe MASS operations through the establishment of procedures, plans and instructions for all foreseeable modes of operation, including for any ROC(s) involved, if applicable. In order to accomplish this, the following should be considered:

.1 Risk control measures addressing autonomous or remotely-operated functions.

.2 Internal processes should verify the effectiveness of procedures, plans and instructions to address autonomous or remotely-operated functions.

.3 Human-machine interface (HMI) aspects of autonomous or remotely-operated functions.

.4 The role and expected performance for ROC(s), where autonomous or remotely-operated functions are executed.

.5 With respect to autonomous or remotely-operated functions:

.1 their interaction, capabilities and limitations;

.2 the complexity of systems, including software systems or data services;

.3 equipment and systems necessary to maintain contact with the MASS;

.4 lines of communication to maintain contact with the MASS;

.5 cyber risks; and

.6 fallback actions and processes to maintain their safe operation.

11.2.3 The SMS of the Company should provide for the safety and well-being of the personnel involved in the operations by identification of resources and training required and establishment of procedures, plans and instructions for all foreseeable operating conditions of the MASS, including for any ROC involved, if applicable. In order to accomplish this, the following should be considered:

.1 Risk control measures addressing autonomous or remotely-operated functions.

.2 Internal processes verifying the effectiveness of procedures, plans and instructions addressing autonomous or remotely-operated functions.

.3 HMI aspects of autonomous or remotely-operated functions.

.4 Responsibilities with regard to the interaction in MASS operations.

.5 Maintenance of the principle of the overriding authority of the master.

.6 Emotional pressure, specific stresses and strains to humans involved in the MASS operations.

11.2.4 The SMS of the Company should provide for the safety of the MASS under all expected emergency conditions by establishment of contingency plan(s), including emergency scenarios involving different physical locations, if applicable. In order to accomplish this, the following should be considered:

.1 Risk control measures addressing autonomous or remotely-operated functions.

.2 Internal processes verifying the effectiveness of procedures, plans and instructions addressing autonomous or remotely-operated functions.

.3 HMI aspects of autonomous or remotely-operated functions.

.4 Monitoring the performance of autonomous or remotely-operated functions, including relevant system and MASS parameters.

.5 Assistance for emergency handling or handling of other potentially unsafe situations.

.6 Capabilities and limitations of emergency response in the MASS operation.

.7 Maintaining a minimum level of connectivity between the MASS and the ROC, if applicable.

.8 Procedures for connecting to shore-based assistance during emergencies.

.9 Cyber risks during emergencies addressing autonomous or remotely-operated functions.

.10 Means and procedures for emergency standby arrangements and equipment addressing autonomous or remotely-operated functions.

.11 Emergency procedures should be executed based on predefined contingency plans and adjusted appropriately as needed, considering further:

.1 An appropriate mode of operation should be adopted, including suspension of operations if necessary.

.2 Emergency response data and relevant information should be accessible at any location involved in the response.

.3 Resources from the MASS and the ROC should be promptly mobilized to address the emergency situations.

11.3 Alternative management for the safe operation of Remote Operations Centre(s)

11.3.1 With regard to a Remote Operation Management (ROM) company operating one or multiple ROC(s), this company could, to the satisfaction of the Administration, establish a SMS for the operation of those ROCs (ROC Safety Management System (ROCSMS)) under their responsibility. This ROCSMS should supplement the MASS's SMS developed by the Company, and the MASS ROC Certificate clearly establishing the relationship between the SMS and ROCSMS, to ensure that the safety level of the MASS established through the MASS's SMS is maintained.

11.3.2 The alternative ROM certification should follow a similar approach to that of the ISM Code with:

.1 a ROCSMS;

.2 a Document of Compliance for ROM (ROM DoC); and

.3 a ROC Management Certificate (RMC) for each ROC.

CHAPTER 12 – SPECIAL MEASURES TO ENHANCE MARITIME SECURITY

12.1 Purpose

The purpose of this chapter is to ensure adequate security.

12.2 General

To achieve the above-mentioned purpose, in addition to the requirements in SOLAS chapter XI-2 and the ISPS Code, the following provisions should be applied.

12.3 Implementation of security measures

12.3.1 The ship security assessment (SSA) and ship security plan (SSP) should identify and address additional security risks related to MASS operations.

12.3.2 The following should be considered in the implementation of security measures:

.1 Measures and procedures should be in place on board a MASS to ensure a level of security not less than that of a conventional ship.

.2 The security of the MASS should not be compromised by the use of autonomous and remotely-operated systems, considering inter alia:

  .1 physical security;

  .2 structural integrity;

  .3 personnel protection systems;

  .4 procedural policies including the SSP;

  .5 radio and telecommunication systems including computer systems and networks; and

  .6 that any other areas, if damaged or used for illicit observation, should not pose a risk to persons, property, or operations on board the MASS.

.3 Systems deployed to serve security purposes should be secure, resilient to attempts to compromise them, and exchange information in such a way that it does not compromise the security of the data.

.4 The MASS should be able to communicate and exchange security-related information, as appropriate, with a Remote Operations Centre (ROC), the Administration, Governments, port authorities, port facilities and Company upon request, taking into account the sensitivity of the information and authorization to access security-sensitive information.

.5 Means should be provided to enable the assessment of the effectiveness of additional security measures for MASS operations.

.6 The SSP should be stored such that duly authorized personnel required to take action are able to access it.

.7 Record of activities addressed in the SSP should be stored such that duly authorized personnel required to access and amend them are able to do so at any time.

12.4 Remote operations

12.4.1 Ship security assessment and plans should account for the ROC(s), where appropriate, aligning as closely as possible with the concept, terminology and appropriate provisions of the ISPS Code.

12.4.2 Where responsibilities are transferred from onboard crew to remote operators, the remote operators should be subject to the requirements of the ISPS Code as supplemented by the following:

.1 The role of remote operators, and those with responsibilities that have been transferred from the MASS, should be addressed in the SSP.

.2 Remote operators should take part in training, drills and exercises as laid out in the ISPS Code.

.3 Records of the activities as laid out in the ISPS Code, section A/10.1, should include the involvement of remote operators.

.4 When conducting ship security assessments, identification of weaknesses in the infrastructure, policies and procedures should consider human factors, including remote operators.

12.4.3 In the event of the security of a ROC being compromised, measures and procedures should be in the SSP and should be implemented to ensure that this does not impact the security of the MASS.

.1 Means should be provided for early detection of a security breach.

.2 There should be a separate mechanism for safely isolating and shutting down communications and control when the security of the ROC has been compromised

.3 The MASS should either enter a predefined fallback state until secure communications can be established with a secure ROC or, if available, control can be assumed at a separate control location, which may include the MASS itself.

.4 Communication with the compromised ROC should only be re-established once the security of the ROC has been ensured and validated.

.5 Procedures should be documented in the SSP, with plans in place to state where control will be assumed, and how communications will be re-established.

12.5 Access control

Unauthorized access should be prevented to ensure the security of the MASS, its cargo and onboard personnel, and any ROCs, if appropriate.

.1 Means should be provided to detect:

.1 physical intrusion by unauthorized personnel;

.2 physical attacks on the MASS during its voyage; and

.3 cyber intrusion or interference.

12.6 Communications

Communication with the MASS should be maintained during and following a security event on board, or impacting upon, a MASS.

.1 Systems should allow for coordination between the MASS and third-party responders, and should provide sufficient information to ensure the safety and security of external responders, other ships, and the marine environment.

.2 Means should be included in the design and implementation of communication systems such that reasonably foreseeable security incidents would not result in damage to, or compromise of, all other systems.

.3 In the event communication is lost following a security incident, the MASS should enter an appropriate fallback state and be capable of maintaining that state during and following the event until secure communications and control can be re-established.

CHAPTER 13 – ALERT MANAGEMENT

13.1 Purpose

The purpose of alert management is to enhance the monitoring, handling, distribution, and presentation of alerts for MASS and Remote Operations Centres (ROCs) thereby allowing for the prompt identification and addressing of any alert situation that arises and ensuring safe operation.

13.2 General

13.2.1 As part of the alert management system, taking into account the specificities of MASS operation, the following should be considered.

13.2.2 An alert management optimization should be performed taking into account the Concept of Operations (ConOps) so that the alert management provides:

.1 the means to draw the attention of the onboard crew and remote operators to the existence of alert situations;

.2 the means to enable the human operator to identify and evaluate the situation and handle alert announcements;

.3 the means for onboard crew and remote operators and relevant third parties to assess the urgency of different alerts in cases where more than one alert should be handled;

.4 the means to manage alerts in a distributed system structure in a consistent manner; and

.5 support for effective supervision of autonomous and remotely-operated functions.

13.3 Principles

The alert management for MASS and ROC should be based on the following principles:

.1 Alerting should follow the basic principles of the Bridge Alert Management (BAM) concept outlined by resolution MSC.302(87) on *Performance Standards for Bridge Alert Management (BAM)*, as may be amended.

.2 If practicable, there should be no more than one alert for one situation that requires attention.

.3 Alerts should provide information for the operator to sufficiently understand the consequences of the situation and determine appropriate actions.

.4 The alert management should handle alerts from all systems or components required to support MASS and ROC operation. Furthermore, it should have the capability to handle all other alerts in a consistent manner.

.5 The logical architecture of the alert management and the handling concept for alerts should provide the capability to minimize the number of alerts, especially those on a high priority level.

.6 Audible alerts should guide human operators to the task stations or displays which are directly assigned to the function generating the alert and presenting upon request at least the cause of the announcement and related information for decision support, e.g., dangerous target alarms should appear and have to be acknowledged at the control station where the collision avoidance function is provided.

.7 As alerts can be displayed at several locations and task stations, the system should be consistent as far as practicable with respect to how alerts are presented, silenced and acknowledged at any one task station. Actions taken in a task station should be visible to all other relevant task stations.

.8 Alerts should only be presented for handling (e.g. acknowledgement or silencing) at task station(s) used by the operator in charge of the tasks related to the initiated alerts. Alerts may be presented visually for information at other task stations.

.9 The master should receive alerts and have access to the alert management at all times.

.10 The operator responsible for the MASS should be able to directly handle the alert management Human-Machine Interface (HMI). It should be possible to provide the central alert management HMI at the control position for the operator.

13.4 Autonomous or remote operations and functions

13.4.1 In addition to relevant alerts associated with conventional ships, specific consideration should be given to those alerts related to the operations and functions to which this Code applies, as outlined in other chapters. Examples of such alerts, inter alia, would include:

.1 upon entering a fallback state or upon recognizing the need to enter a fallback state;

.2 in case the MASS is not able to enter a fallback state when deviating from its Operational Envelope (OE);

.3 in case of equipment failure affecting operations of MASS functions or significantly increasing the risk of MASS operation e.g. loss of redundancy;

.4 in case a system, that is critical to MASS operation, exceeds or is about to exceed its Operational Design Domain (ODD); and

.5 in case of ROC-specific alerts and conditions requiring attention (e.g. power failures, task station failures, communication system failures at ROC-level, software failures at ROC-level).

13.4.2 Task stations presenting alerts for multiple MASS should have the means to organize alerts per MASS and have the means to delegate alert handling for selected MASS to another task station.

13.4.3 When an emergency alarm is activated, dedicated human operators, including the master, should be able to take control of the MASS until the emergency is over.

13.4.4 The observation of abnormal situations and conditions concerning more than one MASS should be classified as alarms.

CHAPTER 14 – MANNING, TRAINING AND WATCHKEEPING

14.1 Purpose

14.1.1 The purpose of this chapter is to ensure that all MASS are appropriately manned and operated by trained, competent and experienced personnel.

14.1.2 For the purpose of this chapter, the training and watchkeeping standards as addressed by the 1978 STCW Convention and STCW Code may be considered by the Administration for the assigned roles in the Remote Operations Centre (ROC).

14.1.3 A ROC may be considered by the Administration as a directly associated location to the navigational bridge or part of the machinery space, as applicable, to ensure that the watchkeeping provisions of the 1978 STCW Convention and STCW Code may also apply to remote operators.

14.2 Safe manning

14.2.1 *General*

To ensure all MASS are manned safely as outlined in II/5.9 (Minimum safe manning documents), the following principles should be followed:

.1 The applicable international instruments, regulations and principles of safe manning should be adhered to when structuring manning levels.

.2 The task allocation summary (annex 1, paragraph 2.4) should be taken into account when determining the safe manning levels.

.3 The minimum level of safe manning should ensure sufficient onboard crew and/or remote operators to operate the MASS in an effective and efficient manner:

  .1 providing safety and security of the MASS, safe navigation and operations at sea, safe operations in port, prevention of human injury or loss of life, avoidance of damage to the marine environment and property;

  .2 ensuring the welfare and health of onboard crew and/or remote operators through the avoidance of fatigue; and

  .3 maintaining an effective response to emergency situations or failures of systems.

.4 The roles of all personnel as outlined in the Minimum Safe Manning Document (MSMD), should be clearly identified, defined and allocated.

.5 The MSMD should define whether a particular capacity is to be fulfilled by onboard crew and/or remote operators.

.6 Clear lines of authority and responsibility between onboard crew and/or remote operators should be established to ensure the safety and security of personnel and operations.

.7 All personnel defined by the MSMD should be qualified, competent and capable of performing their function(s) at the appropriate level(s) of responsibility, regardless of the mode of operation.

.8 The minimum level of safe manning should take into account the impacts of fatigue on all personnel defined within the MSMD.[5]

.9 The minimum level of safe manning should provide for sufficient hours of rest, taking into account applicable requirements, the provisions set out in the 1978 STCW Convention and STCW Code and the provisions set out in IMO's principles of safe manning.

.10 Regardless of the mode of operation, the master is responsible for the safe operation of the MASS at all times.

.11 The master responsible for a MASS may be located physically on board or at a ROC.

.12 If there are crew or persons on board, the master should be physically present on board to ensure the safety of personnel and operations.

.13 Multiple masters may be operationally responsible for a MASS on a single voyage.

.14 Only one master should be responsible for a MASS at any given time.

.15 Where command is transferred to or within a ROC, or between ROCs, sufficient time, resources and procedures should be provided to ensure that the master can establish situational awareness and is fully familiar with the MASS and any ROC before assuming responsibility for the MASS.

14.2.2 ***Safe manning for ROC(s)***

Where the levels of safe manning are to be met by the inclusion of remote operators:

.1 they should be qualified and competent to a level not less than what is required under the 1978 STCW Convention and STCW Code, to undertake their assigned tasks, duties and responsibilities from a ROC, that is certified in accordance with this Code;

.2 remote operators should not be assigned any task, duty or responsibility, which owing to the characteristics of a ROC or the MASS, cannot be discharged safely and effectively from the ROC, or has been determined by the Administration to be required to be carried out on board; and

.3 where remote operators perform watchkeeping duties, there should be:

  .1 a sufficient number of remote operators that meet the appropriate training and certification requirements to cover all watches, that are intended to be performed at a ROC; and

  .2 sufficient time, resources, and procedures should be provided to ensure that they can establish situational awareness and are fully familiar with the MASS and any ROC before assuming responsibility for a watch.

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[5] Refer to MSC.1/Circ.1598 on *Guidelines on fatigue.*

14.3 Watchkeeping

Watches should be carried out based on the following bridge, engine-room and ROC resource management principles:

.1 remote operators may maintain a safe watch or watches at the ROC without being physically present on board the MASS;

.2 an appropriate and effective watch or watches should be maintained for the purpose of safety of the MASS, which includes duties specific to a ROC;

.3 watchkeeping may be shared between onboard crew and remote operators, provided that clear lines of authority and responsibility are established between all watchkeeping personnel to ensure the safety and security of personnel and operations; and

.4 watchkeeping duties, tasks and functions should be designed to maintain operational attentiveness.

14.4 Training, familiarization and competence

14.4.1 *Onboard crew*

In addition to being qualified as required by the 1978 STCW Convention and STCW Code, onboard crew should have completed training to attain the competencies that are appropriate to the capacity to be filled and so that their duties and responsibility can be taken up, including:

.1 where the MASS operation includes the use of a ROC certified in accordance with this Code, training and drills for emergencies and failures of systems should be conducted between onboard crew and remote operators; and

.2 with reference to the task allocation summary, onboard crew should receive relevant additional training related to technologies and systems applied on MASS, including evidence to verify that they have the capacity to operate MASS as required for their duties and responsibilities.

14.4.2 *Remote operators*

Remote operators at any level of responsibility should, at a minimum, be qualified to a level not less than that required by the 1978 STCW Convention and STCW Code and have completed training to attain the competencies that are appropriate to the capacity to be filled so that their duties and responsibility can be taken up, including:

.1 demonstration of the capacity to perform necessary functions for their assigned level(s) of responsibility;

.2 additional training in remote operations, and the associated demonstration of knowledge, understanding, proficiency and experience, along with its evaluation;

.3 additional training in remote operations to enable understanding of the operation of ROC and MASS systems and their associated components in order to operate them safely;

.4 on being assigned to a MASS, familiarization with their specific duties and with all ROC and MASS operations, arrangements, installations, equipment, procedures, documentation and characteristics that are relevant to their routine or emergency duties; and

.5 as appropriate, training or drills required of MASS should be extended to any ROC(s) and remote operators undertaking duties for that MASS, including any specialized training required to safely operate a MASS remotely and respond to emergencies.

14.4.3 *Documents knowledge*

All onboard crew or remote operators should be knowledgeable of the type and purpose of documentation associated with autonomous and/or remote operations.

14.5 Other Matters

14.5.1 The Administration may consider evidence of remote operational experience as equivalent to approved sea-going service for those working within a ROC for revalidation of certificates.

14.5.2 The provisions on working language set out in SOLAS regulations V/14.3 and 14.4 should extend to any ROC(s) and remote operators.

CHAPTER 15 – MAINTENANCE

15.1 The purpose of this chapter is to ensure that autonomous and remotely-operated systems can be safely maintained, tested and inspected to ensure their reliability.

15.2 Maintenance of autonomous or remotely-operated systems should not result in unsafe events. This should include:

.1 systems should be able to be safely isolated and verified prior to commencing maintenance; and

.2 systems should be able to be restarted safely following maintenance allowing time for rebooting or reconfiguring of systems.

15.3 Qualified and authorized persons should be available on board or remotely to monitor the system and equipment faults and abnormal conditions to verify their cause and implement corrective actions.

15.4 Technical, operating and maintenance manuals or information should be made accessible to authorized operating and maintenance personnel.

PART III

GOALS, FUNCTIONAL REQUIREMENTS AND EXPECTED PERFORMANCE APPLICABLE TO SPECIFIC MASS OPERATIONS AND FUNCTIONS

GENERAL

Each chapter in this part consists of the Goal of the chapter and related Functional Requirements to fulfil the goal. Also included are, where appropriate, Expected Performances (EPs) associated with those functional requirements.

Chapters should be applied in full, but application of chapters in this part of the Code may be waived in agreement with the Administration as part of the approval process depending on the Concept of Operations and/or MASS functions implemented.

A MASS should be considered to meet a functional requirement set out in this part when either:

.1 the MASS's design and arrangements meet all the expected performances associated with that functional requirement; or

.2 part(s) or all of the MASS's relevant design and arrangements have been reviewed and confirmed to be in accordance with applicable provisions of IMO instruments, and any remaining parts of the MASS meet the relevant expected performance as outlined in this Code.

The functional requirements and associated expected performances should take into account the modes of operation of the MASS and any human presence on board.

CHAPTER 16 – SAFETY OF NAVIGATION

16.1 Goal

The goal of this chapter is to provide for safe navigation.

16.2 Functional requirements

To achieve the above-mentioned goal, a MASS should comply with all relevant requirements for safety of navigation in SOLAS, as supplemented by the functional requirements of this chapter, and the Convention on the International Regulations for Preventing Collisions at Sea, 1972, as amended (COLREG).

16.3 General

16.3.1 A MASS should comply with the following functional requirements for navigation in general.

16.3.2 Autonomous and remote navigation systems for MASS operations should be designed, constructed, and installed to maintain their functionality under the expected conditions in the Operational Envelope (OE).

EP 1 An Autonomous Navigation System (ANS) or system for remote navigation should be installed enabling the functionalities described in the Concept of Operations (ConOps), other design documents and the task allocation summary.

EP 2 The use of autonomous or remotely-operated systems for non-navigation functions or tasks should not endanger the safe operation of an ANS or system for remote navigation.

EP 3 An ANS or system for remote navigation should effectively integrate and coordinate with other MASS systems to prevent conflicting operational commands.

EP 4 In the event of a failure of an ANS or system for remote navigation, the MASS should be able to be operated safely by alternative means.

16.3.3 All data necessary for safe navigation should be available, in an appropriate format.

EP 1 A MASS should meet the requirements of SOLAS regulations V/19.2.1.4 and 19.2.1.5 by electronic means.

EP 2 Data used by, or for input into, an ANS or system for remote navigation should be in a machine-readable format.

EP 3 The voyage plan should be accessible, at all locations where navigation tasks are executed.

16.4 Sub-functions for MASS navigation

Any or all of the navigation sub-functions below could be autonomous or remotely-operated, while having different modes of operation according to the ConOps:

.1 Voyage planning: 16.4.1;

.2 Situational awareness: 16.4.2;

.3 Collision and grounding avoidance: 16.4.3; and

.4 Route execution and monitoring: 16.4.4.

As such, a MASS should comply with the relevant sub-function related requirements only when that sub-function is planned to be autonomous or remotely-operated.

16.4.1 *Voyage planning*

16.4.1.1 An ANS or system for remote navigation that is provided with the voyage plan should have a means to ensure that the voyage plan is safe for navigation.

EP 1 An ANS or system for remote navigation should provide a means to review and as necessary modify the voyage plan.

EP 2 An ANS or system for remote navigation should be capable of confirming to the master that the voyage plan has been correctly received and is able to validate and implement the voyage plan received.

EP 3 The use of the voyage plan, and any modification of the voyage plan, by the ANS or system for remote navigation should not be possible without an approval, including verification of its correctness, by the master.

16.4.1.2 An ANS or system for remote navigation that is capable of developing the voyage plan should have a means to ensure that the voyage plan is safe for navigation, taking into account the Guidance developed by the Organization.[6]

EP 1 An ANS or system for remote navigation should be provided with access to all nautical and hydrographic data necessary to appraise and plan a voyage.

EP 2 The voyage plan developed by an ANS or system for remote navigation should be presented in a form that allows the master to approve the plan.

EP 3 The voyage plan should provide an ANS and/or system for remote navigation and the master with all information necessary to execute and monitor a voyage.

EP 4 An ANS or system for remote navigation should provide a means to review and as necessary modify the voyage plan.

16.4.2 *Situational awareness*

An ANS or system for remote navigation should maintain adequate situational awareness for the purpose of ensuring safe navigation.

EP 1 An ANS or system for remote navigation should continuously monitor all information necessary for safe navigation, based on the OE.

EP 2 An ANS or system for remote navigation should continuously analyse the current situation in order to perceive and process navigational and environmental elements and project or predict future statuses. This should be done while considering the operation goals and objectives, the system's capability, and the modes of operation.

EP 3 An ANS or system for remote navigation should provide a means to make the information obtained and all analysis accessible as necessary.

16.4.3 *Collision and grounding avoidance*

An ANS or system for remote navigation should ensure there is a means to take action in accordance with COLREG to prevent collisions, as well as allisions and groundings.

EP 1 Planning and decisions to alter course and/or speed should be both timely and in accordance with safe operating limits.

EP 2 Any action to avoid collisions, allisions or groundings should be based on an assessment of the risk and the action necessary to avoid the risk of a collision, allision or grounding.

EP 3 Action to avoid collisions, allisions or groundings should not result in another situation which presents intolerable risk to the MASS, other ships or the marine environment.

[6] Refer to the *Guidelines for voyage planning* (resolution A.893(21)).

16.4.4 *Route execution and monitoring*

An ANS or system for remote navigation should safely execute the voyage plan and appropriate monitoring should be provided.

EP 1 An ANS or system for remote navigation should execute the planned route within the pre-defined limits of allowable deviation taking into account the factors listed in the Guidance developed by the Organization.[7]

EP 2 An ANS or system for remote navigation should alert the master if the prevailing circumstances and conditions necessitate a deviation from the voyage plan.

EP 3 An ANS or system for remote navigation should continuously monitor the progress of the MASS against the voyage plan and make the information available, as necessary.

16.5 Override

An ANS or system for remote navigation should be capable of being overridden from location(s) where control of navigation can be exercised.

EP 1 Means for overriding operation of an ANS or system for remote navigation should be simple to operate, independent of the systems that they control and allow for control to be taken immediately.

CHAPTER 17 – CONNECTIVITY

17.1 Goal

The goal of this chapter is to ensure that connectivity is maintained between the MASS and the Remote Operations Centre(s) (ROC(s)), and that it is sufficient for the effective monitoring and/or control of MASS functions.

17.2 Functional requirements

17.2.1 To achieve the above-mentioned goal, a MASS and ROC should meet the functional requirements of this chapter.

17.2.2 Connectivity between the MASS and ROC is essential for remote monitoring or control and should be ensured as described in the Concept of Operations (ConOps).

17.2.3 The infrastructure for connectivity should cover the operational context of a MASS and provide a quality of service and connectivity, adequate to ensure the safe operation of MASS, taking into account factors such as bandwidth, data integrity, reliability, resilience, and network latency.

17.2.4 Connectivity should be such as to operate the MASS safely, considering operational limitations of connectivity, such as meteorological and oceanographic conditions.

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7 Refer to the *Guidelines for voyage planning* (resolution A.893(21)).

17.2.5 Connectivity should be maintained at capacity in the case of a single failure in the system.

17.2.6 Redundancy measures should be implemented based on the risk assessment.

17.2.7 The data exchanged should be categorized and prioritized according to a pre-defined prioritization scheme to enable data with higher priority to prevail on lower prioritized data in case of decrease in communication capacity. The pre-defined categorization and prioritization of exchange of data should be included in the ConOps.

17.2.8 Connectivity requirements of the MASS should be established for the different voyage phases and modes of operation.

17.2.9 Connectivity performance should be monitored against stated requirements and measures should be in place to address disconnection or performance degradation and to implement necessary actions including entering a fallback state when necessary.

17.2.10 Connectivity including Computer Based System (CBS)[8] on board MASS and ROCs should ensure the integrity of transmitted data, and that they are sent from authorized authenticated sources. At the same time, measures[9] should be taken to protect the security of transmitted data.

CHAPTER 18 – REMOTE OPERATIONS

18.1 Goal

The goal of this chapter is to ensure the safe and secure remote operation of MASS systems or functions, when duties and responsibilities for safe operation are assigned to a Remote Operations Centre (ROC).

18.2 Functional Requirements

18.2.1 To achieve the above-mentioned goal, a MASS and ROC should meet the functional requirements of this chapter.

18.2.2 A ROC should be at a suitable location to enable the safe and secure remote operation.

EP 1 A ROC should have:

.1 facilities that are secure and protected from unauthorized access;

.2 means to enable reliable connectivity and communication between ROC(s) and the MASS, third parties and persons on board;

.3 facilities to allow access to, and sharing of, certificates and other documents required to demonstrate that the MASS is compliant with applicable international, national and regional requirements;

8 Refer to IACS UR E22 on *Computer-based systems*, UR E26 on *Cyber resilience of ships* and UR E27 on *Cyber resilience of on-board systems and equipment*.

9 Refer to MSC.1/Circ.1639 on *The guidelines on cyber security onboard ships* and MSC-FAL.1/Circ.3/Rev.3, as may be amended on *Guidelines on maritime cyber risk management.*

.4 arrangements, such that the failure and subsequent recovery of the ROC would not result in an unsafe state or intolerable risk on or around the MASS in service;

.5 verified and validated systems to support its operation;

.6 sufficient and relevant qualified personnel to enable safe MASS operations; and

.7 facilities to ensure data and information used, produced, sent or received is retained in reliable and tamper-proof storage, and at a suitable standard of data quality, and considering the SOLAS requirements for voyage data recorders.

18.2.3 A remote control station should be provided to ensure the safe and secure remote operation.

EP 1 A remote control station should:

.1 have appropriate verified and validated systems;

.2 have means to monitor the communication and information received, or transmitted, by the MASS and to communicate through the MASS in accordance with relevant communication requirements;

.3 provide sufficient and accurate data and information to enable the remote operators to carry out their role(s) effectively;

.4 be fully compatible with the MASS systems assigned to it;

.5 be tested to ensure that when installing and updating system(s) that the related onboard equipment and devices have appropriate compatibility and interoperability;

.6 ensure failure and recovery of the control station(s) would not result in an unsafe state or intolerable risk, on or around the MASS in service; and

.7 be designed and operated in such a way that its location does not impact on its ability to control the MASS.

18.2.4 Verified and validated systems and interfaces between remote control station(s) and the MASS should be provided to ensure the remote operators can operate the MASS safely and securely.

EP 1 This should be accomplished by ensuring the remote operators are able to:

.1 maintain a watch, as appropriate and applicable, and in a manner conforming to the principles of watchkeeping (as described in chapter 14 (Manning, training and watchkeeping));

.2 send and receive sufficient, timely and accurate information/commands effectively and securely between the ROC, the MASS, third parties, and persons on board;

.3 take all decisions necessary to ensure the safe remote operation of the MASS, including support for abandonment of the MASS;

.4 know the status of the connectivity at the remote control station(s) with the MASS and, where relevant, with third parties;

.5 know which systems can be controlled, and from where control is being exercised;

.6 know when conditions on the MASS or at the ROC deviate from the Operational Envelope (OE); and

.7 monitor the condition and operation of equipment and systems and take measures to mitigate risks.

18.2.5 The transfer of operation should be safe and secure.

EP 1 Safe transfer of operation of the MASS will be accomplished by ensuring that:

.1 transfer and synchronization of all necessary information is possible between remote control station(s), ROC(s) and the MASS;

.2 operation can be transferred safely and securely during failure and/or recovery or an emergency situation at the ROC or remote control station(s);

.3 control cannot be exercised at multiple locations at the same time;

.4 the present control location is clearly indicated both in ROC and on board the MASS; and

.5 there is no loss of control of the MASS when the operation is transferred.

18.2.6 The software used for remote operation should be appropriately designed, managed and maintained to ensure the safe and secure operation.

EP 1 The software used should be:

.1 designed in accordance with chapter 10 (Software principles), taking into account chapter 13 (Alert management);

.2 integrated, managed, maintained and supported throughout its operational life;

.3 able to receive, recognize and assist with the prioritization of emergency and non-emergency situations occurring on board the MASS, to enable the remote operators to carry out their role(s) effectively; and

.4 presented in a form that allows the remote operators to be able to understand the information transmitted to the ROC.

CHAPTER 19 – STRUCTURE, SUBDIVISION, STABILITY AND WATERTIGHT INTEGRITY

19.1 Goal

The goal of this chapter is to ensure that the structure, subdivision, stability, and watertight integrity are within acceptable limits.

19.2 Functional Requirements

19.2.1 To achieve the above-mentioned goal, a MASS should comply with all relevant SOLAS structural, stability, subdivision and watertight integrity requirements, as well as the International Convention on Load Lines, 1966 as amended by the 1988 Protocol, and the 2008 Intact Stability Code, as supplemented by the functional requirements of this chapter.

19.2.2 A stability control system (SCS) should be in place, capable of continuously assessing the intact stability of the MASS during its operation as well as supporting the assessment of the survivability of the MASS in case of damage.

EP 1 To enable timely mitigation, the SCS should, including during fallback states, be able to:

.1 continuously assess the intact stability of the MASS; and

.2 identify when the stability of the MASS is outside the Operational Envelope (OE).

EP 2 The SCS should be able to continuously monitor the loading conditions towards the longitudinal strength.

EP 3 The SCS should be able to support the assessment of survivability of the MASS in case of damage by providing information on any internal flooding, compartments and spaces affected, draughts and attitude.

EP 4 The SCS should have resilience to single points of failure.

EP 5 The SCS should be able to detect existing or predictable stability failures and raise alerts.

EP 6 The SCS should be able to suggest mitigation actions when the system has detected non-compliance with intact stability criteria.

EP 7 The SCS should be able to transmit data to relevant systems and onboard crew or remote operators in an appropriate format.

EP 8 The SCS should be able to be continuously supervised by an independent/supervising function, or human operator, capable of detecting failures or degraded performance.

19.2.3 Accurate and reliable data should be acquired to ensure that the stability, subdivision, weathertight and watertight integrity of the MASS can be maintained under all foreseeable conditions.

19.2.4 Means should be provided for the SCS to reduce the risk of excessive motions of the MASS in adverse sea conditions.

EP 1 The SCS should be able to continuously measure amplitudes and accelerations of MASS motions.

EP 2 The SCS should be able to detect when the motions of the MASS exceed predefined thresholds based on its OE, and trigger relevant alerts.

EP 3 The SCS should be able to suggest adjusting speed and course, in response to the wave direction to ensure compliance with predefined limits for the MASS's motions.

EP 4 The SCS should be able to suggest appropriate mitigation actions if the approved voyage plan may cause the MASS to exceed its stability thresholds.

CHAPTER 20 – FIRE PROTECTION, FIRE DETECTION AND FIRE EXTINCTION

20.1 Goal

The goal of this chapter is to ensure that fire-safety systems and equipment are effective.

20.2 Functional requirements

20.2.1 To achieve the above-mentioned goal, a MASS should comply with all relevant SOLAS fire safety objectives and requirements, as supplemented by the functional requirements of this chapter.

20.2.2 A MASS should remain under control or enter a fallback state during and following a fire event in any single compartment that is directly linked to the control of the MASS.

20.2.3 A fire which is limited to a single compartment that does not have a direct link to the control of the MASS, should not cause a loss of control or lead to a fallback state.

20.2.4 Means should be provided to detect, confirm, and locate a fire incident.

EP 1 The detection, confirmation and location of fire incidents should be routed to control station(s).

EP 2 Means for timely detection of a fire should be provided in all spaces with a fire risk.

EP 3 Onboard crew and remote operators should be made aware of the detection and location of a fire along with the status of, and any actions taken by, fire protection systems.

EP 4 Means for detection and confirmation should be independent.

EP 5 If alarm signals are not acknowledged, a secondary alarm should be automatically activated at control station(s) and throughout the MASS.

EP 6 After detection and confirmation of the fire, means should be provided to locate the seat of fire, so that the most appropriate fire-extinguishing means may be activated.

20.2.5 Means should be provided to enable the appropriate use of fire-extinguishing systems, taking into account possible human presence.

EP 1 Information and instructions in relation to fire safety should be provided to any personnel boarding the MASS.

EP 2 Fire-extinguishing systems should be able to be safely isolated and verified prior to compartment access.

EP 3 Fire-extinguishing systems should provide onboard indication and warning prior to, and during, activation.

EP 4 The stability of the MASS should be monitored during any fire-fighting operation.

20.2.6 Means should be provided to monitor and assess fire growth and fire-fighting effectiveness during and after fire.

EP 1 Means should be provided to assess any smoke development.

EP 2 Means should be provided to assess the temperature development in spaces adjacent to the compartment affected by the fire.

20.2.7 Means should be provided to enable the remote and onboard control of all active fire protection measures, including containment measures.

EP 1 All active fire protection measures should be individually controllable, allowing activation, deactivation, and status monitoring at control station(s).

EP 2 Means should be available to detect fire protection systems-related faults and provide indication at control station(s).

20.2.8 Means should be provided to facilitate an intervention from external fire responders.

EP 1 Procedures should be in place to transmit any relevant information and data to external fire responders during and following a fire incident.

EP 2 Means of communication between the external fire responders and the MASS and Remote Operations Centre (ROC) should be ensured during and following a fire incident.

CHAPTER 21 – SEARCH AND RESCUE

21.1 Goal

The goal of this chapter is to ensure that the duties and tasks regarding search and rescue are fulfilled.

21.2 Functional requirements

21.2.1 To achieve the above-mentioned goal, the master should comply with all relevant requirements in SOLAS for providing assistance to persons in distress, and as provided in the functional requirements of this chapter and applicable international law.

21.2.2 A MASS and its associated Remote Operations Centre(s) (ROC(s)) should be provided with a ship-specific plan and procedures which enable the master to provide assistance to persons in distress when obligated to do so.

21.2.3 Rescue equipment provided on board should be able to be safely used independently of the presence of crew.[10]

21.2.4 Persons retrieved on board should be able to be safely accommodated until such time as they can be delivered to a place of safety.

> EP 1 Persons retrieved on board should be provided with information and arrangements to communicate with a ROC.
>
> EP 2 Persons retrieved on board should be provided with access to any arrangements provided for their safety.

CHAPTER 22 – CARRIAGE OF CARGOES

22.1 Goal

The goal of this chapter is to provide for the carriage of cargoes in a manner that ensures that the MASS, persons on board and the environment are safe.

22.2 Functional requirements

22.2.1 To achieve the above-mentioned goal, the MASS should comply with the requirements of SOLAS chapters VI and VII and relevant regulations relating to the carriage of cargoes, as supplemented by the functional requirements of this chapter.

22.2.2 Means should be provided to enable for the safe carriage of cargo involving autonomous or remotely-operated systems and functions.

> EP 1 Consideration should be given to the need for any special arrangements regarding:
>
> .1 transfer of cargo information;

---

[10] According to SOLAS regulation III/I7-1, MSC.1/Circ.1447 on *Guidelines for the development of plans and procedures for the recovery of persons from the water*, MSC.1/Circ.1182/Rev.1 on *Guide to recovery techniques* and MSC.1/Circ.1185/Rev.1 on *Guide for cold water survival*.

.2 cargo handling, stowing and securing;

.3 cargo monitoring; and

.4 emergency response.

CHAPTER 23 – ANCHORING, TOWING AND MOORING

23.1 Goal

The goal of this chapter is to ensure safe and secure anchoring, towing and mooring operations.

23.2 Functional Requirements

23.2.1 To achieve the above-mentioned goal, the MASS should comply with the functional requirements of this chapter. It should be noted that these functions may be treated independently from each other.

23.2.2 Autonomous or remotely-operated anchoring, towing and mooring arrangements should allow the safe conduct of these operations.

23.2.3 Where anchoring, towing and mooring operations involve a Remote Operations Centre (ROC), the remote operators should have sufficient information, oversight and control to enable safe and effective operations with due consideration to interactions with any third parties, infrastructure and/or involved personnel.

23.2.4 The emergency towing arrangements in SOLAS regulation II-1/3-4 should apply to all MASS, and means should be provided to enable remote or autonomous activation where no alternative means of rapid deployment are available.

23.2.5 Anchoring arrangements should be able to be activated autonomously or remotely during fallback states and in emergency situations.

CHAPTER 24 – MACHINERY AND ELECTRICAL INSTALLATIONS

24.1 Goal

The goal of this chapter is to provide for safe and reliable machinery and electrical installations.

24.2 Functional requirements

24.2.1 To achieve the above-mentioned goal, the MASS should comply with the SOLAS requirements for machinery and electrical installations, as supplemented by the functional requirements of this chapter.

24.2.2 Machinery and electrical installations should ensure their availability, including backup functions.

24.2.3 Machinery and electrical installations should be sufficient for the autonomous and remotely-operated functions to be maintained during normal operation, fallback states and emergency situations.

24.2.4 Electrical power production and distribution should be capable of maintaining the MASS in normal operation and fallback states, and ensuring that essential systems remain operational in emergency situations for the period(s) specified by SOLAS.

24.2.5 Machinery and electrical installations should be able to support predefined fallback states, and be fault-tolerant to connectivity being lost or below an acceptable threshold.

24.2.6 Monitoring should be provided to assess system robustness, reliability and effectiveness.

24.2.7 Measures should be provided to prevent machinery or electrical systems being autonomously or remotely-activated when operated or serviced by authorized persons on board, and to ensure the safe reactivation upon completion.

24.2.8 Measures should be provided to detect machinery or electrical system malfunctions or failures to maintain safe operation in normal and emergency situations.

24.2.9 Measures should be provided to ensure availability and resilience according to the mode of operation to respond to machinery or electrical system malfunctions and failures.

APPENDIX

FORMAT FOR CERTIFICATES AND RECORDS

The objective of this appendix is to offer guidance for the development of the MASS and ROC certificates and records as required in chapter 5 (Surveys and certificates) of this Code.

Depending on the Concept of Operations (ConOps) of the respective MASS and associated ROC(s), not all of the elements in the templates proposed in this appendix need to be addressed by the Administration.

Form of certificate for maritime autonomous surface ships

MARITIME AUTONOMOUS SURFACE SHIP SAFETY CERTIFICATE

This Certificate should be supplemented by a Record of MASS for the Maritime Autonomous Surface Ship Safety Certificate (Form MASS).[1]

(official seal) *(State)*

Issued under the provisions of the INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS CODE), 2026, as adopted by RESOLUTION MSC.595(111)

under the authority of the Government of

____

(name of the State)

by ____

(person or organization authorized)

Particulars of MASS[2]

Name of MASS________________________________
Distinctive number or letters ________________________________
Port of registry ________________________________
Gross tonnage ________________________________
IMO Number[3] ________________________________
Date of application of the MASS Code[4]________________________________
Date of any major repairs, renewals or modifications of equipment, or systems related to autonomous or remotely-operated functions________________________________

THIS IS TO CERTIFY:

1 That the MASS has been surveyed in accordance with the provision of II/5.2 of the International Code of Safety for Maritime Autonomous Surface Ships.

2 That it has been shown that:

2.1 the inspection, verification and testing of MASS functionality and connectivity with any associated ROCs were satisfactory;

2.2 the autonomous and/or remotely-operated functions of the MASS have been demonstrated to be safe and their condition is in all respects satisfactory and that the MASS complied with the relevant provisions of the Code; and

[1] Please insert the version of the Record of MASS: Document no.[…], version no. […], and issue date [dd/mm/yyyy].

[2] Alternatively, the particulars of the ship may be placed horizontally in boxes.

[3] In accordance with the *Integrated IMO Identification Number Scheme* (resolution A.1215(34)).

[4] Administrations may request the history of the application of the MASS Code.

2.3 the MASS complied with goals, functional requirements and expected performances in following chapters of the Code where the Administration deems that compliance with other applied instruments is impracticable or insufficient:

check box, if applicable:

☐ III/16 Safety of Navigation
☐ III/17 Connectivity
☐ III/18 Remote Operations
☐ III/19 Structure, Subdivision, Stability and Watertight Integrity
☐ III/20 Fire Protection, Fire Detection and Fire Extinction
☐ III/21 Search and Rescue
☐ III/22 Carriage of Cargoes
☐ III/23 Anchoring, Towing and Mooring
☐ III/24 Machinery and Electrical Installations

This certificate is valid until____subject to the annual/ intermediate surveys in accordance with II/5.2 of the Code.

Completion date of the survey on which this certificate is based
_____________________ (*dd/mm/yyyy*)

Issued at ____
(place of issue of the certificate)

________________ ____
(date of issue) *(signature of authorized official issuing the certificate)*

(seal or stamp of the issuing authority, as appropriate)

Endorsement for annual and intermediate surveys

THIS IS TO CERTIFY that, at a survey required by II/5.2 of the Code, the MASS was found to comply with the relevant requirements of the Code.

Annual survey Signed ______________________________
(*signature of authorized official*)
Place ______________________________
Date ______________________________

(*seal or stamp of the authority, as appropriate*)

Annual/Intermediate[5] survey Signed ______________________________
(*signature of authorized official*)
Place ______________________________
Date ______________________________

(*seal or stamp of the authority, as appropriate*)

Annual/Intermediate[5] survey Signed ______________________________
(*signature of authorized official*)
Place ______________________________
Date ______________________________

(*seal or stamp of the authority, as appropriate*)

Annual survey Signed ______________________________
(*signature of authorized official*)
Place ______________________________
Date ______________________________

(*seal or stamp of the authority, as appropriate*)

[5] Delete as appropriate

Endorsement to extend the certificate if valid for less than five years in alignment with the provisions of regulation I/14(c) of the SOLAS Convention

The MASS complies with the provisions of II/5.2 of the Code, and this certificate should, in alignment with the provisions of regulation I/14(c) of the SOLAS Convention, be accepted as valid until__________________

Signed ____________________________
(signature of authorized official)
Place ____________________________
Date ____________________________

(seal or stamp of the authority, as appropriate)

Endorsement for renewal surveys years in alignment with the provisions of regulation I/14(d) of the SOLAS Convention

THIS IS TO CERTIFY that, at a survey required by II/5.2.2.2 of the Code, the MASS was found to comply with the relevant provisions of the Code.

Renewal survey:

Signed ____________________________
(signature of authorized official)
Place ____________________________
Date ____________________________

Endorsement to extend the validity of the certificate until reaching the port of survey or for a period of grace in alignment with the provisions of regulations I/14(e) or I/14(f) of the SOLAS Convention

The certificate should, in alignment with the provisions of regulation I/14(e)/I/14(f)[5] of the SOLAS Convention, be accepted as valid until ___________________________________

Signed ____________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Endorsement for advancement of anniversary date **in** ***alignment with the provisions of regulation I/14(h) of the SOLAS Convention***

In alignment with the provisions of regulation I/14(h) of the SOLAS Convention, the new anniversary date is ______________

Signed ____________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

In alignment with the provisions of regulation I/14(h) of the Convention, the new anniversary date is______________

Signed ____________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

[5] Delete as appropriate.

Form of certificate for maritime autonomous surface ships remote operations centre

MARITIME AUTONOMOUS SURFACE SHIPS
REMOTE OPERATIONS CENTRE CERTIFICATE

This Certificate should be supplemented by a Record of MASS Remote Operations Centre (ROC) for the MASS Remote Operations Centre Certificate (Form MASS-ROC).[1]

(official seal) *(State)*

Issued under the provisions of the INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS CODE), 2026, as adopted by RESOLUTION MSC.595(111)

under the authority of the Government of

____
(name of the State)

by ______________________________________
(person or organization authorized)

Particulars of ROC[2]
ROC identifier______________________________
ROC Company Name______________________________
ROC Company Address______________________________
ROC location (Physical address or other)______________________________

Provide the above information as applicable.

Particulars of the MASS operated by ROC[3]
Name of MASS______________________________
Distinctive number or letters ______________________________
Port of registry ______________________________
Gross tonnage ______________________________
IMO Number[4] ______________________________

THIS IS TO CERTIFY:

[1] Please insert the version of the Record of MASS ROC: Document no.[…], version no. […], and issue date [dd/mm/yyyy].

[2] Alternatively, the particulars of the ROC may be placed horizontally in boxes.

[3] Alternatively, the particulars of the ship may be placed horizontally in boxes.

[4] In accordance with the *Integrated IMO Identification Number Scheme* (resolution A.1215(34)).

1 That the ROC has been surveyed in accordance with the provisions of II/5.4 of the International Code of Safety for Maritime Autonomous Surface Ships.

2 That it has been shown that:

2.1 the inspection, verification and testing of the ROC and MASS remote operation functionality were satisfactory;

2.2 the ROC is demonstrated to have the ability to support the autonomous and/or remotely-operated functions of the MASS in compliance with the relevant provisions of the Code.

2.3 the ROC complied with the requirements of III/17 and III/18 of the Code;

2.4 the ROC complied with goals, functional requirements and expected performances in the following chapters of the Code where the Administration deems that compliance with other applied instruments is impracticable or insufficient:

check box, if applicable:

☐ III/16 Safety of Navigation
☐ III/19 Structure, Subdivision, Stability and Watertight Integrity
☐ III/20 Fire Protection, Fire Detection and Fire Extinction
☐ III/21 Search and Rescue
☐ III/22 Carriage of Cargoes
☐ III/23 Anchoring, Towing and Mooring
☐ III/24 Machinery and Electrical Installations

This certificate is valid until__________________subject to the annual/ intermediate surveys in accordance with II/5.4 of the Code.

Completion date of the survey on which this certificate is based ___________________ (*dd/mm/yyyy*)

Issued at ____
(place of issue of the certificate)

___________________ ____
(date of issue) *(signature of duly authorized official issuing the certificate)*

(seal or stamp of the issuing authority, as appropriate)

Endorsement for annual and intermediate surveys

THIS IS TO CERTIFY that, at a survey required by II/5.4 of the Code, the ROC was found to comply with the relevant requirements of the Code.

Annual survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual/Intermediate[5] survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual/Intermediate[5] survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

5 Delete as appropriate.

Endorsement to extend the certificate if valid for less than five years in alignment with the provisions of regulation I/14(c) of the SOLAS Convention

The ROC complies with the provisions of II/5.4 of the Code, and this certificate should, in alignment with the provisions of regulation I/14(c) of the SOLAS Convention, be accepted as valid until__________________

Signed ____________________________
(signature of authorized official)
Place _____________________________
Date _____________________________

(seal or stamp of the authority, as appropriate)

Endorsement for renewal surveys years in alignment with the provisions of regulation I/14(d) of the SOLAS Convention

THIS IS TO CERTIFY that, at a survey required by II/5.4.2.2 of the Code, the ROC was found to comply with the relevant provisions of the Code.

Signed ____________________________
(signature of authorized official)
Place _____________________________
Date _____________________________

(seal or stamp of the authority, as appropriate)

Endorsement to extend the validity of the certificate until the MASS reaches the port of survey or for a period of grace in alignment with the provisions of regulations I/14(e) or I/14(f) of the SOLAS Convention

The certificate should, in alignment with the provisions of regulation I/14(e)/I/14(f)[5] of the SOLAS Convention, be accepted as valid until ____

Signed ______________________________
(signature of authorized official)
Place _______________________________
Date _______________________________

(seal or stamp of the authority, as appropriate)

Endorsement for advancement of anniversary date **in** ***alignment with the provisions of regulation I/14(h) of the SOLAS Convention***

In alignment with the provisions of regulation I/14(h) of the SOLAS Convention, the new anniversary date is ______________

Signed ______________________________
(signature of authorized official)
Place _______________________________
Date _______________________________

(seal or stamp of the authority, as appropriate)

In alignment with the provisions of regulation I/14(h) of the SOLAS Convention, the new anniversary date is ______________

Signed ______________________________
(signature of authorized official)
Place _______________________________
Date _______________________________

(seal or stamp of the authority, as appropriate)

[5] Delete as appropriate.

Form of provisional certificate for maritime autonomous surface ships

PROVISIONAL MARITIME AUTONOMOUS SURFACE SHIP SAFETY CERTIFICATE

This provisional Certificate should be supplemented by a Record of MASS for the Maritime Autonomous Surface Ships Safety Certificate (Form MASS).[1]

(official seal) *(State)*

Issued under the provisions of the INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS CODE), 2026, as adopted by RESOLUTION MSC.595(111)

under the authority of the Government of

____

(name of the State)

by ____

(person or organization authorized)

Particulars of MASS[2]

Name of MASS____

Distinctive number or letters ________________________________

Port of registry ____

Gross tonnage ____

IMO Number[3] ____

Date of application of the MASS Code[4]_________________________

Date of any major repairs, renewals or modifications of equipment, or systems related to autonomous or remotely-operated functions___________________________

1 Please insert the version of the Record of MASS: Document no.[…], version no. […], and issue date [dd/mm/yyyy].

2 Alternatively, the particulars of the MASS may be placed horizontally in boxes.

3 In accordance with the *Integrated IMO Identification Number Scheme* (resolution A.1215(34)).

4 Administrations may request the history of the application of the MASS Code.

THIS IS TO CERTIFY:

1 That the MASS complied with the provision of II/5.5 of the International Code of Safety for Maritime Autonomous Surface Ships which enables initiation of operations during the testing and verification stage.

2 That individual MASS systems have been tested and verified, and results of ship simulation (if applicable) have been reviewed and accepted.

3 That all the design documents have been updated accordingly and approved according to the simulation and system testing results.

4 That the MASS period of testing is limited to (dd/mm/yyyy)____________________

5 That the MASS area of testing is limited to_________________________________

6 That an approved verification and validation plan is in place covering the management of safety and scope of testing to be completed.

This provisional certificate is valid until ________________, subject to the annual/ intermediate surveys listed in II/5.2 of the Code, and any additional surveys covered by the verification and validation plan.

Completion date of the survey on which this certificate is based
____________________ (*dd/mm/yyyy*)

Issued at ____
(place of issue of the certificate)

__________________ ____
(date of issue) *(signature of authorized official issuing the certificate)*

(seal or stamp of the issuing authority, as appropriate)

Endorsement for annual and intermediate surveys

THIS IS TO CERTIFY that, at a survey required by II/5.2 of the Code, the MASS was found to comply with the relevant requirements of the Code.

Annual survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual/Intermediate[5] survey ______________________________

Signed
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual/Intermediate[5] survey ______________________________

Signed
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

5 Delete as appropriate.

Form of provisional certificate for maritime autonomous surface ships remote operations centre

PROVISIONAL MARITIME AUTONOMOUS SURFACE SHIPS
REMOTE OPERATIONS CENTRE CERTIFICATE

This provisional Certificate should be supplemented by a Record of MASS Remote Operations Centre (ROC) for the MASS Remote Operations Centre Certificate (Form MASS-ROC).[1]

(official seal) *(State)*

Issued under the provisions of the INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS CODE), 2026, as adopted by RESOLUTION MSC.595(111)

under the authority of the Government of

____
(name of the State)

by ____
(person or organization authorized)

Particulars of ROC[2]
ROC Identifier____
ROC Company Name____
ROC Company Address____
ROC Location (Physical address or other)_____________________________

Particulars of the MASS operated by ROC[3]
Name of MASS____
Distinctive number or letters ____
Port of registry ____
Gross tonnage ____
IMO Number[4] ____

1 Please insert the version of the Record of MASS ROC: Document no.[…], version no. […], and issue date [dd/mm/yyyy].

2 Alternatively, the particulars of the ROC may be placed horizontally in boxes.

3 Alternatively, the particulars of the ship may be placed horizontally in boxes.

4 In accordance with the *Integrated IMO Identification Number Scheme* (resolution A.1215(34)).

THIS IS TO CERTIFY:

1 That the ROC complied with the provision of II/5.5 of the International Code of Safety for Maritime Autonomous Surface Ships, which enables initiation of operations during the testing and verification stage.

2 That individual systems related to MASS remote operation functionality have been tested and verified and results of simulation (if applicable) have been reviewed and accepted.

3 That all the design documents have been updated accordingly and approved according to the simulation and system testing results.

4 That the MASS period of testing is limited to (dd/mm/yyyy)____________________

5 That the MASS area of testing is limited to_________________________________

6 That an approved verification and validation plan is in place covering the management of safety and scope of testing to be completed.

This provisional certificate is valid until _________________, subject to the annual/ intermediate surveys listed in II/5.4 of the Code, and any additional surveys covered by the verification and validation plan.

Completion date of the survey on which this certificate is based ____________________ (*dd/mm/yyyy*)

Issued at ____

(place of issue of the certificate)

__________________ ____

(date of issue) *(signature of duly authorized official issuing the certificate)*

(seal or stamp of the issuing authority, as appropriate)

Endorsement for annual and intermediate surveys

THIS IS TO CERTIFY that, at a survey required by II/5.4 of the Code, the ROC was found to comply with the relevant requirements of the Code.

Annual survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual/Intermediate[5] survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual/Intermediate[5] survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

Annual survey

Signed ______________________________
(signature of authorized official)
Place ______________________________
Date ______________________________

(seal or stamp of the authority, as appropriate)

5 Delete as appropriate.

Record of MASS for the Maritime Autonomous Surface Ship Safety Certificate (Form MASS)

This Record should be permanently attached to the Maritime Autonomous Surface Ship Safety Certificate

RECORD OF MASS FOR COMPLIANCE WITH THE INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS

1 DESCRIPTION OF THE CONCEPT OF OPERATIONS (CONOPS)

1.1 Particulars of MASS

Name of MASS	
Name of Company	
Distinctive number or letters	
Port of registry	
Gross tonnage	
IMO Number[1]	

1.2 Overview of MASS and MASS functions

General description of the scope of operations the MASS is authorized to perform	
Brief description of autonomous functions	
Brief description of remote operation functions	
Other descriptions of MASS functions	

1.3 Key systems

Description and list of key systems related to autonomous and/or remotely-operated functions. *(Consistent function/system identifiers should be used throughout this Record)*

ID	Function	System	Description
Systems essential to the safe and secure operation of the ship as required in **Part II of the MASS Code:** *(for example, alert management, maintenance, etc)*			
1			
2			
Systems required as described in **Part III of the MASS Code**: *(for example, navigation, stability, cargo handling, etc)*			
1			
2			

1 In accordance with the *Integrated IMO Identification Number Scheme* (resolution A.1215(34)).

1.4 Operational Envelope

1.4.1 Modes of operation

Overview of configuration(s), as applicable, for the allocation of MASS functions and their supervision, taking into account different modes of operation during different voyage phases. Note that the Minimum Safe Manning Document (MSMD) should address each mode of operation. *(Consistent mode of operation identifiers should be used throughout this Record).*

<table>
<tr><th colspan="4">Voyage Phase A:</th></tr>
<tr><th>MASS Function</th><th>Mode of Operation</th><th>Function Allocation & Location</th><th>Supervision & Location</th></tr>
<tr><td rowspan="3">Function 1</td><td>1:</td><td></td><td></td></tr>
<tr><td>2:</td><td></td><td></td></tr>
<tr><td>3:</td><td></td><td></td></tr>
<tr><td rowspan="3">Function 2</td><td>1:</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>2:</td></tr>
<tr><td>3:</td></tr>
<tr><td rowspan="3">Function 3</td><td>1:</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>2:</td></tr>
<tr><td>3:</td></tr>
<tr><th colspan="4">Voyage Phase B:</th></tr>
<tr><th>MASS Function</th><th>Mode of Operation</th><th>Function Allocation & Location</th><th>Supervision & Location</th></tr>
<tr><td rowspan="3">Function 1</td><td>1:</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>2:</td></tr>
<tr><td>3:</td></tr>
<tr><td rowspan="3">Function 2</td><td>1:</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>2:</td></tr>
<tr><td>3:</td></tr>
<tr><td rowspan="3">Function 3</td><td>1:</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>2:</td></tr>
<tr><td>3:</td></tr>
</table>

1.4.2 Limitations of autonomous and/or remote operation

Limitations under which the MASS can operate safely in all operating conditions, including all reasonably foreseeable degraded states.

Category	**Description of limitation(s)** *(Variances applicable in different modes of operation and/or normal/degraded states should be clearly stated)*
Environmental limitations	
Geographical limitations	
Operational limitations	
Other limitations, if applicable	

1.5 Fallback State(s) and Contingency Plans

Fallback states and contingency plans for the MASS (as a whole, not individual functions or systems). *(Variances applicable in different modes of operation/voyage phase should be clearly stated. Where multiple fallback states are available, the application of any hierarchy to activation sequencing, should also be clearly stated).*

Fallback state(s)		
ID	**Conditions of entry**	**Predefined fallback response**
1		
2		

Contingency Plans		
ID	**Conditions of activation**	**Predefined actions**
1		
2		

2 SURVEY REQUIREMENTS ASSOCIATED WITH THE SYSTEMS TO WHICH THE MASS CODE IS APPLIED

	Systems (as in 1.3)	**Survey Requirements**
1		
2		

3 TASK ALLOCATION SUMMARY

The document describing the distribution of functions and tasks between human and machine/systems in normal, abnormal and emergency situations, as approved by the Administration, should accompany this Record.

4 REGULATORY GAP ANALYSIS

Authorized MASS-related deviations from applicable rules and regulations.

	Affected rule or regulation	**Description of deviation/alternative solutions**
1		
2		

5 LIST OF ROC(S) APPROVED FOR WORKING WITH THE MASS

Number of approved Remote Operations Centres:__________

ID	**ROC identifier**	**ROC location (Physical address or other)**	**ROC Company Name**	**Description** *(including, for example, scope of remote operation, redundancy arrangements, communication configurations, transfer of control conditions)*
1				
2				

Provide the above information as applicable.

THIS IS TO CERTIFY that this Record is correct in all respects.

Issued at ____

(place of issue of the Record)

____________________ ____

(date of issue) *(signature of duly authorized official issuing the Record)*

(seal or stamp of the issuing authority, as appropriate)

**Record of MASS ROC for MASS Remote Operations Centre Certificate
(Form MASS-ROC)**

This Record should be permanently attached to MASS Remote Operations Centre Certificate

RECORD OF MASS ROC FOR COMPLIANCE WITH THE INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS

1 PARTICULARS OF ROC

ROC Identifier	
ROC Company Name	
ROC Location (Physical address or other)	
Description	

2 DESCRIPTION OF MASS CONCEPT OF OPERATIONS (CONOPS)

A copy of the MASS Safety Certificate and MASS Record should accompany this document. A description of the Concept of Operations (ConOps) for the MASS can be found in its MASS Record.

3 ROC OPERATIONAL LIMITATIONS

Category	**Description of limitation(s)** *(for example, geographical, human element, operational, number of control stations, etc.) (Variances applicable in different modes of operation and/or normal/degraded states should be clearly stated)*

4 INFRASTRUCTURE FOR CONNECTIVITY

Description and list of infrastructure for connectivity *(for example, communications devices authorized for use to communicate with MASS)*	
1	
2	
Description of quality of service and performance *(for example, bandwidth, network latency, data integrity, reliability etc)*	

5 OTHER SYSTEMS

Other systems at the ROC supporting remote operation *(for example, uninterruptable power supply)*

THIS IS TO CERTIFY that this Record is correct in all respects.

Issued at ____

(place of issue of the Record)

____________________ ____

(date of issue) *(signature of duly authorized official issuing the Record)*

(seal or stamp of the issuing authority, as appropriate)

ANNEX 1

APPROVAL PROCESS

Table 1 provides additional guidance in relation to the approval steps that require relevant documentation.

1 Preliminary design development

The following MASS specific documentation should be compiled and submitted:

.1 Concept of Operations (ConOps); as described in II/8.2 of the Code.

.2 Preliminary design documents; the initial set of preliminary documents should be submitted as deemed necessary to illustrate the main characteristics of the MASS and system arrangements, especially related to autonomous and remotely controlled functions.

.3 High-level risk assessment report; the objective of the high-level risk assessment is to identify safety critical areas and functions at an early stage and to assist as far as practicable to the drafting of the initial approval basis.

.4 Approval basis; should be submitted for approval by the Administration at the end of the preliminary design development. It should be highlighted that within the context of an iterative approval process, it is expected that this document will be modified significantly throughout the process.

.5 Preliminary actions register; the necessary actions for the completion of the process should be drafted, while the early involvement of key stakeholders should be ensured for a clear understanding of roles and responsibilities in the approval process.

2 Preliminary design approval

.1 *Risk assessment report*; a risk assessment, as described in chapter 7 (Risk assessment) of the Code should be performed for all the functions affected by autonomous or remote operations. The level of detail of the risk assessment should be proportional to the complexity of the project.

.2 *Preliminary design documents*; as the approval process is an iterative one, the purpose of the preliminary design documents is to further describe and illustrate the key elements of the project that prove the equivalence justification. At the end of this step and possibly after more than one iteration, the design parameters of the systems and system interaction in question should be clear enough to be able to determine appropriate performance criteria that could be verified through testing and other verification methods.

At the end of the step, there should be an alignment between the submitted documents and the risk assessment in terms of assumptions and philosophy, especially regarding mitigation measures. The preliminary design documents could be the following:

.1 Safety philosophy;

.2 Design philosophy;

.3 Operation and maintenance philosophy;

.4 Emergency response philosophy;

.5 General arrangement;

.6 Systems and equipment matrix; and

.7 ConOps including Operational Envelope (OE) (updated).

.3 *Drawings and information documents* (optional): while the iteration process of the project advances, it might be necessary for the approval process to also submit relevant drawings and information documents to clarify certain aspects of the design, especially on issues that are found to be safety critical (i.e. implying very high risk according to the risk analysis). It is expected that such issues that need to be demonstrated at a more detailed level are issues where redundancy, fault tolerance or fail-safe mechanisms need to be further explained.

.4 *Task allocation summary*: a task and function allocation summary should be submitted describing the distribution of functions and tasks between human and machine/systems in both normal, abnormal and emergency situations. The task allocation summary should be aligned with the other design documents. There should be particular focus on the expected control actions performed, while especially in the case of human operators it should be made possible to evaluate their expected workload but also their cognitive support.

.5 *Approval basis*: it is expected to be updated with each iteration, especially when design details and assumptions are decided and documented. At the end of this step the approval basis should be a significantly more detailed document than the one presented in paragraph 1.2 of the present annex.

.6 *Regulatory gap analysis*: a regulatory gap analysis should be submitted to document any deviations from the applicable regulatory framework. At the end of the preliminary approval step, it is not expected that this document will cover all the applicable prescriptive provisions, however it would be beneficial for the detailed design approval to already introduce as much detail as possible. This should be demonstrated through a link between the risk analysis and justification on why design or operational solutions are justified as being equivalent.

.7 *Verification and validation (V&V) plan*: the final step to the preliminary design approval is the detailed definition of how it is intended to perform V&V of the systems and the MASS as a whole. The objective of the V&V plan should be to describe how functionalities regarding autonomous and remote operations will be verified. A V&V plan should be submitted for approval considering the following:

.1 high-risk functions and system components as they stem from the risk assessment;

.2 boundary conditions and system safety requirements and constraints;

.3 cybersecurity-related features upon which the protection of the safety-critical components is based;

.4 incorrect and unexpected inputs and input sequences and timing;

.5 reaction of the system-to-system faults and failures;

.6 fail-safe modes and fallback states;

.7 operational procedures for V&V; and

.8 ensure that no additional hazards are introduced during V&V.

The V&V plan should also include a detailed time frame including intermediate deliverables and reports as deemed necessary. A periodic progress review by the Administration and any organization performing third-party verification should be considered. If the complexity of the project does not allow for a complete time frame to be set at this stage, an initial time frame may be accepted for a specific period to be agreed upon.

.8 *Actions register*: the actions register, as described in paragraph 1.5 of the present annex, should be updated accordingly.

3 Testing, simulation and other verification methods

3.1 Testing and verification should be conducted according to the defined V&V plan and the relevant reports submitted for information. According to the testing results, the design documents, as well as the approval basis, the actions register and the V&V plan may need to be updated accordingly. In the case that the V&V plan is reflecting an outdated time frame, it should be updated accordingly.

3.2 A high degree of transparency with the Administration and any organization conducting third-party verification is strongly recommended to facilitate this approval step.

3.3 Different testing and verification methods might be used upon request and should be approved by the Administration. Model tests or simulations are recommended to verify the control system before a full-scale test of the MASS is performed.

3.4 For tests to be conducted, the relevant procedure(s) should be submitted to the Administration in due time before testing. The test report should be submitted after testing, where a summary or test log should include how the test and its results are linked to the design documents and the V&V plan.

3.5 The testing of certain systems or parts of systems may include an element of simulation-based testing. Such testing should not replace full-scale testing.

4 Final approval

4.1 This approval step should follow the approach from the *Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments* (MSC.1/Circ.1455). It is particularly important to correlate the different components and systems that constitute the MASS under consideration. In addition, this step should be used as a verification that the different steps leading to the final approval are consistent and can be easily verified.

4.2 Before the initial survey of the MASS, testing needs to have been completed to demonstrate the requirements in the approval basis have been met. This evidence would typically include the final design documents and the reports of activities undertaken, including a link to the related item of the V&V plan.

4.3 A summary of the equivalence justifications should be submitted. This summary should articulate the approach taken to demonstrating compliance with the approval basis and include the Submitter statement that compliance with the approval basis has been demonstrated.

4.4 The Submitter should propose any survey or inspection requirements associated with the system(s) in question. The operational requirements (e.g. training, maintenance) to address the innovative technology aspects should also be included in the in-service documentation. Focus should be put on any operational restrictions.

Table 1 – Relevant documentation for approval steps

	Preliminary design development	Preliminary design approval	Testing, simulation and other verification methods	Final approval	Operation
Preliminary design documents	X*	X			
Drawings and information documents		X		X	X**
Risk Assessment	X*	X		X	X**
Task allocation summary		X		X	X**
Approval basis and Actions register	X*	X	X	X	X**
Regulatory gap analysis		X			
Verification and validation plan		X			
Testing and verification reports			X		

* Preliminary and high level only

** In case of changes in the approved concept, assumptions and conditions

ANNEX 2

FRAMEWORK FOR CONCEPT OF OPERATIONS

The objective of this framework is to offer clear guidance during the development of the Concept of Operations (ConOps) as required in chapter 8 (Operational context) of the MASS Code.

1 INTRODUCTION

ConOps is a high-level document that, in conjunction with other design documents, serves as a key source of information for the design, approval, and operation of a MASS. In this section, it should be clearly indicated which step in the approval process this document pertains to. The appropriate degree of detail within ConOps will depend on the development process and should be to the satisfaction of the Administration. Additionally, it should offer a high-level overview of the modifications made to the previous version, along with the reasons for these changes.

2 OVERVIEW OF MASS FUNCTIONS

This section provides an overall picture of the objective of the target MASS, including a general description of the scope and intent of autonomous and/or remotely-operated functions, its use cases and corresponding operation and voyage phases, etc.

3 TECHNICAL CHARACTERISTICS OF MASS

This section provides a general description of particulars and systems related to autonomous and/or remotely-operated functions.

3.1 Particulars of the MASS

This section provides general information on the MASS, including main dimensions, design/service speed, manoeuvrability, cargo type and deadweight, ballast/full load draft, ballast/full load displacement, steering capability, propulsion capacity, fuel/water storage (if applicable), energy storage, self-sustaining capacity, etc. These factors should be considered when designing/aligning autonomous and/or remotely-operated systems/functions.

3.2 Key systems

This section describes systems related to functions which are essential to the safe and secure operation of MASS as described in part II of the MASS Code, including security, alert management, maintenance, etc.

3.3 Systems related to autonomous and/or remotely-operated functions

This section describes systems related to autonomous and/or remotely-operated functions as described in part III of the MASS Code, including navigation, connectivity, remote operations, structure, subdivision, stability and watertight integrity, fire protection, fire detection and fire extinction, search and rescue, carriage of cargoes, anchoring, towing and mooring, and machinery and electrical installations. The inclusion of these systems depends on the specific modes of operation and the functionality being certified.

4 OPERATIONAL ENVELOPE

This section describes MASS functions, conditions, limitations, modes of operation, as well as any other factors that significantly affect MASS operations.

4.1 Modes of operation

This section describes how autonomous and/or remotely-operated functions are used and managed during different phases of voyage, including function overview and corresponding voyage phases, function allocation (human or software), function supervision (human and/or software), function and supervision location (on board or remote), conditions and procedures for mode switch, and other systems and other roles (personnel) involved in performing the control actions.

4.2 Limitations of autonomous and/or remote operation

This section describes environmental, geographical, and operational limitations under which the MASS can operate safely in all operating conditions, including all reasonably foreseeable degraded states. The environmental limitations may include weather conditions (acceptable wind speed, sea state, visibility, water depth, adverse weather, day/night, etc.) and current conditions (acceptable current speed, direction, etc.). The geographical limitations may include coverage/connectivity (areas requiring connectivity, effective coverage of communication systems, redundancy and automatic switching, latency and bandwidth requirements, security, communication with other ships, Vessel Traffic Service, Marine Rescue Service, etc.) and traffic conditions (acceptable traffic density: e.g. no more than "X" ships within six nautical miles in certain scenarios). The operational limitations may indicate ship-specific limitations such as speed and range, and mode of operation.

5 FALLBACK STATE AND CONTINGENCY PLANS

This section defines the conditions under which the MASS should enter a predefined fallback state across different voyage phases, as well as the conditions leading to the activation of contingency plans when the MASS deviates from the Operational Envelope (OE) beyond a predefined fallback state. Predefined fallback states and contingency plans should also be included.

6 REMOTE OPERATIONS CENTRE (IF APPLICABLE)

6.1 Technical characteristics of a Remote Operations Centre

This section describes essential systems installed in a Remote Operations Centre (ROC) that support remote operations.

6.2 Number and location of Remote Operations Centres, provision of redundancy

This section describes the number and locations of ROCs and outlines redundancy provisions required to ensure continuous and reliable remote operations.

6.3 Means of communication and conditions for transferring control between different Remote Operations Centres

This section establishes the conditions and procedures for transferring control between different ROCs to ensure safe and seamless operations.

7 HUMAN INVOLVEMENT

This section describes how humans are involved in MASS functions, including on board and at the ROC. This includes the expected role of the person, the broader context in which they will work and how they will interact with third parties.

7.1 Minimum safe manning levels

This section identifies the minimum safe manning levels for MASS operations, taking into account the principles as outlined in chapter 14 (Manning, training and watchkeeping) and II/5.9 (Minimum safe manning documents).

7.2 Task allocation

This section describes which tasks are automated, and which tasks and responsibilities are allocated to onboard crew or remote operators.

8 RULES AND REGULATIONS

8.1 Applicable rules and regulations

This section identifies the applicable rules and regulations, including special and local rules, such as international, national or industry-specific rules, and technical, safety and operational requirements and constraints in specific areas or regions, that the MASS should comply with, taking into account its operational area.

8.2 Regulatory gap

This section identifies possible deviations from the applicable rules and regulations and provides justification of alternative solutions based on risk assessment.

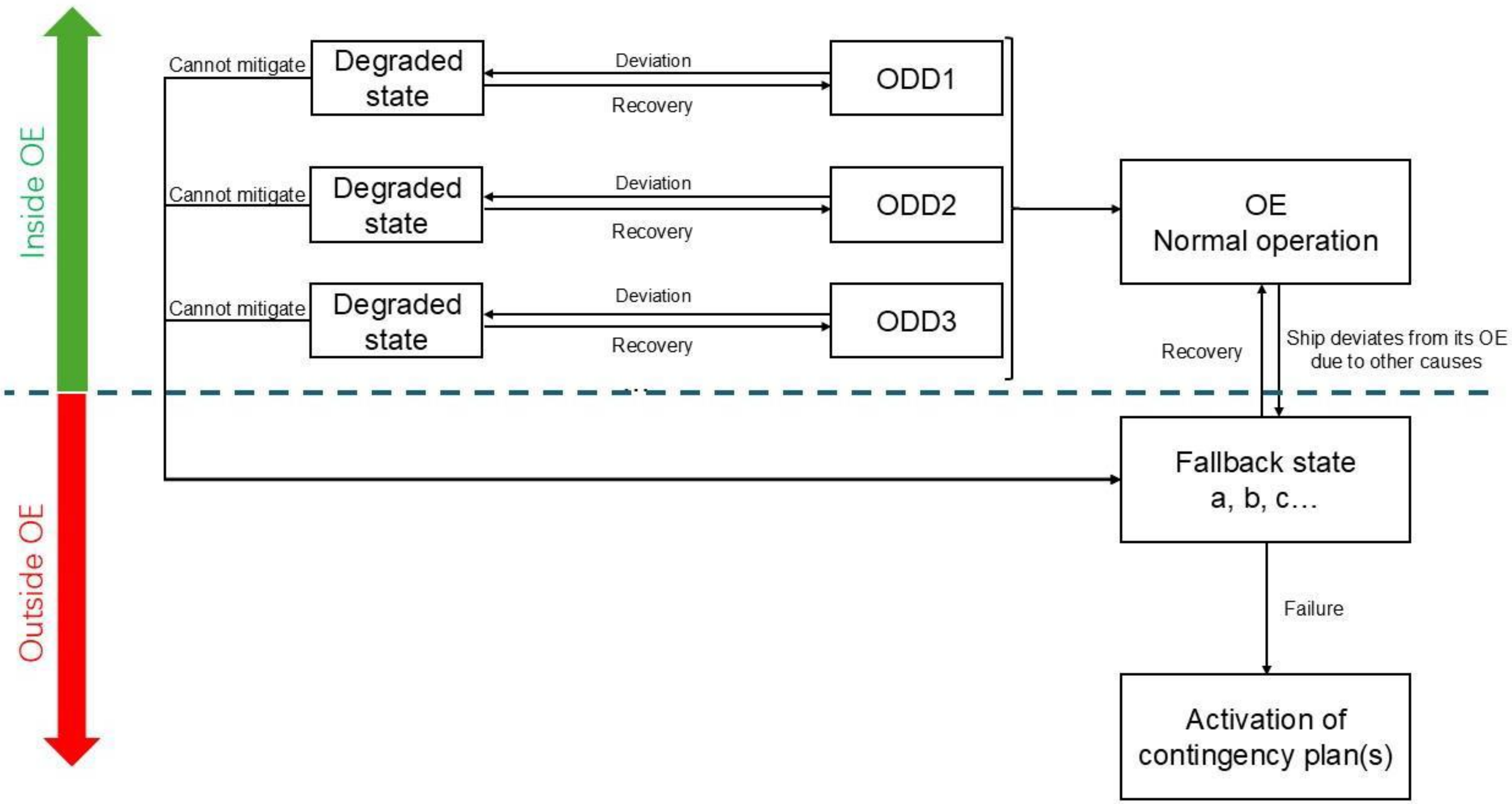

Figure 1: Illustration of the relationship between Operational Envelope, Operational Design Domain, Fallback State and Contingency Plans to support the application of chapter 8 (Operational Context)

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ANNEX 26

RESOLUTION MSC.597(111)
(adopted on 18 May 2026)

REVISED INTERIM RECOMMENDATIONS FOR CARRIAGE OF LIQUEFIED HYDROGEN IN BULK

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

NOTING that the International Convention for the Safety of Life at Sea ("the Convention"), 1974 and the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk ("the IGC Code") currently do not specifically provide requirements for carriage of liquefied hydrogen in bulk by sea,

NOTING ALSO that paragraph 5 of the Preamble of the IGC Code states that requirements for new products and their conditions of carriage will be circulated as recommendations, on an interim basis, prior to the entry into force of the appropriate amendments,

RECOGNIZING a need for the development of the Revised interim recommendations for carriage of liquefied hydrogen in bulk,

ACKNOWLEDGING that, in the interim, there is an urgent need to provide recommendations to the Administrations on safe carriage of liquefied hydrogen in bulk,

ACKNOWLEDGING ALSO that the Revised Interim Recommendations are intended to facilitate establishment of a tripartite agreement for a pilot ship, which will be developed for the research and demonstration of safe long-distance overseas carriage of liquefied hydrogen in bulk,

HAVING CONSIDERED the Revised Interim Recommendations prepared by the Sub-Committee on Carriage of Cargoes and Containers at its eleventh session,

1 ADOPTS the Revised interim recommendations for carriage of liquefied hydrogen in bulk, the text of which is set out in the annex to the present resolution;

2 INVITES Member States to apply the Revised Interim Recommendations to the pilot ship carrying liquefied hydrogen in bulk, taking the explanatory notes into consideration;

3 AGREES to acquire information on safe carriage of liquefied hydrogen in bulk prior to amendment to the IGC Code for the inclusion of liquefied hydrogen;

4 ALSO AGREES that these Revised Interim Recommendations may need to be reviewed if they are to be applied to ships other than the pilot ship; and

5 URGES Member States and the industry to submit information, observations, comments and recommendations based on the practical experience gained through the application of the Revised Interim Recommendations and submit relevant safety analysis on ships carrying liquefied hydrogen in bulk.

6 REVOKES resolution MSC.565(108).

ANNEX

REVISED INTERIM RECOMMENDATIONS FOR CARRIAGE OF LIQUEFIED HYDROGEN IN BULK

1 INTRODUCTION

1.1 For the carriage of liquefied gases in bulk by ships, the ships should comply with the relevant requirements in the IGC Code, as amended ("the Code"). The scope of the Code provided in paragraph 1.1.1 is:

> "The Code applies to ships regardless of their size, including those of less than 500 gross tonnage, engaged in the carriage of liquefied gases having a vapour pressure exceeding 0.28 MPa absolute at a temperature of 37.8°C, and other products, as shown in chapter 19, when carried in bulk".

1.2 A ship carrying liquefied hydrogen in bulk (hereinafter called "liquefied hydrogen carrier") should comply with the Code.

1.3 The Code requires that a gas carrier should comply with the minimum requirements for the cargo listed in chapter 19. However, the requirements for liquefied hydrogen are not specified in the Code.

1.4 This annex provides the Revised Interim Recommendations, as referred to in paragraph 5 of the preamble of the Code, for the carriage of liquefied hydrogen in bulk, which are intended to provide the basis for the future minimum requirements for the carriage of this cargo. The Revised Interim Recommendations are intended to facilitate the establishment of a tripartite agreement among the relevant Administrations for the carriage of liquefied hydrogen in bulk. However, they are not intended to prohibit the adoption of designs and arrangements other than those specified in the Code or in these Revised Interim Recommendations, at the discretion of the Administrations.

1.5 These Revised Interim Recommendations have been developed under the assumption that a liquefied hydrogen carrier does not carry liquefied gases other than liquefied hydrogen. These Revised Interim Recommendations, therefore, are not applicable to liquefied hydrogen carriers carrying gases other than liquefied hydrogen.

1.6 In the Code, reference is made to paragraph 5 of the Preamble; paragraph 1.1.6.1; and Note No.8 on completion of certificate in "model form of international certificate of fitness for the carriage of liquefied gases in bulk" in appendix 2 to the Code.

1.7 These Revised Interim Recommendations consist of the following parts. Part A is applicable to ships with any type of cargo containment system. Part B and subsequent part(s) prescribe additional special requirements for cargo containment systems of specific types.

Part A: General (applicable to ships with any type of cargo containment system);

Part B: Cargo containment systems of independent cargo tanks using vacuum insulation;

Part C: Cargo containment systems of independent cargo tanks using insulation materials and hydrogen gas in the inner insulation spaces; and

Part D: Cargo containment systems of a membrane-type cargo tank maintaining the insulation spaces under vacuum.

1.8 Part A of these Revised Interim Recommendations was developed based on the design of parts B, C and D. If subsequent part(s) are added, the special requirements prescribed in part A may be reviewed.

Part A
General
(Applicable to ships with any type of cargo containment system)

2 GENERAL

2.1 Definition

2.1.1 The following definition should apply for the purpose of these Revised Interim Recommendations.

Permeation is the flow of a fluid through another material by diffusion without a defect or opening of the latter.[1]

2.2 Requirements for carriage of liquefied hydrogen in bulk

2.2.1 The requirements for the carriage of liquefied hydrogen in bulk have been developed based on the results of a comparison study of similar cargoes listed in chapter 19 of the Code, e.g. liquefied natural gas.

2.2.2 Chapter 19 of the Code governs the application of general requirements for respective cargoes. Selections of the general requirements for respective cargoes are expressed in columns 'c' to 'g'. In addition to general requirements, special requirements may apply to specific cargoes depending on the properties/hazards of the cargoes.

2.2.3 Tables 1 and 2 specify the proposed selection of the general requirements and the special requirements, respectively, for liquefied hydrogen. In addition to table 2, special requirements for cargo containment systems of specific types are prescribed in part B or subsequent part(s).

1 See paragraph 3.79 of ISO/TR 15916:2015.

Table 1: Requirements for carriage of liquefied hydrogen in bulk

a	b	c	d	e	f	g	h	i
Product name		***Ship type***	***Independent tank type C required***	***Control of vapour space within cargo tanks***	***Vapour detection***	***Gauging***		***Special requirements***
Hydrogen		2G	-	-	F	C		See table 2 and, either corresponding table 4 or table 5 or table 6, as appropriate for the type of cargo containment systems

Table 2: Special requirements for carriage of liquefied hydrogen in bulk

No.	Special requirement	Related hazard
A-1	Requirements for materials whose design temperature is lower than -165°C should be agreed with the Administration, paying attention to appropriate standards. Where minimum design temperature is lower than -196°C, property testing for insulation materials should be carried out with the appropriate medium, over a range of temperatures expected in service.	Low temperature (see 4.2.1)
A-2	Materials of construction and ancillary equipment such as insulation should be resistant to the effects of high oxygen concentrations caused by condensation and enrichment at the low temperatures attained in parts of the cargo system (refer to the requirement for nitrogen). This special requirement is applied to all locations where contact with condensed oxygen is anticipated under normal conditions and foreseeable single failure scenarios.	Low temperature (see 4.2.2)
A-3	For cargo pipes containing liquid hydrogen and cold hydrogen vapour, measures should be taken to prevent the exposed surfaces from reaching -183°C. For places where preventive measures against low temperature are not sufficiently effective, such as cargo manifolds, other appropriate measures such as ventilation which avoids the formation of highly enriched oxygen and the installation of trays recovering liquid air may be permitted in lieu of the preventive measures. Insulation on liquid hydrogen piping systems exposing to air should be of non-combustible material and should be designed to have a seal in the outer covering to prevent the condensation of air and subsequent oxygen enrichment within the insulation.	Low temperature (see 4.2.2)
A-4	Appropriate means, e.g. filtering, should be provided in cargo piping systems to remove impure substances condensed at low temperature.	Low temperature (see 4.2.3)

No.	Special requirement	Related hazard
A-5	Pressure relief systems should be suitably designed and constructed to prevent blockage due to formation of water or ice.	Low temperature (see 4.2.4)
A-6	At places where contact with hydrogen is anticipated, suitable materials should be used to prevent any structural deterioration owing to hydrogen embrittlement and degradation of strength and fatigue properties due to continual exposure to hydrogen, as necessary.	Hydrogen embrittlement (see 4.3)
A-7	Double tube structures ensuring no leakage, or fixed hydrogen detectors being capable of detecting a hydrogen leak, should be provided for confined places where leakage of hydrogen may occur, such as cargo valves, flanges and seals.	Susceptibility to leakage (see 4.4.2)
A-8	Helium or a mixture of 5% hydrogen and 95% nitrogen should be used as the tightness test medium for cargo tank and cargo piping.	Susceptibility to leakage (see 4.4.3)
A-9	The amount of carbon dioxide carried for a carbon dioxide fire-extinguishing system should be sufficient to provide a quantity of free gas equal to 75% or more of the gross volume of the cargo compressor and pump rooms in all cases.	Fire by Hydrogen (see 4.7.3) Wide range of flammability limits (see 4.10)
A-10	When deterioration of insulation capability by single damage is possible, appropriate safety measures should be adopted taking into account the deterioration.	High pressure (see 4.8)
A-11	Appropriate measures should be provided to prevent vents becoming blocked by accumulations of ice formed from moisture in the air.	Low temperature (see 4.2.2)
A-12	Due consideration should be given to means for handling boil-off gas.	High pressure (see 4.8)
A-13	Due consideration should be given to static electricity associated with rotating or reciprocating machinery including the installation of conductive machinery belts and precautionary measures incorporated in operating and maintenance procedures, in addition to the bonding of tanks, piping and equipment required by paragraph 5.7.4 of the Code. Anti-static clothing and footwear, and a portable hydrogen detector should be provided for each crew member working in the cargo area.	Static electricity (see 4.9.2)
A-14	The cargo operation manuals required in paragraph 18.2 of the Code should include limitations of various operations in relation to environmental conditions.	Wide range of flammability limits (see 4.10)

No.	Special requirement	Related hazard
A-15	An appropriate procedure should be established for warm-up, inert gas purge, gas-free, hydrogen purge and pre-cooling. The procedure should include: .1 selection of inert gas in relation to temperature limit; .2 measurement of gas concentration; .3 measurement of temperature; .4 rates of supply of gases; .5 conditions for commencement, suspension, resuming and termination of each operation; .6 treatment of return gases; and .7 discharge of gases.	Prevention of dangerous purging operation (see 4.11)
A-16	Only almost pure para-hydrogen (i.e. more than 95%) should be loaded in order to avoid excessive heating by ortho- to para-hydrogen conversion.	General (see 4.1)
A-17	Fire detectors for detecting hydrogen fire should be selected, taking into account the features of hydrogen fire, to the satisfaction of the Administration.	Features of hydrogen fire and fire hazard (see 4.7.4)
A-18	At the design stage, dispersion of hydrogen from vent outlets should be analysed in order to minimize risk of ingress of flammable gas into accommodation spaces, service spaces, machinery spaces and control stations. Extension of hazardous areas should be considered based on the results of the analysis.	Low density and high diffusivity (see 4.5)
A-19	Due consideration should be given to appropriate safety measures to prevent formation of explosive mixture in the case of a leakage and permeation of hydrogen, including: .1 installation of hydrogen detectors in order to detect a possible ground-level travel of low temperature hydrogen gas, and at high points in spaces where warm hydrogen gas can be trapped; and .2 application of "best practice" for land-based liquid hydrogen storage taking into account appropriate guidance such as "Cryogenics Safety Manual – Fourth Edition (1998)"[8)].	General (see 4.1)
A-20	In the case that fusible elements are used as a means of fire detection required by paragraph 18.10.3.2 of the Code, flame detectors suitable for hydrogen flames should be provided in addition at the same locations. Appropriate means should be adopted to prevent the activation of the ESD system owing to false alarms of flame detectors, e.g. avoiding activation of the ESD system by a single sensor (voting method).	Fire hazard (see 4.7.4)

No.	Special requirement	Related hazard
A-21	Consideration should be given to enhance the ventilation capacity of the enclosed spaces subject to liquefied hydrogen leakage and permeation, taking into account the latent heat of vaporization, specific heat and the volume of hydrogen gas in relation to temperature and heat capacity of adjacent spaces.	Low density and high diffusivity (see 4.5)
A-22	Liquid and gas hydrogen pipes should not pass through enclosed spaces in addition to other than those referred to in paragraph 5.2.2.1.2 of the Code, unless: .1.1 the spaces are equipped with gas detection systems which activate the alarm at not more than 20% LFL and shut down the isolation valves, as appropriate, at not more than 40% LFL (see sections 16.4.2 and 16.4.8 of the Code); and .1.2 the spaces are adequately ventilated; or .2 the spaces are maintained in an inert condition.	Susceptibility to leakage (see 4.4)
A-23	A risk assessment should be conducted to ensure that risks arising from liquefied hydrogen cargo affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed. Consideration should be given to the hazards associated with properties of liquefied hydrogen and hydrogen gas, physical layout, operation and maintenance, following any reasonably foreseeable failure. For the risk assessment, appropriate methods, e.g. HAZID, HAZOP, FMEA/FMECA, what-if analysis, etc., should be adopted taking into account IEC/ISO 31010:2019 "Risk management – Risk assessment techniques"[7)] and SAE ARP 5580-2001 "Recommended failure modes and effects analysis (FMEA) practices for non-automobile applications"[9)].	General (see 4.1)
A-24	Relief valve sizing should be undertaken for the most onerous scenario. The evaluation should include the fire scenario and should consider the resulting magnitude of the heat flux on the cargo containment system.	High pressure hazard (see 4.8)
A-25	A filling limit exceeding 98% at reference temperature should not be permitted.	High pressure hazard (see 4.8)
A-26	Bolted flange connections of hydrogen piping should be avoided where welded connections are feasible.	Susceptibility to leakage (see 4.4.2)
A-27	Due consideration should be given to the invisible nature of hydrogen fire from the viewpoint of safety of ships and especially personnel in case of fire.	Fire hazard (see 4.7.1)

3 EXPLANATION ON GENERAL REQUIREMENTS

3.1 Properties of liquefied hydrogen

The application of general requirements in the Code for liquefied hydrogen has been considered based on a comparison study on the physical properties of liquefied hydrogen and LNG. LNG and liquefied hydrogen are cryogenic liquids, non-toxic, and generate flammable high pressure gas. For reference, table 3 shows the comparison of physical properties of hydrogen and methane, the major component of LNG.

Table 3: Comparison of physical properties of Hydrogen and Methane

	Hydrogen	Methane	References
Boiling temperature (K)*	20.3	111.6	ISO[1)], Annex A, Table A.3
Liquid density (kg/m^3)*	70.8	422.5	ISO[1)], Annex A, Table A.3
Gas density (kg/m^3)** (Air: 1.198)	0.084	0.668	NIST RefProp[10)]
Viscosity (g/cm•s x 10^{-6}) Gas Liquid	 8.8 13.49	 10.91 116.79	 NIST RefProp[10)] NIST RefProp[10)]
Flame temperature in air (°C)	2396	2230	Calculated using Cantera and GRI 3.0 mechanism
Maximum burning velocity (m/s)	3.15	0.385	Calculated using Cantera and GRI 3.0 mechanism
Heat of vaporization (J/g)*	454.6	510.4	ISO[1)], Annex A, Table A.3
Lower flammability limit (% vol. fraction)***	4	5.3	ISO[1)], Annex B, Table B.2
Upper flammability limit (% vol. fraction)***	77	17.0	ISO[1)], Annex B, Table B.2
Minimum ignition energy (mJ)***	0.017	0.274	ISO[1)], Annex B, Table B.2
Auto-ignition temperature***	858	810	ISO[1)], Annex B, Table B.2
Toxicity	Non	Non	Orange book[5)]
Temperature at critical point (K)	33.19****	190.55	Hydrogen: ISO[1)], Annex A, Table A.1 Methane: The Japan Society of Mechanical Engineers, Data Book, Thermophysical Properties of Fluids (1983)
Pressure at critical point (kPaA)	1315****	4595	Hydrogen: ISO[1)], Annex A, Table A.1 Methane: The Japan Society of Mechanical Engineers, Data Book, Thermophysical Properties of Fluids (1983)

Remarks:
- * At their normal boiling points for comparison purposes.
- ** At normal temperature and pressure.
- *** Ignition and combustion properties for air mixtures at 25°C and 101.3 kPaA.
- **** Normal Hydrogen.

3.2 Explanation on respective requirements

3.2.1 Ship type (column 'c')

As the hazard associated with hydrogen cargo is flammability but not toxicity, the ship type is considered 2G.

3.2.2 Independent tank type C required (column 'd')

Independent tank type C is allocated only to dangerous goods of class 2.3 whose vapour density is heavier than air. Independent tank type C is considered not to be required for liquefied hydrogen.

3.2.3 Control of vapour space within cargo tank (column 'e')

Special environment controls such as drying and inerting are generally required for liquid chemical products in consideration of the reactivity of cargo vapour and air. As is the case for LNG, it is considered not to be necessary to apply such requirements for liquefied hydrogen.

3.2.4 Vapour detection (column 'f')

Because hydrogen is flammable and non-toxic, it is appropriate to require Flammable (F) as vapour detection for liquefied hydrogen.

3.2.5 Gauging (column 'g')

On the grounds that Closed (C) gauging is required, in principle, for flammable or toxic cargoes, such as methane, it is considered to be appropriate to require Closed (C) gauging for hydrogen, taking into account that hydrogen has high ignitability and a wide flammable range in air and that closed gauging is effective to prevent leakage of gases into air.

4 SPECIAL REQUIREMENTS AGAINST HAZARDS OF LIQUEFIED HYDROGEN

4.1 Hazards of liquefied hydrogen to be considered

4.1.1 The hazards related to liquefied hydrogen are low ignition energy, a wide range of flammability limits, low visibility of flames in case of fire, high flame velocity which may lead to the detonation with shockwave, low temperature and liquefaction/solidification of inert gas and constituents of air which may result in an oxygen-enriched atmosphere, high permeation, low viscosity, and hydrogen embrittlement including weld metals. Where vacuum insulation is adopted, due consideration should be given to the possibility of untimely deterioration of insulation properties at the envisaged carriage temperatures of liquid hydrogen. The vacuum insulation evaluation should be specified for the normal range or upper limit of cold vacuum pressure (CVP), and loss of vacuum should be defined with respect to this value. Accordingly, the effect of vacuum pressure should be taken into account at the time of design and testing of piping with vacuum insulation. Supporting structure and adjacent hull structure should be designed taking into account the cooling owing to loss of vacuum insulation.

4.1.2 Hydrogen is essentially a mixture of ortho- and para-hydrogen, with an equilibrium concentration of 75% ortho-hydrogen and 25% para-hydrogen at ambient temperature. When liquefied at 20K, there is a slow but continuous transformation of ortho-hydrogen to para-hydrogen. The exothermic conversion of the nuclear spin isomers of hydrogen (ortho- to para-hydrogen) may take place and the effect of the conversion may have an impact on the cooling capacity and relief valve capacity of the vessel's equipment.

4.1.3 Trace amounts of air will condense or solidify in an environment with liquid hydrogen possibly resulting in an unstable and explosive mixture. Precautions should be taken to assure that the possibility of condensed air is accounted for within properly secured hazard areas.

4.2 Low temperature hazard

4.2.1 Selection of appropriate material

4.2.1.1 Tables 6.3 and 6.4 in the Code prescribe material selection for piping or cargo tanks whose design temperature is -165°C or higher. According to Note 2 of table 6.3 and Note 3 of table 6.4 of the Code, the requirements for materials whose design temperatures are lower than -165°C should be specially agreed with the Administration. In this regard, the publication by AIAA[2)] introduces some appropriate materials corresponding to the design temperature and the Administration should take into account such references for the material selection.

4.2.1.2 Although paragraph 4.19.3 in the Code requires testing of materials used for thermal insulation for various properties adequate for the intended service temperature, the minimum test temperature is -196°C. The requirements in the Code do not refer to the normal boiling point of hydrogen, being -253°C. In case of carriage of liquefied hydrogen, special requirements should be provided to consider the lower design temperature.

4.2.2 Measures for condensed air

4.2.2.1 In the case of nitrogen whose normal boiling point is -196°C, for which air condensation and oxygen enrichment are concerns, the following special requirement has already been included in paragraph 17.17 in the Code:

> "Material of construction and ancillary equipment such as insulation shall be resistant to the effect of high oxygen concentrations caused by condensation and enrichment at the low temperatures attained in parts of the cargo system. Due consideration shall be given to ventilation in such areas where condensation might occur to avoid the stratification of oxygen-enriched atmosphere."

A similar special requirement is applicable to hydrogen.

4.2.2.2 A vent may be blocked by accumulation of ice formed from moisture in the air, which may result in excessive pressure leading to rupture of the vent and relevant piping (see paragraph 4.2.4).

4.2.3 Removal of impure substances condensed

The removal of impure substances, such as those contained in condensate in pipes, should be separately considered. Installation of filters can be an appropriate measure and should be stipulated as a special requirement.

4.2.4 Prevention of blockage due to formation of water or ice

Pressure relief systems may become blocked owing to the formation of water or ice, depending on the temperature and humidity of air, resulting from the low temperature of the cargo and its vapour (see paragraph 4.2.2). Appropriate means should be provided to prevent such phenomena.

4.3 Hydrogen embrittlement

4.3.1 Selection of appropriate materials should be required to prevent failures owing to hydrogen embrittlement. The publication by AIAA[2)] introduces some appropriate materials resistant to hydrogen embrittlement, and concludes that aluminium is the material least affected.

4.3.2 International or national standards should be followed for the selection of materials for the design of liquefied and gaseous hydrogen installations in a marine environment.

4.4 Susceptibility to leakage

4.4.1 Prevention of leakage from pipes

To mitigate undetected accumulation of hydrogen in a confined space, effective measures should be employed to reduce the possibility of leakage of hydrogen, taking its leakage characteristics into account. Effective measures can be double tube structures, or fixed hydrogen leak detectors in areas assessed as being highly hazardous with regard to hydrogen leakage. Hydrogen leakage through welds, joints and seals is an important consideration for the design of hydrogen systems and an important operational issue.

4.4.2 Implementation of effective tightness test

4.4.2.1 Tightness tests for cargo tanks and cargo pipes/valves are required by paragraphs 4.20.3.2, 5.13.1 and 5.13.2.3 in the Code respectively. Helium or a mixture of 5% hydrogen and 95% nitrogen should be used as the medium for tightness tests, instead of air, because hydrogen is highly susceptible to leakage.

4.4.2.2 For a hydrogen installation, the pipework should be pressure-tested at its design pressure. Consideration should be given to using oxygen-free nitrogen with a small molecule tracer gas, such as helium as the test medium and an electronic leak detector for identifying leaks.

4.4.3 Confirmation of appropriate operating procedure

Instructions/manuals containing the operating procedures for the prevention of leakage during transport, methods for early detection in case of leakage, and appropriate measures after such events, should be provided. For this, paragraph 18.3 of the Code requires that the information shall be on board and available to all concerned, giving the necessary data for the safe carriage of cargo. In detail, the Code requires such information on action to be taken in the event of spills or leak, countermeasures against accidental personal contact, procedures for cargo transfer, and emergency procedures to be on board. With regard to the manuals on procedures for liquefied hydrogen during carriage and transfer operations, the requirements in the Code are applicable and no special requirement is necessary.

4.5 Low density and high diffusivity

Though low density and high diffusivity of hydrogen may reduce the possibility of formation of a flammable atmosphere in open spaces, adequate ventilation is necessary for enclosed spaces in cargo areas where formation of hydrogen-oxygen/air mixture may occur. Paragraph 12.2 of the Code requires fixed ventilation systems or portable mechanical ventilation for such enclosed spaces. These requirements in the Code are applicable to liquefied hydrogen carriers and no special requirement is necessary in this regard.

4.6 Ignitability

4.6.1 The Code requires electrical bonds of the piping and the cargo tanks in paragraph 5.7.4, exclusion of all sources of ignition in paragraph 11.1.2, electrical installations to minimize the risk of fire and explosion from flammable products in paragraph 10.2.1 and so on, in order to prevent ignition of flammable cargoes.

4.6.2 The Code requires compliance with the relevant standards issued by the International Electrotechnical Commission (IEC) and the IEC standards specify the details of such safety measures depending on the respective properties of flammable gases including hydrogen. No special requirement is necessary with regard to ignitability of hydrogen.[2]

4.7 Fire hazard

4.7.1 Safety of personnel in case of fire

To avoid the effects of flame and UV radiation produced by a hydrogen fire, it is effective to use fire-fighter's outfits and protective equipment. The Code already requires fire-fighter's outfits for ships carrying flammable products in paragraph 11.6.1 and safety equipment in paragraph 14.3. This issue should be considered as the matter of cargo information required by paragraph 18.3 of the Code. Due consideration should be given to the invisible nature of hydrogen fire.

4.7.2 Compatibility of fire-extinguishing systems

Dry chemical powder fire-extinguishing or carbon dioxide fire-extinguishing systems are considered to be effective in case of hydrogen fire and such fire-extinguishing systems are already required by paragraphs 11.4 and 11.5 of the Code. Special requirements for installation of other types of fire-extinguishing systems are considered unnecessary, except with regard to the increase in the amount of carbon dioxide required, as mentioned in the next paragraph in this document.

4.7.3 Increase of the amount of gas for carbon dioxide fire-extinguishing systems

4.7.3.1 Paragraph 11.5.1 of the Code requires as follows:

> "Enclosed spaces meeting the criteria of cargo machinery spaces in 1.2.10, and the cargo motor room within the cargo area of any ship, shall be provided with a fixed fire-extinguishing system complying with the provisions of the FSS Code and taking into account the necessary concentrations/application rate required for extinguishing gas fires."

4.7.3.2 Chapter 5 of the FSS Code, i.e. Fixed gas fire-extinguishing systems, requires that the quantity of carbon dioxide for cargo spaces, unless otherwise provided, shall 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, in paragraph 2.2.1.1.

4.7.3.3 On the other hand, NFPA 12[3)] requires that the design quantity of carbon dioxide for hydrogen fire should be 75% or more of the gross volume of the protected space. The special requirement for an increased amount of carbon dioxide should be provided for carbon dioxide fire-extinguishing systems.

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2 Electrical equipment used in hydrogen/air mixture should be, at least, the type of "II-C" and "T-1" as the group based on the maximum experimental safe gap for flameproof enclosures and the temperature class based on maximum surface temperature, respectively, according to ISO/IEC 80079-20-1[4)].

4.7.4 Features of hydrogen fire

Hydrogen burns at high temperature, but generally gives off less radiant heat than propane or other hydrocarbons (e.g. only about 10% of that radiated by an equal-sized propane flame). Although the heat radiated by a hydrogen flame is also relatively low compared to hydrocarbons, it is important to take into account the differences in heats of combustion, burning rate and flame size. Hydrogen flames are colourless or nearly colourless. Both of these characteristics make it more difficult to detect a hydrogen fire. Even relatively small hydrogen fires are very difficult to extinguish. The only reliable approach to extinguish a fire is to shut off the source of hydrogen supply.

4.8 High pressure hazard

4.8.1 High pressure is a hazard common to hydrogen and other flammable gases listed in the Code. To prevent overpressure, the Code requires various measures such as pressure control and pressure design. Specifically, paragraph 8.2, in regard to the provision of pressure control of cargo tanks, requires fittings of pressure relief valves to the cargo tanks. Furthermore, paragraph 7.1.1 requires temperature control by the use of mechanical refrigeration and/or design to withstand possible increases of temperature and pressure. In addition, paragraph 15.2 specifies the filling limit of cargo tanks taking into account cargo volume increase by its thermal expansion. These requirements are applicable for hydrogen and no special requirement is considered necessary in this regard.

4.8.2 Boil-off may be a more significant issue for hydrogen than for LNG in particular when insulation properties have deteriorated. Means of handling boil-off gas should be carefully considered taking into account the following issues:

.1 Re-liquefaction of hydrogen involves very specific and costly equipment. Cargo cooling in order to avoid boil-off shows the same kind of issues; and

.2 Notwithstanding the provision in paragraph 7.4.1 of the Code, thermal oxidation of hydrogen may be permitted in accordance with paragraph 1.3 of the Code.

4.8.3 The special requirements in these aspects are considered necessary.

4.9 Health hazard

4.9.1 Human safety concern under low temperature

With regard to the influences of cold hydrogen on persons' bodies, suitable protective equipment is effective. In this aspect, paragraph 14.1 of the Code requires suitable protective equipment taking into account the character of the products, therefore, no special requirement is considered necessary.

4.9.2 Static electricity

Hydrogen ignition energy is very low and hydrogen can be easily ignitable by static electricity and due consideration should be given to this issue, in accordance with the requirement in the Code on suitable protective equipment.

4.9.3 Oxygen depletion and asphyxiation

Leakage of hydrogen may cause a low level of oxygen and associated asphyxiation.

4.10 Wide range of flammable limits

4.10.1 Extinguishing hydrogen fire

4.10.1.1 As mentioned in paragraph 4.6, for flammable products the Code already requires elimination of sources of ignition, including use of electrical installations of appropriate types in order to minimize the risk of fire and explosion. No special requirement is considered necessary with regard to ignitability of hydrogen.

4.10.1.2 Furthermore, with regard to the wide range of flammable limits of hydrogen, the increased quantities of carbon dioxide as a fire-extinguishing medium should be specified as mentioned in paragraph 4.7. No additional special requirement is considered to be necessary with regard to the wide range of flammable limits of hydrogen.

4.10.2 Disposal of cold hydrogen gas

The wide flammability range makes disposal of cold hydrogen gas a major hazard. Cold plumes of released hydrogen may impede adequate dilution of hydrogen down to below 4% and may lead to flash-back to the vent from distant ignition sources outside safety-controlled areas. The low ignition energy and wide flammable range may present significant challenges.

4.11 Prevention of dangerous purging operation

4.11.1 During cargo operations for maintenance, pipes and tanks should be purged with an inert gas or inert gases as illustrated in the figure below. For safety, due consideration should be given to temperature and boiling points of the inert gases. Residual pockets of hydrogen or the purge gas will remain in the enclosure if the purging rate, duration, or extent of mixing is too low. Therefore, reliable gas concentration measurements should be obtained at a number of different locations within the system for suitable purges. Temperature should also be measured at a number of locations. Oxidizing agents may exist in a hydrogen containing equipment, specifically: air, cold box atmospheres containing air diluted with nitrogen, or oxygen-enriched air that can be condensed on process pipe work within the cold box in special circumstances.

4.11.2 There are special measures that may need to be put in place in order to mitigate the hazards, e.g. air should be eliminated by nitrogen purge prior to introduction of hydrogen into cargo piping or processing equipment. Nitrogen should then be eliminated by hydrogen purge, where there is a possibility of its solidification in the subsequent process.

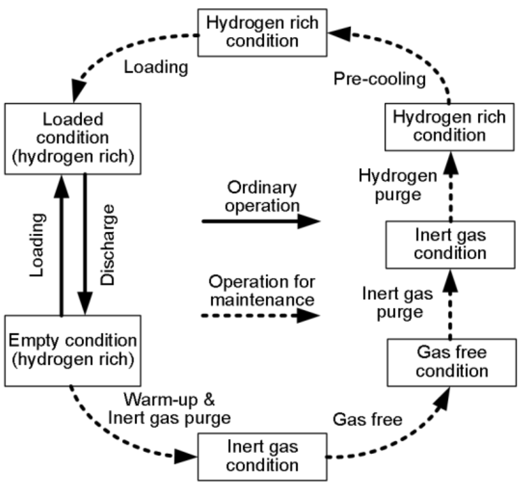

Figure 1

References in part A

1 ISO/TR 15916:2015, Basic consideration for the safety of hydrogen systems (ISO)

2 American Institute of Aeronautics and Astronautics, "Safety Standard for Hydrogen and Hydrogen Systems (Guide to Safety of Hydrogen and Hydrogen Systems)", 2005 (AIAA)

3 NFPA 12: Standard on Carbon Dioxide Extinguishing Systems 2020 Edition (NFPA)

4 ISO/IEC 80079-20-1:2017 Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data

5 UN Recommendations on the Transport of Dangerous Goods – Model Regulations, twenty-second revised edition

6 NFPA 2: Hydrogen Technologies Code 2016 Edition (NFPA)

7 IEC/ISO 31010: 2019 Risk management – Risk assessment techniques

8 Cryogenics Safety Manual – Fourth Edition (1998)

9 SAE ARP 5580-2001 "Recommended failure modes and effects analysis (FMEA) practices for non-automobile applications"

10 National Institute of Standards and Technology (NIST) RefProp database

Part B
Cargo containment systems of independent cargo tanks using vacuum insulation

5 Additional requirements

5.1 Additional special requirements for cargo containment systems of independent cargo tanks using vacuum insulation are prescribed in table 4 and these special requirements should apply in addition to the requirements in table 2.

Table 4: Special requirements for cargo containment systems of independent cargo tanks using vacuum insulation

No.	Special requirement	Related hazard
B-1	The insulation performance of vacuum insulation of cargo containment system should be evaluated to the satisfaction of the Administration based on experiments, as necessary.	General (see 4.1 and 6.1)
B-2	Notwithstanding special requirement A-22, liquid and gas hydrogen pipes may pass through spaces constituting a part of a cargo containment system using vacuum insulation where the degree of vacuum is monitored.	Susceptibility to leakage (see 4.4)
B-3	When selecting the most onerous scenario stipulated in special requirement A-24, the evaluation should include fire or loss of vacuum from the overall insulation system and should also consider the resulting magnitude of the heat flux in case of a single failure on the cargo containment system in each case.	High pressure hazard (see 4.8 and 6.2)

6 Additional special requirements to mitigate hazards of liquefied hydrogen

6.1 Hazards of liquefied hydrogen to be considered

6.1.1 In addition to 4.1.1, due consideration should be given to the possibility of untimely deterioration of insulation properties at the envisaged carriage temperatures of liquid hydrogen. The vacuum insulation evaluation should be specified for the normal range or upper limit of cold vacuum pressure (CVP), and loss of vacuum should be defined with respect to this value. Accordingly, the effect of vacuum pressure should be taken into account at the time of design and testing of cargo containment systems. Supporting structure and adjacent hull structure should be designed taking into account the cooling owing to loss of vacuum insulation.

6.1.2 For consideration on the special requirements for this part, bibliographic studies were conducted using the references at the end of this document, in particular, ISO/TR 15916[1)], "High Pressure Gas Safety Act" (Japanese law), "Safety standard for hydrogen and hydrogen system" by AIAA[2)] and NFPA 2 "Hydrogen Technologies Code"[3)]. The majority of special requirements for liquefied hydrogen carriers are provided based on ISO/TR 15916. This standard refers to liquefied hydrogen tank storage facilities on shore, tank trucks and so on, and includes basic viewpoints when discussing the properties of liquefied hydrogen.

6.2 High pressure hazard

In addition to 4.8, vacuum insulation systems are likely to be used for liquefied hydrogen containment systems and the insulation capability of such systems may be adversely affected by damage to the system, depending on the design of the system. If a rapid deterioration of the insulation system took place, rapid increase of temperature in the cargo tank would occur and/or the rate of vaporization of liquefied hydrogen might exceed the capacity of pressure relief valves. To prevent such dangerous deterioration of insulation, appropriate safety measures should be taken.

References in part B

1 ISO/TR 15916:2015, Basic consideration for the safety of hydrogen systems (ISO)

2 American Institute of Aeronautics and Astronautics, "Safety Standard for Hydrogen and Hydrogen Systems (Guide to Safety of Hydrogen and Hydrogen Systems)", 2005 (AIAA)

3 NFPA 2: Hydrogen Technologies Code 2016 Edition (NFPA)

Part C
Cargo containment systems of independent cargo tanks using insulation materials and hydrogen gas in the inner insulation spaces

7 Application of the requirements in this part

7.1 Design of cargo containment systems

The safety measures set out in this part should apply to cargo containment systems of independent cargo tanks using insulation materials and hydrogen gas in the inner insulation spaces as described below.

Figure 2 illustrates a cargo containment system of independent cargo tanks using insulation materials and hydrogen gas in the inner insulation spaces. In this cargo containment system, an inner shell corresponds to a cargo tank. An insulation structure is installed outside of the inner shell. The insulation structure consists of an inner insulation space, an outer shell and an outer insulation layer from the inside. The inner insulation layer, which is located outside the inner shell, is a part of the inner insulation space. The inner insulation space needs to be filled with the appropriate gas to prevent condensation and/or solidification of a large amount of gas caused by the low temperature of the inner shell surface, which will be almost equal to the boiling point of hydrogen. Thus, the inner insulation space is filled with hydrogen gas and no liquid.

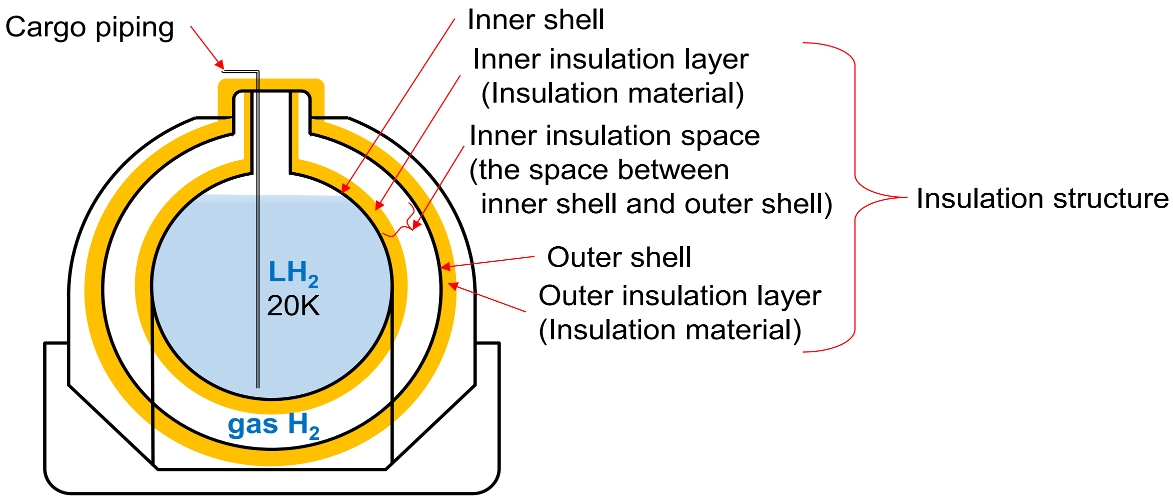

Figure 2 Illustration of cargo containment system

7.2 Conditions for the application of the requirements in this part

The safety requirements set out in this part should apply under the following conditions of use:

.1 the inner shell satisfies the requirements of the Code for a cargo tank; and

Note: This part focuses on the safety measures for the inner insulation space and the outer shell, as a part of the insulation structure for which no specific requirements are specified in the Code.

.2 appropriate measures are adopted to prevent leakage of gas from the inner insulation space to ensure the reliability of the insulation structure, taking into account that the space is filled with flammable gas.

8 Additional requirements

Special requirements for the cargo containment systems are prescribed in table 5 and these special requirements should apply in addition to the requirements in table 2.

Table 5: Special requirements for cargo containment systems of independent cargo tanks using insulation materials and hydrogen gas in the inner insulation spaces

No.	Special requirement	Explanation
C-1	The outer shell of the cargo containment system should be located at the distance from the ship's outer shell, as required in paragraphs 2.4.1 and 2.4.2 of the Code for cargo tanks of type 2G ship.	
C-2	Strength of the outer shell should be determined by analyses and tests considering safety principles, all applicable design conditions, materials used, and construction processes in reference to chapter 4 of the Code, and should be approved by the Administration.	
C-3	Notwithstanding special requirement C-2, the temperature of the outer shell should be determined by a temperature calculation, under the assumption that the inner shell is at the cargo temperature.	
C-4	The following special requirements should be applied to the outer shell: .1 All joints of the outer shell should be welded and of full penetration type. All joints of the outer shell should be of in-plane butt weld, as far as practicable. Tee welds of full penetration type may be used depending on the results of the test carried out at the approval of the welding procedure where the in-plane butt weld is not practicable owing to the construction process and structure of the outer shell. .2 If a manhole is sealed by welding using backing rings, backing rings may be left after welding without removal, provided that they do not cause any significant harmful effects.	see 9.1
C-5	The outer shell should be subjected to pneumatic pressure testing to check its strength.	see 9.2
C-6	Appropriate thermal insulation should be provided to keep the temperature of the outer shell and outer insulation layer above the boiling point of oxygen. The insulation performance should be evaluated to the satisfaction of the Administration based on experiments, as necessary. When applying paragraph 4.19.1.1.5 of the Code, the degradation of insulation performance caused by a hydrogen atmosphere should be considered. Means should be provided for monitoring the condition of the insulation for detection of failures.	
C-7	The pressure of the inner insulation space should be monitored taking into account the requirement for a cargo tank in paragraph 13.4 of the Code.	see 9.3
C-8	Under normal conditions, appropriate measures should be taken to maintain the pressure of the inner insulation space within the design limits.	see 9.3

No.	Special requirement	Explanation
C-9	Pressure and vacuum relief valves should be provided for inner insulation space which may be subject to pressures beyond their design capabilities, taking into account the requirements for pressure relief systems of cargo tanks in paragraphs 8.2 and 8.3 of the Code. The appropriate capacity of vacuum relief valves should be provided taking into account the expected rate of pressure drop in the inner insulation space of the cargo tanks of the ship under normal cargo operations, which replaces the requirements of paragraph 8.3.1.2 of the Code. When applying 8.3.2 of the Code, the vacuum relief valves should not admit air to the inner insulation space. In the event that the pressure relief valve for the inner insulation space is activated, the hydrogen gas release should be vented to a safe location.	see 9.3
C-10	The requirements in chapter 5 other than 5.3 and 5.10 of the Code, i.e. the requirements for cargo piping outside the cargo areas, should be applied for piping handling hydrogen for the inner insulation space.	
C-11	Appropriate measures should be taken for atmosphere control of the inner insulation space, e.g. inerting, gas freeing, aerating and purging, etc. (see also A-15).	
C-12	The special requirement A-8 should be applied to the tightness test of the outer shell.	
C-13	The special requirements A-3 and A-4 should be applied to piping handling hydrogen for the inner insulation space.	
C-14	The special requirements A-8 and A-26 should be applied to exposed parts of piping handling hydrogen for the inner insulation space.	
C-15	Special requirement A-7 need not be applied to piping handling hydrogen for the inner insulation space, other than piping penetrating the inner shell, located inside the inner insulation space.	see 9.4
C-16	Notwithstanding special requirement A-22, piping handling hydrogen for an inner insulation space may pass through other inner insulation spaces.	
C-17	The requirements for type C independent tank should be applied to the inner shell.	
C-18	Manholes for access from or to the inner insulation space through the inner shell should not be permitted.	
C-19	Cargo piping connected to the inside of the inner shell should be led directly from the weather deck. No pipe should penetrate the inner shell from or to the inner insulation space.	

9 Explanation of special requirements

9.1 Welding of the outer shell

9.1.1 As mentioned in 7.2, the outer shell is a part of the insulation structure that has the function to contain hydrogen gas in the inner insulation space, but not to contain liquefied hydrogen.

9.1.2 Owing to the high leakage of hydrogen, which is filled in the inner insulation space, it is essential to ensure the reliability of the tightness of the outer shell. This reliability is subject to evaluation and approval by the Administration. To ensure the tightness of the outer shell, equivalent welding requirements for the inner shell, i.e. cargo tank, should be applied to the outer shell as far as practicable. Therefore, all joints of the outer shell should be of the in-plane butt weld full penetration type, referring to paragraph 4.20.1 of the Code. On the other hand, it may not be practicable to use in-plane butt weld for the outer shell owing to the construction procedure and structure. Considering that only gas is filled in the inner insulation space, no liquid pressure is applied on the outer shell. Therefore, using tee welds of the full penetration type is deemed acceptable for those areas, depending on the results of the test carried out with the approval of the welding procedure.

9.1.3 A manhole, when installed on the outer shell, can be sealed by gaskets or by welding. Welding is deemed to be a more reliable method to prevent hydrogen leakage, and removal of the backing rings is typically not possible owing to the construction procedure. Considering that no liquid pressure is applied on manholes and backing rings, there is no significant concern from a strength point of view. Therefore, not removing backing rings is deemed acceptable, unless any conceivable harmful effects, such as fatigue strength, are identified.

9.2 Testing of outer shell

While pressure testing is to be conducted on the outer shell to check for strength, filling the inner insulation space with water is unrealistic because the insulation materials are installed in the inner insulation space. In addition, it is assumed that only gas is stored in the inner insulation space, therefore, a pneumatic pressure test is sufficient to reproduce the operational condition of the outer shell. This special requirement is related to paragraphs 4.20.3.1 and 4.23.6.7 of the Code.

9.3 Pressure of the inner insulation space

Keeping an appropriate pressure of the inner insulation space is essential for preventing the inner and the outer shell from rupturing and buckling.

9.4 Leak detection for piping handling hydrogen for the inner insulation space located inside the inner insulation space

The purpose of special requirement A-7 is to avoid forming a flammable atmosphere. Because the inner insulation space is filled with hydrogen, no additional risk is created by leakage of hydrogen from the places, located inside the inner insulation space, where leakage of hydrogen may occur such as valves, flanges and seals of piping handling hydrogen for the inner insulation space. Thus, special requirement A-7 does not contribute to improve safety for such piping, which is different from the piping for cargo handling. Provision C-15 is necessary to enable the design for control to change atmosphere or for maintenance.

References in part C

1 ISO/TR 15916:2015, Basic consideration for the safety of hydrogen systems (ISO)

2 American Institute of Aeronautics and Astronautics, "Safety Standard for Hydrogen and Hydrogen Systems (Guide to Safety of Hydrogen and Hydrogen Systems)", 2005 (AIAA)

3 NFPA 2: Hydrogen Technologies Code 2016 Edition (NFPA)

Part D
Cargo containment systems of membrane-type cargo tanks maintaining the insulation spaces under vacuum

10 APPLICATION OF THE REQUIREMENTS IN THIS PART

10.1 Definitions

The following definitions apply for the purpose of this part;

.1 the *primary insulation space* is the inter-barrier space as defined in 1.2.30 of the Code; and

.2 the *secondary insulation space* is the space between the secondary barrier and the inner hull.

10.2 Design of the cargo containment system

The safety measures set out in this part should apply to membrane-type cargo containment systems for liquefied hydrogen maintaining the insulation spaces under vacuum, as an equivalent arrangement under paragraph 1.3 of the Code to the inerting requirements specified in paragraph 9.2.1.

Figure 3 illustrates an example of the cargo containment system. The system consists of thin liquid-tight and gas-tight layers (denoted as primary and secondary barriers in figure 3) supported through insulation by the adjacent hull structure. The primary and secondary insulation spaces are filled with insulation materials, and maintained under vacuum during the normal operation of the containment system.

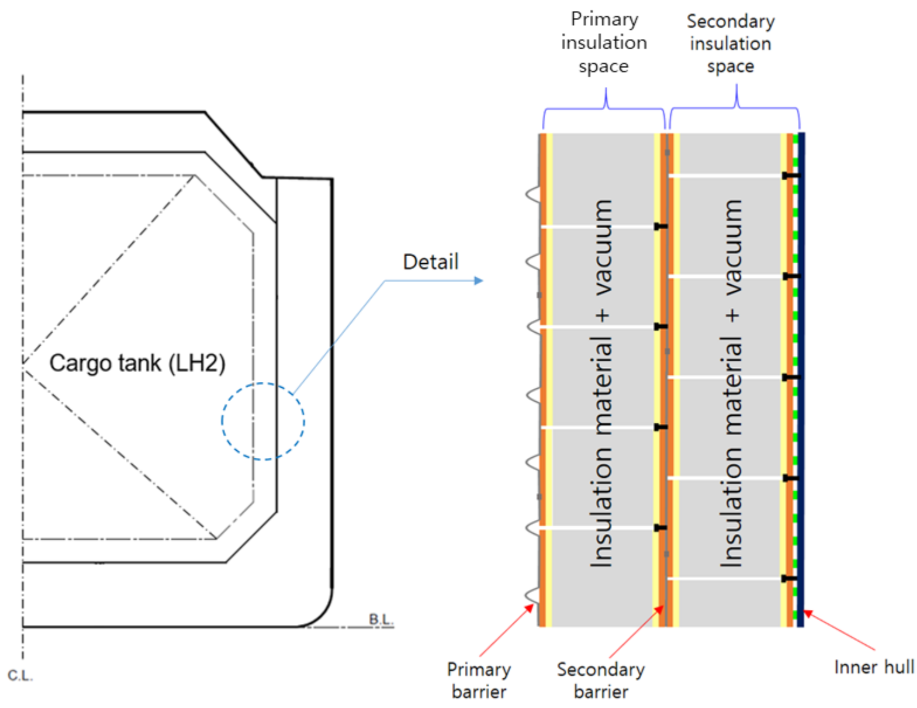

Figure 3: Illustration of a membrane LH_2 cargo containment system maintaining the insulation spaces under vacuum

11 ADDITIONAL REQUIREMENTS

Instead of filling the insulation spaces with dry inert gas, the cargo containment system creates and maintains vacuum in the spaces. Therefore, additional safety requirements should be provided for:

.1 structural integrity of the inner hull, primary and secondary barriers and insulation components in the spaces under vacuum environment;

.2 generation, maintaining, and monitoring of the vacuum; and

.3 emergency cases: cargo leakage into the primary insulation space or loss of vacuum due to air ingress into the insulation spaces.

The additional requirements are prescribed in table 6 and these special requirements should be applied in addition to the requirements in table 2.

Table 6: Special requirements for membrane-type cargo containment systems maintaining the insulation spaces under vacuum

No.	Special requirement	Explanation
D-1	Structural integrity should be verified for all the structural components of the cargo containment system and the inner hull structure considering the vacuum environment of the insulation spaces.	12.1.1

No.	Special requirement	Explanation
D-2	Both the primary and secondary barriers should be made of metallic materials and be liquid-tight and gas-tight. The quality assurance/quality control programme ensuring the continued conformity of the weld procedure qualification, design details, materials, construction, inspection and production testing of components, should be established to the satisfaction of the Administration.	12.1.2
D-3	Tightness test should be conducted for both the primary and secondary barriers after installation and during renewal surveys using the test medium specified in the requirement A-8.	12.1.2
D-4	Pressure relief system should be provided for the insulation spaces that may be subject to pressures beyond their design capabilities. The designer should demonstrate adequate capacity of the pressure relief system for the spaces to the satisfaction of the Administration.	12.1.2
D-5	Procedures for the in-service maintenance and monitoring, initial and periodical examination/test for the primary and secondary insulation spaces, should be established to the satisfaction of the Administration.	12.1.3
D-6	The insulation performance of the insulation system should be evaluated to the satisfaction of the Administration considering the anticipated operational conditions, the degree of vacuum, vacuum deterioration over time and the designed tolerance levels in the insulation spaces, based on experiments as necessary.	12.2.1
D-7	The required degree of vacuum in the insulation spaces should be adequate to prevent any damage to the insulation system components due to the condensation and/or solidification of the remaining gas components.	12.2.1
D-8	The degree of vacuum in the insulation spaces should be monitored and maintained within the designed level during the normal operation period. At least one vacuum system should be provided for each tank. The vacuum system should have sufficient capacity to maintain the designed level of vacuum in each insulation space. The vacuum systems are to be considered as an essential auxiliary and at least one of them for each tank should be supplied from the emergency source of electrical power. In addition, a back-up pump should be provided, able to maintain vacuum in the largest space under vacuum.	12.2.2
D-9	In addition to the requirement A-15, appropriate atmosphere handling procedures for the insulation spaces should also be established. It should be verified through testing that the insulation components do not prevent the effective atmosphere control operation for the spaces, including but not limited to gas displacement, evacuation and removal of leaked hydrogen.	12.2.3

No.	Special requirement	Explanation
D-10	Appropriate emergency control procedures should be established to address the possibility of cargo leakage into the primary insulation space. The procedures should include, but not be limited to, leakage detection, handling of leaked hydrogen and measures to restore insulation performance and tightness of the primary barrier.	12.3.1.1
D-11	For the detection and identification of the emergency cases, such as hydrogen leakage into the primary insulation space and loss of vacuum due to air ingress into the insulation spaces, appropriate indicating and detecting instruments should be provided and arranged. They should be sufficiently redundant to the satisfaction of the Administration.	12.3.1
D-12	Pressure control systems for the primary insulation space, such as pressure relief or vacuum pumping systems, should be explosion-proof and be able to discharge cryogenic hydrogen to a safe location with sufficient capacity. Pressure control systems for the primary and secondary insulation spaces should also be designed and arranged to prevent blockage due to the frozen air or loose/damaged insulation material.	12.3.1
D-13	Hydrogen-compatibility of the insulation materials should be verified by test. It should be ensured that the insulation performance of the insulation materials in contact with the leaked hydrogen remains acceptable to the satisfaction of the Administration after repair works are completed.	12.3.1
D-14	The insulation components' low permeability to hydrogen should be demonstrated or adequate measures and operating procedures to avoid any risk of potential damage due to the permeated hydrogen should be provided to the satisfaction of the Administration.	12.3.1.4
D-15	To prevent air intrusion into the insulation spaces, the number of pipes passing through the spaces should be minimized, and furthermore, all the pipe joints connected to the spaces should be weld-type.	12.3.2
D-16	Appropriate measures should be provided to control the incoming air and prevent further ingress when outside air intrudes into the secondary insulation space. The measures should be effective for at least 15 days. When the secondary insulation space is pressurized with an inert gas as one of the measures to prevent further ingress of air, appropriate measures should be adopted taking into account the possibility of condensation of the inert gas within the space, such as maintaining the temperature of the inner boundary of the secondary insulation space above the boiling point of the inert gas.	12.3.2.2
D-17	Insulation system and the inner hull structure's steel grade should be arranged to safely accommodate a degradation or loss of the insulation performance in any one of the insulation spaces.	-

No.	Special requirement	Explanation
D-18	Regarding the relief valve sizing for the cargo tank, the evaluation should include the scenarios of fire or loss of vacuum in any one of the insulation spaces in addition to the special requirement A-24.	-

12 EXPLANATION OF THE SPECIAL REQUIREMENTS

12.1 Structural integrity of the components

12.1.1 Strength assessment under vacuum environment

In addition to the design loads described in the Code, chapter 4, part B, a strength assessment should be carried out for the inner hull structure, primary and secondary barriers and the structural components in the insulation spaces, taking into account the vacuum pressure for the anticipated operating scenarios.

12.1.2 The inner hull, primary and secondary barriers

12.1.2.1 Liquid and gas tightness is required for the inner hull and both the primary and secondary barriers so that the vacuum environment can be maintained during the operation period and also any leaked hydrogen can be contained in the primary insulation space without permeation into the secondary insulation space for at least 15 days.

12.1.2.2 The quality assurance/quality control programme should ensure the continued conformity of the weld procedure qualification, design details, materials, construction, inspection and production testing of components, according to 6.6.5 of the Code. The programme should be developed and established to the satisfaction of the Administration. Tightness test specified in A-8 should be conducted for both the primary and secondary barriers.

12.1.2.3 In addition to 8.2.2 of the Code, the secondary insulation space should be provided with a pressure relief system as well as the inter-barrier space, if the space may be subject to pressures beyond its capability. The capacity of the pressure relief system of the insulation spaces should be adequately determined and demonstrated to the satisfaction of the Administration.

12.1.3 Maintenance, monitoring and examination

Procedures for the in-service maintenance and monitoring, initial and periodical examination/test for the primary and secondary insulation spaces, should be established to the satisfaction of the Administration.

12.2 Vacuum control in the insulation spaces

12.2.1 Required degree of vacuum

12.2.1.1 The insulation performance is affected by the degree of vacuum. If the cold vacuum pressure (CVP) is taken into account in the evaluation of the insulation performance, the required degree of vacuum should be determined based on the evaluation conditions. The vacuum insulation evaluation should be specified for the normal range or upper limit of cold vacuum pressure, and loss of vacuum should be defined with respect to this value.

12.2.1.2 Owing to the low temperature of the cargo, the remaining gas components can be condensed and/or solidified. Therefore, the required degree of vacuum should also be determined so as to prevent any damage to the insulation system components by condensation and/or solidification of the remaining gas components in the spaces.

12.2.2 Monitoring and maintaining the degree of vacuum

The degree of vacuum in the insulation spaces should be monitored and maintained within the designed level throughout the normal operation period. Appropriate vacuum systems, such as a vacuum pumping system, should be permanently installed, and they should have sufficient capacity and redundancy to the satisfaction of the Administration.

12.2.3 Atmosphere handling

In addition to the special requirement A-15, an appropriate procedure should also be established for the atmosphere handling within the insulation spaces. Purging with dry inert gas may be conducted before creating a vacuum in the insulation spaces to prevent the formation of a flammable mixture as much as possible. As the insulation spaces are filled with insulation materials, it should be confirmed that they do not disable the gas displacement and evacuation operations for the spaces. In addition, considering the cargo leakage scenario, leaked hydrogen may permeate inside the insulation materials. The methodology of removing the permeated hydrogen should also be prepared and verified to ensure that repair works after the leakage can be safely carried out.

12.3 Emergency control

12.3.1 Cargo leakage into the primary insulation space

12.3.1.1 Appropriate emergency control procedures should be established to address the possibility of cargo leakage into the primary insulation space. The procedures should include, but not be limited to, leakage detection, handling of leaked hydrogen and measures to restore insulation performance and tightness of the primary barrier.

12.3.1.2 Any cargo leakage into the primary insulation space may be detected and identified by hydrogen gas detectors together with monitoring the pressure and temperature changes in the insulation space. Meanwhile, air ingress into the primary or secondary insulation space may be detected and identified by oxygen detectors together with monitoring the pressure changes in the insulation spaces. Appropriate indicating and detecting instruments should be provided and arranged. They should be sufficiently redundant to the satisfaction of the Administration.

12.3.1.3 Cargo hydrogen may leak into the primary insulation space. Therefore, the pressure control systems, such as pressure relief valves or vacuum pumping systems installed for the primary insulation space, should be able to discharge the leaked hydrogen to a safe location. They should also be explosion-proof and be able to handle cryogenic gas.

12.3.1.4 Any leaked hydrogen in the primary insulation space may permeate into the insulation materials and cause damage to the barriers and/or insulation components as it heats up. It can also cause degradation of the insulation performance. Therefore, the insulation components' low permeability to hydrogen should be demonstrated or adequate measures and operating procedures to avoid any risk of potential damage due to the permeated hydrogen should be provided to the satisfaction of the Administration.

12.3.2 Loss of vacuum in the insulation spaces due to air intrusion

12.3.2.1 In case of external leakage on the pipes or valves connected to the primary or secondary insulation spaces, outside air may intrude into the spaces. In the primary insulation space, the air intrusion may not be detected for some time if the amount of ingress is small, because it immediately condenses owing to the extremely low temperature. Therefore, the design should prevent air intrusion into the primary and secondary insulation spaces as much as possible. The number of pipes passing through the spaces should be limited to a minimum and only weld-type pipe joints should be allowed.

12.3.2.2 In the secondary insulation space, appropriate instruments, such as oxygen detectors and pressure indicators, should be installed to detect air ingress into the secondary insulation space. When air ingress is detected, appropriate measures should be adopted to prevent further air ingress and prevent the intruded air from forming a flammable mixture. For this purpose, inert gas circulation may be implemented with a shipboard inert gas generation system or shipboard inert gas storage. The inerting pressure should be managed to prevent further air ingress into the space. In that case, the amount of inert gas should be sufficient for consumption of at least 15 days.

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ANNEX 20

DRAFT AMENDMENTS TO THE IGC CODE

DRAFT MSC RESOLUTION

AMENDMENTS TO THE INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK (IGC CODE)

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

NOTING resolution MSC.5(48), by which it adopted the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk ("the IGC Code"), which has become mandatory under chapter VII of the International Convention for the Safety of Life at Sea, 1974 ("the Convention"),

NOTING ALSO resolution MSC.370(93), by which it adopted the comprehensive revision of the IGC Code, and subsequent amendments adopted to the IGC Code,

NOTING FURTHER article VIII(b) and regulation VII/11.1 of the Convention concerning the procedure for amending the IGC Code,

HAVING CONSIDERED, at its [112th] session, amendments to the IGC Code proposed and circulated in accordance with article VIII(b)(i) of the Convention,

1 ADOPTS, in accordance with article VIII(b)(iv) of the Convention, amendments to the IGC Code the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article VIII(b)(vi)(2)(bb) of the Convention, that the said amendments shall be deemed to have been accepted on [1 January 2028], unless, prior to that date, more than one third of the Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet have notified the Secretary-General of their objections to the amendments;

3 INVITES Contracting Governments to the Convention to note that, in accordance with article VIII(b)(vii)(2) of the Convention, the amendments shall enter into force on [1 July 2028] upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article VIII(b)(v) of the Convention, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Contracting Governments to the Convention;

5 ALSO REQUESTS the Secretary-General to transmit copies of this resolution and its annex to Members of the Organization which are not Contracting Governments to the Convention.

ANNEX

DRAFT AMENDMENTS TO THE INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK (IGC CODE)

CHAPTER 1
GENERAL

1.1 Application and implementation

1 The following new paragraphs 1.1.1.1 to 1.1.1.3 are added after existing paragraph 1.1.1:

> "1.1.1.1 Ships subject to this Code may use products listed in chapter 19 as fuel, subject to the requirements of chapter 16. If the product is not carried as cargo and only used as fuel, the ship shall comply with the most stringent requirements for the cargo or fuel, as appropriate.
>
> 1.1.1.2 Ships subject to this Code using gaseous fuels or low-flashpoint fuels, other than the products listed in chapter 19, shall be approved by the Administration, taking into account the guidelines developed by the Organization specifically for ships subject to this Code.
>
> 1.1.1.3 The products shall be listed on the ship's International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and identified as cargo and/or fuel, as appropriate."

2 Paragraph 1.1.2.2 is amended, as follows:

> "1.1.2.2 For the purpose of the Code, the expression "ships constructed" means ships the keels of which are laid or which are at a similar stage of construction, unless otherwise specified in the Code."

3 The following new paragraph is added after the existing paragraph 1.1.2.2:

> "1.1.2.2.1 The expression "ships constructed on or after [1 July 2028]" means ships:
>
> .1 for which the building contract is placed on or after [1 July 2028]; or
>
> .2 in the absence of a building contract, the keels of which are laid or which are at a similar stage of construction on or after [1 January 2029]; or
>
> .3 the delivery of which is on or after [1 July 2032]."

1.2 Definitions

4 The following new definitions are inserted in the respective alphabetical order, together with the associated footnote, and subsequent paragraphs are renumbered accordingly:

"1.2.18 *Essential safety functions* are safety functions required by the Code, which include a system that initiates required actions to prevent escalation of potential hazards."

"1.2.25 *Gastight* means a physical barrier which prevents any significant quantity of flammable gas from entering an adjoining area in accordance with specifications at least equivalent to standards acceptable to the Organization.*

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* Refer to the recommendations published by the International Electrotechnical Commission, IEC 60092-502:1999."

"1.2.32 *Integrated system* is a combination of computer-based systems which are interconnected in order to allow centralized access to sensor information and/or command and control. Integration of systems shall ensure that no failure of any component of the system will result in an unacceptable loss of control, alarm or safety functions."

"1.2.49 *Reversionary control* is an alternative means of control that may be local manual or local automatic."

CHAPTER 2
SHIP SURVIVAL CAPABILITY AND LOCATION OF CARGO TANKS

2.1 General

5 Paragraph 2.1.4 is amended, as follows:

"2.1.4 If a ship is intended to carry more than one of the products listed in chapter 19, the standard of damage shall correspond to the product having the most stringent ship type requirements. If a product listed in chapter 19 is only used as fuel, not carried as a cargo, and bunkered in dedicated deck tanks, the standard of damage shall correspond to the ship type requirements of the ship's cargo. The requirements for the location of individual cargo and gas fuel tanks, however, shall be those for ship types related to the respective products intended to be carried."

2.7 Survival requirements

2.7.2 At final equilibrium after flooding

6 Paragraph 2.7.2.1 is amended, as follows:

".1 the righting lever curve shall have a minimum range of 20° beyond the position of equilibrium in association with a maximum residual righting lever of at least 0.1 m within the 20° range; the area under the curve within this range shall not be less than 0.0175 m-radians. The 20° range may be measured from any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs). Unprotected openings shall not be immersed within this range unless the space concerned is assumed to be flooded. Within this range, the immersion of any of the openings listed in 2.7.1.1 and other openings capable of being closed weathertight may be permitted, except for those ventilators (in compliance with regulation 19(4) of the International Convention on Load Lines, 1966/88) which have to remain open to supply air to the engine-room or emergency generator room (if the same is considered buoyant in the stability calculation or protecting openings leading below) for the effective operation of the ship; and"

CHAPTER 3
SHIP ARRANGEMENTS

3.2 Accommodation, service and machinery spaces and control stations

7 Paragraph 3.2.6 is renumbered as 3.2.6.1 and the following new paragraphs are added after the renumbered paragraph 3.2.6.1:

"3.2.6.2 Engine-room casings, cargo machinery spaces, electric motor rooms and steering gear compartments are generally considered as spaces not covered by paragraph 3.2.6.1 and, therefore, the requirement for closing devices need not be applied to these spaces.

3.2.6.3 The closing devices shall be gastight. For ships constructed on or after [1 July 2028], ordinary steel fire-flaps without gaskets/seals shall not be considered to be satisfactory.

3.2.6.4 Regardless of paragraphs 3.2.6.2 and 3.2.6.3, the closing devices for main inlets and outlets of all ventilation systems shall be operable from outside of the protected space in accordance with SOLAS regulation II-2/5.2.1.1."

3.3 Cargo machinery spaces and turret compartments

8 Paragraph 3.3.1 is amended, as follows:

"3.3.1 Cargo machinery spaces shall be situated above the weather deck and located within the cargo area. Cargo machinery spaces and turret compartments shall be treated as cargo pump-rooms for the purpose of fire protection according to SOLAS regulation II-2/9.2.4~~, and for the purpose of prevention of potential explosion according to SOLAS regulation II-2/4.5.10~~."

3.5 Access to spaces in the cargo area

9 Paragraph 3.5.3.1.2 is amended, as follows:

".2 access through horizontal openings, hatches or manholes. The dimensions shall be sufficient to allow a person wearing a breathing apparatus to ascend or descend any ladder without obstruction, and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening shall be not less than 600 mm x 600 mm. For ships constructed on or after [1 July 2028], the minimum clear opening of 600 mm x 600 mm may have corner radii up to 100 mm. In a case where the stress needs to be reduced around the opening as a consequence of structural analysis of a given design, appropriate measures shall be taken to reduce the stress such as making the opening larger with increased radii, e.g. 600 x 800 with 300 mm radii, in which a clear opening of 600 mm x 600 mm with corner radii up to 100 mm maximum fits;"

10 Paragraph 3.5.3.1.3 is amended, as follows, and the subsequent figures in this chapter are renumbered accordingly:

".3 access through vertical openings or manholes providing passage through the length and breadth of the space. The minimum clear opening shall be not less than 600 mm x 800 mm at a height of not more than 600 mm from the bottom plating unless gratings or other footholds are provided. For ships constructed on or after [1 July 2028], the minimum clear opening of not less than 600 mm x 800 mm may also include an opening with corner radii of 300 mm (see figure 3.1). An opening of 600 mm in height x 800 mm in width may be accepted as access openings in vertical structures where it is not desirable to make a large opening in the structural strength aspects, i.e. girders and floors in double bottom tanks.

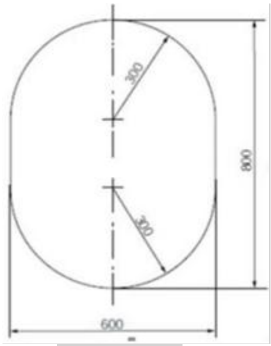

Figure 3.1

Subject to verification of easy evacuation of an injured person on a stretcher the vertical opening 850 mm x 620 mm with wider upper half than 600 mm, while the lower half may be less than 600 mm with the overall height not less than 850 mm is considered an acceptable alternative to the traditional opening of 600 mm x 800 mm with corner radii of 300 mm (see figure 3.2).

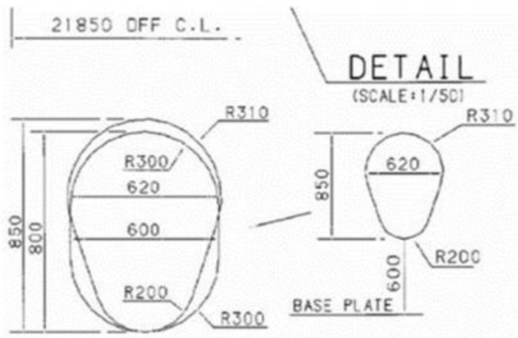

Figure 3.2

If a vertical opening is at a height of more than 600 mm, steps and handgrips shall be provided. In such arrangements it shall be demonstrated that an injured person can be easily evacuated; and"

3.7 Bilge, ballast and oil fuel arrangements

11 Paragraph 3.7.5 is amended, as follows:

"3.7.5 Ballast spaces, including wet duct keels used as ballast piping, oil fuel tanks and non-hazardous spaces, may be connected to pumps in the machinery spaces. Dry duct keels with ballast piping passing through may be connected to pumps in the machinery spaces, provided the connections are led directly to the pumps, and the discharge from the pumps is led directly overboard with no valves or manifolds in either line that could connect the line from the duct keel to lines serving non-hazardous spaces. For pumps in the machinery spaces serving dry duct keels through which ballast piping passes, ~~P~~pump vents shall not be open to machinery spaces."

CHAPTER 4
CARGO CONTAINMENT

4.19 Materials

4.19.1 Materials forming ship structure

12 Paragraph 4.19.1.6.2 is amended, as follows:

".2 the heating system shall be considered as an essential auxiliary. All electrical components of at least one of the systems provided in accordance with paragraph ~~4.19.1.5.1~~ 4.19.1.6.1 shall be supplied from the emergency source of electrical power; and"

13 The following new paragraph is added after the existing paragraph 4.19.1.6:

"4.19.1.7 For ships constructed on or after [1 July 2028], the heating system referred to in paragraph 4.19.1.6.1 shall also comply with the following requirements:

.1 In case of a single failure of a mechanical or electrical component in any part of the system, heating can be maintained at not less than 100% of the theoretical heat requirement.

.2 Where the above requirements are met by duplication of the system components, i.e. heaters, glycol circulation pumps, electrical control panel, auxiliary boilers etc. all electrical components of at least one of the systems shall be supplied from the emergency source of electrical power.

.3 Where duplication of the primary source of heat, e.g. an oil-fired boiler, is not feasible, alternative means may be accepted such as an electric heater capable of providing 100% of the theoretical heat requirement provided and supplied by an individual circuit arranged separately on the emergency switchboard. Other means may be accepted as satisfying the requirements of paragraph 4.19.1.6.1, provided a suitable risk assessment is conducted to the satisfaction of the Administration. In such cases, essential electrical components of at least one of the systems shall be supplied from the emergency source of electrical power."

4.20 Construction processes

4.20.1 Weld joint design

14 The following new paragraph is added after the existing paragraph 4.20.1.1:

"4.20.1.1.1 For ships constructed on or after [1 July 2028], all welded joints of the shells of type A independent tanks and type B independent tanks, primarily constructed of plane surfaces, shall be of the in-plane butt weld full penetration type. Welded corners (i.e. corners made of weld metal) shall not be used in the main tank shell construction, i.e. corners between shell side (sloped plane surfaces parallel to hopper or top side inclusive if any) and bottom or top of the tank, and between tank end transverse bulkheads and bottom, top or shell sides (sloped plane surfaces inclusive if any) of the tank. Instead, tank corners which are constructed using bent plating aligned with the tank surfaces and connected with in-plane welds shall be used. For localized constructions of the shell, such as suction well, sump, dome, and their connections to shell, however, tee welds of the full penetration type may be used depending on the results of the tests carried out at the approval of the welding procedure. Except for small penetrations on domes, nozzle welds shall also be designed with full penetration."

15 Paragraph 4.20.1.2 is amended as follows, and the subsequent figures in this chapter are renumbered accordingly:

"4.20.1.2 Welding joint details for type C independent tanks and for the liquid-tight primary barriers of type B independent tanks primarily constructed of curved surfaces, shall be as follows:

.1 all longitudinal and circumferential joints shall be of butt welded, full penetration, double vee or single vee type. Full penetration butt welds shall be obtained by double welding or by the use of backing rings. If used, backing rings shall be removed except from very small process pressure vessels. Other edge preparations may be permitted, depending on the results of the tests carried out at the approval of the welding procedure; ~~and~~

.2 the bevel preparation of the joints between the tank body and domes and between domes and relevant fittings shall be designed according to a standard acceptable to the Administration or recognized organization acting on its behalf. All welds connecting nozzles, domes or other penetrations of the vessel and all welds connecting flanges to the vessel or nozzles shall be full penetration welds~~.~~; and

.3 for welding joint details of type C independent tanks installed for ships constructed on or after 1 July 2028, cruciform full penetration welded joints in a bi-lobe tank with centreline bulkhead may be accepted for the tank structure construction at tank centreline welds with bevel preparation subject to the approval of the Administration or recognized organization acting on its behalf, depending on the results of the tests carried out at the approval of the welding procedure (see figure 4.1).

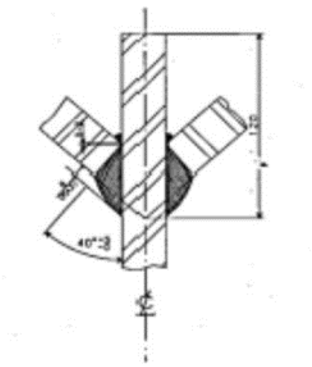

Figure 4.1"

4.23 Type C independent tanks

4.23.1 Design basis

16 Paragraph 4.23.1.1 is amended, as follows:

"4.23.1.1 The design basis for type C independent tanks is based on pressure vessel criteria modified to include fracture mechanics and crack propagation criteria. The minimum design vapour pressure defined in 4.23.1.2 is intended to ensure that the dynamic stress range ~~is~~ shall be sufficiently ~~low~~ small so that an initial surface flaw will not ~~propagate more than half the thickness of the shell during the lifetime of the tank~~ have significant propagation."

4.23.3 Ultimate design condition

17 The following new paragraph 4.23.3.3 is added after existing paragraph 4.23.3.2:

"4.23.3.3 For ships constructed on or after [1 July 2028], guidance is given in 4.28.4 and 4.28.5 for finite element analysis and buckling assessment respectively."

4.23.4 Fatigue design condition

18 Paragraph 4.23.4 is amended, as follows:

"**4.23.4 Fatigue design condition**

For large type C independent tanks, ~~where the cargo at atmospheric pressure is below -55°C,~~ the Administration or recognized organization acting on its behalf may require additional fatigue verification ~~to check their compliance with 4.23.1.1 regarding static and dynamic stress~~ as follows:

.1 C_w shall be less than or equal to 0.1; or

.2 predicted failure development time, from the assumed initial defect until reaching a critical state, shall not be less than three times the lifetime of the tank."

4.28 Guidance notes for chapter 4

19 The following new paragraphs 4.28.4 and 4.28.5 are added after existing paragraph 4.28.3 (Stress categories):

"**4.28.4 Guidance to finite element analysis of type C tanks for ships constructed on or after [1 July 2028]**

4.28.4.1 General

4.28.4.1.1 The allowable stresses described in 4.23.3.1 are applicable for the finite element analysis of the type C tanks.

4.28.4.1.2 As a supplement to the prescriptive requirements, the finite element analysis of the type C cargo tanks may be carried out for the following cases:

.1 Locations where a structural strength cannot be assessed by the prescriptive requirements, e.g. structural discontinuities in way of tank support, Y connection of bi-lobe and multi-lobe tank, etc.

.2 Tanks of novel design or configuration.

4.28.4.1.3 The procedure for finite element analysis should be in accordance with the recognized standards, such as ASME Boiler and Pressure Vessel Code, section VIII, Division 2, or other equivalent which is acceptable to the Administration, provided the maximum strength utilizations in 4.23.3.1 are complied with.

4.28.4.1.4 The scantling defined by the prescriptive requirements on the type C tank of the Code should not be reduced by any form of alternative calculations using finite element analysis.

4.28.4.1.5 For calculation of reaction forces at the tank supports, the following factors should be taken into account:

.1 elasticity of support material (intermediate layer of wood or similar material); and

.2 change in contact surface between tank and support, and of the relevant reactions, due to thermal shrinkage of tank and elastic deformations of tank and support material.

4.28.4.1.6 The final distribution of the reaction forces at the supports should not show any tensile forces.

4.28.4.2 Allowable stresses for finite element analysis

4.28.4.2.1 In general, finite element models composed of 2D shell element or 3D solid element are considered acceptable for stress calculation. The mesh size of the finite element model should be to the satisfaction of the Administration or recognized organization acting on its behalf.

4.28.4.2.2 The application of allowable stresses for linear finite element analysis of the type C tank body using 2D shell element or 3D solid element is given in the following table.

4.28.4.2.3 The strength of stiffening rings of type C tanks should be checked. The calculated stresses of the stiffening ring of type C tanks using finite element method should be performed according to 4.28.4, and the permissible stresses of the stiffening rings shall not exceed that of the tank body defined in 4.28.4.

Application of allowable stresses for finite element analysis of the type C tank body using the finite element analysis of 2D shell element or 3D solid element for ships constructed on or after [1 July 2028]

Code criterion given in 4.23.3.1	Application for 2D shell element or 3D solid element	
	Finite element results check	Locations where check should be applied
$\sigma_{\mathrm{m}} \leq \mathrm{f}$	$\sigma_{\mathrm{e\_membrane}} \leq \mathrm{f}$ 1)	(A) Areas remote from structural discontinuities
$\sigma_L \leq 1.5f$	$\sigma_{e\_membrane} \leq 1.5f$ 1)	(B) Area in way of structural discontinuities
$\sigma_b \leq 1.5f$	$\sigma_{e\_surface} \leq 1.5f$ 1)	(C) Any area ((A) or (B) where bending stresses exist)
$\sigma_L + \sigma_b \leq 1.5f$	$\sigma_{e\_surface} \leq 1.5f$ 1)	See (B) and (C)
$\sigma_m + \sigma_b \leq 1.5f$	$\sigma_{e\_surface} \leq 1.5f$ 1)	See (A) and (C)
$\sigma_m + \sigma_b + \sigma_g \leq 3.0f$	$\sigma_{e\_surface} \leq 3.0f$ 1), 2), 3)	See (A) and (C)
$\sigma_L + \sigma_b + \sigma_g \leq 3.0f$	$\sigma_{e\_surface} \leq 3.0f$ 1), 2), 3)	See (B) and (C)

where:

$\sigma_{e\_membrane}$ is element equivalent stress derived from the stress components at the mid layer/thickness of the element.

$\sigma_{e\_surface}$ is element equivalent stress derived from the stress components at the top and bottom layer/surface of the element, whichever is greater.

Note:

1) For accident and testing load conditions, the allowable stresses can be modified according to 4.23.5.2 and 4.23.6.1 of the Code.

2) The factor f is defined in 4.23.3 of the Code.

3) For the criterion $\leq 3.0f$, it should be carefully evaluated especially for materials with under matched weld properties. In such cases, the transverse weld tensile strength should not be less than the actual yield strength of the parent metal, the respective R_e and R_m of the weld, after any applied heat treatment, should be used.

4.28.5 Buckling assessment of type C cargo tanks for ships constructed on or after [1 July 2028]

4.28.5.1 General

4.28.5.1.1 The buckling assessment of type C cargo tanks should be carried out in accordance with a recognized pressure vessel standard acceptable to the Administration or recognized organization acting on its behalf. The selected standard should be used for design and fabrication. The scantlings of a type C tank subject to external pressure should not be less than the value required by the formulas in 4.28.5.2.

4.28.5.1.2 The lateral buckling of stiffening ring should be considered additionally in accordance with international standards (e.g. PD 5500) or equivalent regulations.

4.28.5.1.3 For novel configurations where the requirements given in this subsection or recognized standards are not applicable, more advanced buckling assessment methods may be used, as deemed appropriate by the Administration.

4.28.5.1.4 Non-linear finite element analysis, considering geometrical and material non-linearity, may be accepted as an advanced method, provided that the buckling capacity reflects the plate edge misalignment, ovality and deviation from true circular form over a specified arc or chord length.

4.28.5.2 Scantling of shells and stiffening rings under external pressure

4.28.5.2.1 For cylindrical shell, the critical buckling pressure P_c, in MPa, may be taken as:

$$P_c = \frac{1}{3} \cdot \left[n^2 - 1 + \frac{2n^2 - 1 - \nu}{n^2 \cdot \left(\frac{2L}{\pi D}\right)^2 - 1} \right] \cdot \frac{2E}{(1-\nu^2)} \cdot \left(\frac{t}{D}\right)^3 + \frac{2E \cdot \frac{t}{D}}{(n^2 - 1) \cdot \left[n^2 \cdot \left(\frac{2L}{\pi D}\right)^2 + 1 \right]^2}$$

where:

D = outside diameter of the cylindrical shell, in mm, based on gross scantling

t = net thickness of the cylindrical shell, in mm, exclusive of corrosion allowance

E = Young's modulus, in N/mm^2

v = Poisson's ratio

n = number of circumferential buckling waves. It is to be taken as the integral value to minimize the critical pressure P_c with $n \geq Max\left(2, \frac{\pi D}{2L}\right)$.

L = effective distance between stiffening rings, in mm

4.28.5.2.2 For spherical shells, such as hemispherical, torispherical and ellipsoidal ends, the critical buckling pressure P_c, in MPa, may be taken as:

$$P_c = 1.21 \cdot \mathrm{E} \cdot \left(\frac{t}{R}\right)^2$$

where:

R = outside radius of the sphere shell, in mm, based on gross scantling
E = Young's modulus, in N/mm^2

t = net thickness of the spherical shell, in mm, exclusive of corrosion allowance

The critical buckling pressure formula for the spherical shell above should be used for hemispherical, torispherical and ellipsoidal tank ends, where R is taken as the outside radius of the corresponding spherical shell for hemispherical and tori spherical tank ends, and the maximum outside radius of the crown for an ellipsoidal tank end, i.e. D2/(4h), where h is the external height of the tank end measured based on gross scantling from the connection plane between the cylindrical shell and tank end.

4.28.5.2.3 For stiffening ring, the moment of inertia I, in mm^4, should not be less than

$$I = \frac{0.18 \cdot D^3 \cdot L \cdot P_e}{E}$$

where:

D = outside diameter of the cylindrical shell, in mm, based on gross scantling

E = Young's modulus, in N/mm^2

L = effective distance between stiffening rings, in mm

P_e = external design pressure, in MPa

The width of shell, in mm, contributing to the moment of inertia should not be greater than $0.75\sqrt{Dt}$, where t=net thickness of the cylindrical shell, in mm, exclusive of corrosion allowance.

4.28.5.2.4 Cylindrical and spherical shells should satisfy the following criteria:

$\frac{P_c}{P_e} \geq 4$ for cylindrical shell

$\frac{P_c}{P_e} \geq 15$ for spherical shell

where:

P_c = critical buckling pressure, in MPa

P_e = external design pressure, in MPa."

CHAPTER 5
PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR AND PRESSURE PIPING SYSTEMS

5.2 System requirements

5.2.2 Arrangements: general

20 Paragraph 5.2.2.1 and sub-paragraph .1 are amended, as follows:

"5.2.2.1 Any piping system addressed in 5.1.1 that may contain cargo liquid or vapour shall:

.1 be segregated from other piping systems, except where interconnections are required for cargo-related operations such as purging, gas freeing or inerting. The requirements of 9.4.4 and 16.4.1.5 shall be taken into account with regard to preventing back-flow of cargo. In such cases, precautions shall be taken to ensure that cargo or cargo vapour cannot enter other piping systems through the interconnections;"

21 The following new sub-paragraph 5.2.2.1.2 is inserted after sub-paragraph 5.2.2.1.1 and subsequent sub-paragraphs are renumbered accordingly.

".2 notwithstanding .1 above, ships operating in fixed locations, in a re-gasification and gas discharge mode or a gas receiving, processing, liquefaction and storage mode are not considered as vessels "at sea" with regard to sub-paragraph .6 of this paragraph. Cargo piping only operated in fixed locations (example: re-gasification systems and its piping) and kept depressurized inerted and isolated at sea, other than athwartship shore connection piping or emergency cargo jettisoning piping systems, may also be located outboard of the transverse tank location requirements of 2.4.1, but not closer than a minimum distance of 0.8 metre from the ship outer shell;"

5.4 Design pressure

22 Paragraph 5.4.4 is amended, as follows:

"5.4.4 The design pressure of the outer pipe or duct of gas fuel systems shall not be less than the maximum ~~working~~ built-up pressure ~~of the inner gas pipe. Alternatively, for gas fuel piping systems with a working pressure greater than 1 MPa, the design pressure of the outer duct shall not be less than the maximum built-up pressure arising in the annular space considering the local instantaneous peak pressure in way of any rupture and the ventilation arrangements.~~ arising in the annular space considering the local instantaneous peak pressure in way of any rupture and a suitable pressure relief system shall be considered in the design:

.1 for gas fuel systems with inner pipe working pressures not greater than 1 MPa, the maximum built-up pressure arising in the annular space, after the inner pipe rupture shall not be less than the maximum working pressure of inner gas pipe; and

.2 for ships constructed on or after [1 July 2028], for gas fuel systems with inner pipe having a working pressure greater than 1 MPa, the maximum built-up pressure arising in the annular space, after the inner pipe rupture, shall be calculated in accordance with paragraph 5.11.4.2."

5.5 Cargo system valve requirements

23 The following new paragraph 5.5.1.3 is added after existing paragraph 5.5.1.2:

"5.5.1.3 For ships constructed on or after [1 July 2028], in addition, remotely operated valves shall be fitted, as appropriate, as part of the emergency shutdown (ESD) system (see paragraph 18.10)."

5.5.2 Cargo tank connections

24 Paragraph 5.5.2.1 is amended, as follows:

"5.5.2.1 All liquid and vapour connections, except for safety relief valve~~s~~ inlet and discharge lines, and liquid level gauging devices, shall have shut-off valves located as close to the tank as practicable. These valves shall provide full closure and shall be capable of local manual operation. ~~They may also be capable of remote operation.~~

25 The following new paragraph is added after the existing paragraph 5.5.2.2, as follows:

"5.5.2.3 For ships constructed on or after [1 July 2028], all liquid and vapour connections, except for safety relief valve inlet and discharge lines and liquid level gauging devices, shall be equipped with remotely controlled ESD valves, located as close to the tank as practicable. Such ESD valves shall comply with the requirements of 18.10.2 and provide full closure of the line. A single valve may be substituted for the two separate valves, provided the valve complies with the requirements of 18.10.2 and provides full closure of the line."

5.5.3 Cargo manifold connections

26 Paragraph 5.5.3 is amended, as follows:

"5.5.3.1 One remotely controlled ESD valve shall be provided at each cargo transfer connection ~~in use~~ to stop liquid and vapour transfer to or from the ship. Transfer connections not in use shall be isolated with suitable blank flanges.

5.5.3.2 If the cargo tank MARVS exceeds 0.07 MPa, an additional manual valve shall be provided for each transfer connection ~~in use~~, and may be inboard or outboard of the ESD valve to suit the ship's design.

5.5.3.3 For ships constructed on or after [1 July 2028], in addition to the ESD valve, a manual valve shall be provided for each liquid connection. A manual valve shall also be provided for vapour connections where cargo tank MARVS exceeds 0.07 MPa. The manual valves may be located inboard or outboard of the ESD valve to suit the ship's design."

5.6 Cargo transfer arrangements

5.6.5 Cargo sampling connections

27 Paragraph 5.6.5.1 is amended, as follows:

"5.6.5.1 Connections to cargo piping systems for taking cargo liquid samples, if fitted on board, shall be clearly marked and shall be designed to minimize the release of cargo vapours. For vessels permitted to carry toxic products, the sampling system, if fitted on board, shall be of a closed loop design to ensure that cargo liquid and vapour are not vented to atmosphere. Connections used for control of atmosphere in cargo tanks during inerting or gassing up are not considered as cargo sampling connections."

5.6.6 Cargo filters

28 Paragraph 5.6.6 is amended, as follows:

"**5.6.6 Cargo filters**

5.6.6.1 The cargo liquid and vapour systems shall be capable of being fitted with filters to protect against damage by extraneous objects. Such filters may be permanent or temporary, and the standards of filtration shall be appropriate to the risk of debris, etc., entering the cargo system. Means shall be provided to indicate that filters are becoming blocked, and to isolate, depressurize and clean the filters safely.

5.6.6.2 Means to indicate that filters are becoming blocked and filter maintenance is required shall be provided for fixed in-line filter arrangement and portable filter installations where dedicated filter housing piping is provided. Where portable filters for fitting to manifold presentation flanges are used without dedicated filter housing, and these can be visually inspected after each loading and discharging operation, no additional arrangements for indicating blockage or facilitating drainage are required."

5.11 Piping system component requirements

29 Paragraph 5.11.2.2 is amended, as follows:

"5.11.2.2 The minimum wall thickness ~~of pipes~~ shall ~~not be less than~~ be calculated as follows:

$$t = \frac{t_0 + b + c}{1 - \frac{|a|\ \cancel{a}}{100}}\ (mm)$$

where:

t_0 = theoretical thickness, determined by the following formula

$$t_0 = \frac{P \cdot D}{2 \cdot K \cdot e + P}\ (mm)$$

with:

P = design pressure (MPa) referred to in 5.4;

D = outside diameter (mm);

K = allowable stress (N/mm²) referred to in 5.11.3; and

e = efficiency factor equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by approved manufacturers of welded pipes, that are considered equivalent to seamless pipes when non-destructive testing on welds is carried out in accordance with recognized standards. In other cases, an efficiency factor of less than 1.0, in accordance with recognized standards, may be required depending on the manufacturing process;

b = allowance for bending (mm). The value of b shall be chosen so that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress. Where such justification is not given, b shall be:

$$b = \frac{D \cdot t_0}{2.5 \cdot r}$$

with:

r = mean radius of the bend (mm);

c = corrosion allowance (mm). If corrosion or erosion is expected, the wall thickness of the piping shall be increased over that required by other design requirements. This allowance shall be consistent with the expected life of the piping; and

a = negative manufacturing tolerance for thickness (%), i.e. where a is the manufacturing tolerance of –5%, |a| is equal to 5 and shall be entered into the formula as 1– (5/100)."

5.11.4 High-pressure gas fuel outer pipes or ducting scantlings

30 Paragraph 5.11.4 is amended, as follows:

"**5.11.4 High-pressure gas fuel outer pipes or ducting scantlings**

5.11.4.1 In fuel gas piping systems of design pressure greater than the ~~critical~~ peak pressure, the tangential membrane stress of a straight section of pipe or ducting shall not exceed the tensile strength divided by 1.5 (R_m /1.5) when subjected to the design pressure specified in 5.4. The pressure ratings of all other piping components shall reflect the same level of strength as straight pipes. For ships constructed on or after [1 July 2028], the peak pressure shall be calculated in accordance with 5.11.4.2.

5.11.4.2 For ships constructed on or after [1 July 2028], for inner pipes having a working pressure greater than 1 MPa, the design pressure of the outer pipe or the duct shall be taken as the higher of the following:

.1 The maximum built-up pressure: static pressure in way of the rupture resulting from the gas flowing in the annular space;

.2 the local instantaneous peak pressure in way of the rupture is given by the following expression:

$$p = p_0 \cdot \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}}$$

where:

p_0 = maximum working pressure of the inner pipe (absolute pressure)

k = C_p/C_v constant pressure specific heat divided by the constant volume specific heat

As an alternative to the above formula, the peak pressure found from representative tests can be used. Tests reports shall then be submitted."

5.11.6 Flanges, valves and fittings

31 Paragraph 5.11.6.1 is amended, as follows:

"5.11.6.1 Flanges, valves, bellows expansion joints and other fittings shall comply with recognized standards, taking into account the material selected and the design pressure defined in 5.4. For ships constructed before [1 July 2028], bellows expansion joints used in vapour service, a lower minimum design pressure may be accepted, except for any new installation or replacement."

5.12 Materials

32 Paragraph 5.12.4 is amended, as follows:

"~~5.12.4~~ 5.12.3 Where the cargo piping system is ~~of a material susceptible to stress corrosion cracking in the presence of~~ located in a salt-laden atmosphere, including on the exposed deck, adequate measures to avoid ~~this~~ corrosion and stress corrosion cracking occurring shall be taken by ~~considering~~ material selection~~,~~ and protection ~~of~~ against exposure to salt~~y~~ water ~~and/or readiness for inspection~~. For ships constructed on or after [1 July 2028], the following shall apply:

.1 use of stainless steel having a pitting resistance equivalent number (PREN = 1 • %Cr + 3.3 (%Mo + 0.5 • %W) + 16 • %N) more than 22, such as 316/316L; or

.2 use of stainless steel not meeting the above requirements, such as 304/304L provided the piping is protected by a coating system suitable for the intended service conditions, including cryogenic temperature–ultraviolet solar radiation; or

.3 use of other materials permitted by table 6.4 of the IGC Code, protected by a coating system suitable for the intended service conditions, including cryogenic temperature–ultraviolet solar radiation."

5.12.3 Cargo piping insulation system

33 Section 5.12.3, and paragraphs 5.12.3.1 and 5.12.3.2 therein are amended, as follows:

"**~~5.12.3~~ 5.12.4 Cargo piping insulation system**

~~5.12.3.1~~ 5.12.4.1 Cargo piping systems shall be provided with a thermal insulation system as ~~required~~ necessary to minimize heat leak into the cargo during transfer operations and to protect personnel from direct contact with cold surfaces.

For ships constructed on or after [1 July 2028], the requirements in sub-paragraphs .1 and .2 below shall be complied with to address cold or hot surfaces:

.1 The properties of the piping insulation shall be considered when calculating the heat balance of the containment system and capacity of the pressure/temperature control system.

.2 Surfaces of cargo piping, process pressure vessels, and equipment with which personnel are likely to contact under normal conditions shall be protected by thermal insulation, except for the following:

.1 surfaces which are protected by physical screening measures to prevent direct contact;

.2 surfaces of manual valves having extended spindles that protect the operator from the cargo temperature;

.3 surfaces whose design temperature, based on inner fluid temperature, is above –10°C and below 60°C; and

.4 surfaces located where contact by personnel is unlikely under normal conditions based on recognized standards, preferably more than 2.0 m vertically and/or 0.6 m horizontally away from walkways or floors of working areas.

~~5.12.3.2~~ 5.12.4.2 Where applicable, owing to location or environmental conditions, insulation materials shall have suitable properties of resistance to fire and flame spread and shall be adequately protected against penetration of water vapour and mechanical damage."

5.13 Testing requirements

5.13.1 Type testing of piping components

34 Paragraph 5.13.1.1 is amended, as follows:

"5.13.1.1 *Valves**

Each type of valve intended to be used at a working temperature below -55°C shall be subject to the following type tests:

.1 each size and type of valve shall be subjected to seat tightness testing over the full range of operating pressures for bi-directional flow and temperatures, at intervals, up to the rated design pressure of the valve. Allowable leakage rates shall be to the requirements of the Administration or recognized organization acting on its behalf. During the testing, satisfactory operation of the valve shall be verified;

.2 the flow or capacity shall be certified to a recognized standard for each size and type of valve~~;~~, which annotates that:

.1 for pressure relief valves (PRVs) that are subject to paragraph 8.2.6, the flow or capacity shall be certified by the Administration or recognized organization acting on its behalf; and

.2 for other types of valves, the manufacturer shall certify the flow properties of the valves based on tests carried out according to recognized standards;

.3 pressurized components shall be pressure tested to at least 1.5 times the rated pressure; and

.4 for emergency shutdown valves, with materials contributing to shell or seat tightness of the valve having melting temperatures lower than 925°C, the type testing shall include a fire test to a standard acceptable to the Administration.

____

* Refer to SIGTTO Publication on "*The Selection and Testing of Valves for LNG Applications*"."

5.13.2 System testing requirements

35 Paragraph 5.13.2.1 is amended, as follows:

"5.13.2.1 The requirements of this section shall apply to piping inside and outside the cargo tanks. However, the Administration may accept relaxations from these requirements for open-ended piping and piping inside cargo tanks, except pumps discharge lines."

36 Paragraph 5.13.2.4 is amended, as follows:

"15.13.2.4 In double-wall gas-fuel piping systems, the outer pipe or duct shall also be pressure tested to show that it can withstand the expected maximum pressure at gas pipe rupture. The maximum pressure at gas pipe rupture is the maximum pressure to which the outer pipe or duct is subjected after the inner pipe rupture and for testing purposes it is the same as the design pressure used in paragraph 5.4.4."

CHAPTER 8
VENT SYSTEMS FOR CARGO CONTAINMENT

8.1 General

37 Section 8.1 is amended, as follows:

"**8.1 General**

8.1.1 All cargo tanks shall be provided with a pressure relief system appropriate to the design of the cargo containment system and the cargo being carried. Hold spaces and inter-barrier spaces, which may be subject to pressures beyond their design capabilities, shall also be provided with a suitable pressure relief system. Pressure control systems specified in chapter 7 shall be independent of the pressure relief systems.

8.1.2 For ships constructed on or after [1 July 2028], inter-barrier spaces which may be subject to pressures beyond their design capabilities, shall also be provided with a suitable pressure relief system, as defined below:

.1 The formula for determining the relieving capacity given in 8.2.5 is for inter-barrier spaces surrounding independent type A cargo tanks, where the thermal insulation is fitted to the cargo tanks.

.2 The relieving capacity of pressure relief devices of inter-barrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in 8.2.5. However, the leakage rate shall be determined in accordance with paragraph 4.7.2.

.3 The relieving capacity of pressure relief devices for inter-barrier spaces of membrane and semi-membrane tanks shall be evaluated on the basis of specific membrane/semi-membrane tank design.

.4 The relieving capacity of pressure relief devices for inter-barrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks."

8.2 Pressure relief systems

38 The following new paragraph is inserted after existing paragraph 8.2.4 and the subsequent paragraphs, figures and cross references to those figures in this chapter are renumbered accordingly:

"8.2.5 For ships constructed on or after [1 July 2028], the combined relieving capacity of the pressure relief devices for inter-barrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks may be determined by the following formula:

$$Q_{sa} = 3.4 \cdot A_c \cdot \frac{\rho}{\rho_v} \cdot \sqrt{h}$$

where:

Q_{sa} = minimum required discharge rate of air (m^3/s) at standard conditions of 273 K and 1.013 bar

A_c = design crack opening area (m^2)

$$A_c = \pi/4 \cdot \delta \cdot l$$

δ = max, crack opening width (m)

δ = 0.2 t (m)

t = thickness of tank bottom plating (m)

l = design crack length (m) equal to the diagonal of the largest plate panel of the tank bottom, see figure 8.1.

h = max liquid height above tank bottom plus 10.MARVS (m)

ρ = density of product liquid phase (kg/m^3) at the set pressure of the inter-barrier space relief device

ρ_V = density of product vapour phase (kg/m^3) at the set pressure of the inter-barrier space relief device and a temperature of 273 K

MARVS = max allowable relief valve setting of the cargo tank (bar).

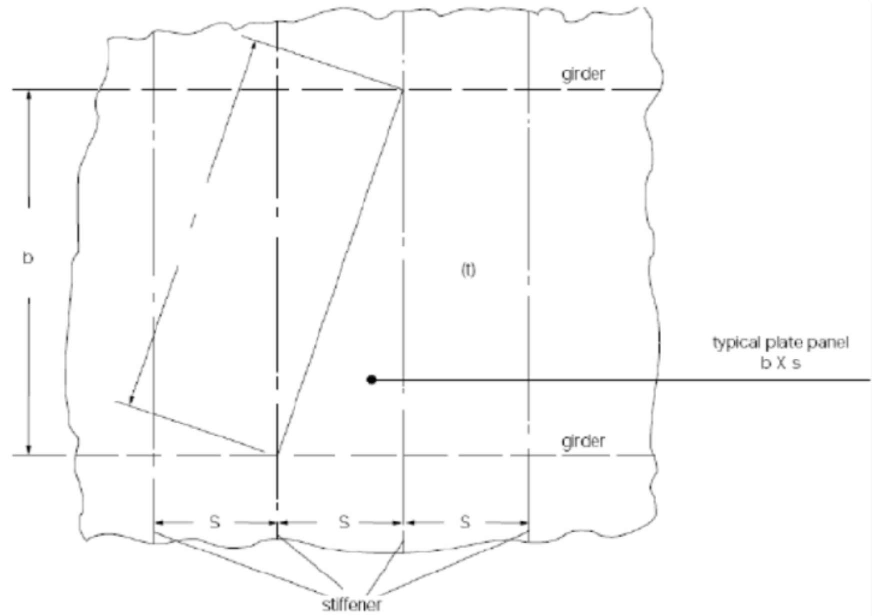

Figure 8.1"

39 Renumbered paragraph 8.2.10 is amended, as follows:

"8.2.~~9~~10 In the event of a failure of a cargo tank-installed PRV, a safe means of emergency isolation shall be available:

.1 Procedures shall be provided and included in the cargo operations manual (see 18.2).

.2 The procedures shall allow only one of the cargo tank installed PRVs to be isolated. For ships constructed on or after [1 July 2028], if an isolation valve is installed, a mechanical locking system shall be used to prevent full or partial isolation so that only one of the cargo tank-installed PRVs can be isolated. If the PRVs are fitted with a remotely sensed pilot line, an isolation valve shall also be fitted with a locking system synchronized with the locking system of the isolation of the main PRV.

.3 For ships constructed on or after [1 July 2028], if an isolation valve is installed, safe means to depressurize the trapped cargo between that isolation valve and PRV shall be provided.

~~.3~~ .4 Isolation of the PRV shall be carried out under the supervision of the master. This action shall be recorded in the ship's log and a sign posted in the cargo control room, if provided, and at the PRV.

~~.4~~ .5 The tank shall not be loaded until the full relieving capacity is restored."

40 Renumbered paragraph 8.2.19 is amended, as follows:

"8.2.~~18~~19 The adequacy of the vent system ~~fitted on tanks loaded in accordance with 15.5.2~~ designed for two phase flow for tanks having a MARVS above 0.07 MPa shall be demonstrated, taking into account the recommendations developed by the Organization.* A relevant certificate shall be permanently kept on the ship. For the purpose~~s~~ of this paragraph, vent system means:

.1 the tank outlet and the piping to the PRV;

.2 the PRV; and

.3 the piping from the PRV~~s~~ downstream to the location of the discharge to the atmosphere, including any interconnections and piping that joins other tanks.

This paragraph need not apply when the reference temperature is defined in accordance with 15.1.3.1.

---

* Refer to the *Guidelines for the evaluation of the adequacy of type C tank vent systems* (resolution A.829(19))."

8.4 Sizing of pressure relieving system

8.4.1 Sizing of pressure relief valves

41 The following new paragraph is added after existing paragraph 8.4.1.3:

"8.4.1.4 For ships constructed on or after [1 July 2028], for prismatic tanks, vapours generated under fire exposure shall be computed using the formula given in paragraph 8.4.1.2 and the following formula variables:

.1 For non-tapered tanks, L_{min} is the smaller of the horizontal dimensions of the flat bottom of the tank. For tapered tanks, as would be used for the forward tank, L_{min} is the smaller of the length and the average width.

.2 For prismatic tanks whose distance between the flat bottom of the tank and bottom of the hold space is equal to or less than $L_{min}/10$:

A = external surface area minus flat bottom surface area.

.3 For prismatic tanks whose distance between the flat bottom of the tank and bottom of the hold space is greater than $L_{min}/10$:

A = external surface area. "

42 Paragraphs 8.4.2 and 8.4.3 are amended, as follows:

"**8.4.2 Sizing of vent ~~pipe~~ system**

8.4.2.1 Pressure losses upstream and downstream of the PRVs shall be taken into account when determining ~~their~~ the pipe size and routeing to ensure the flow capacity required by 8.4.1.

8.4.2.2 For ships constructed on or after [1 July 2028], the inclusion of isolation valves in which the flow area of the valve is equal to or larger than the inlet flow area of the pressure relief device and does not affect the PRV flow, capacity and stability are acceptable.

8.4.3 Upstream pressure losses

8.4.3.1 The pressure ~~drop~~ losses in the vent line from the tank to the PRV inlet shall not exceed 3% of the valve set pressure at the calculated flow rate, in accordance with 8.4.1. For ships constructed on or after [1 July 2028], the compliance shall be documented by flow calculations.

8.4.3.2 Pilot-operated PRVs shall be unaffected by inlet pipe pressure losses when the pilot senses directly from the tank dome. For ships constructed on or after [1 July 2028], pilot-operated PRV sensing lines shall be sized to avoid pressure losses which affect the function of the PRV. The sensing line shall be self-draining and free from liquid pockets.

~~8.4.3.3 Pressure losses in remotely sensed pilot lines shall be considered for flowing type pilots.~~"

43 Paragraph 8.4.5 is amended, as follows:

"8.4.5 To ensure stable PRV operation, the blow-down shall not be less than the sum of the inlet pressure loss and 0.02 MARVS at the rated capacity. This limitation does not apply to pilot-operated PRV fitted with a remote sensing line if confirmed by the PRV manufacturer."

CHAPTER 9
CARGO CONTAINMENT SYSTEM ATMOSPHERE CONTROL

9.4 Inerting

44 Paragraph 9.4.6 is amended, as follows:

"9.4.6 Where insulation spaces are continually supplied with an inert gas as part of a leak detection system, effective means shall be provided to monitor the quantity of gas being supplied to each individual space."

45 The following new paragraph 9.4.7 is added after existing paragraph 9.4.6:

"9.4.7 For ships constructed on or after [1 July 2028], abnormal flow of inert gas in leak detection system shall trigger audible and visible alarms at the locations specified in 13.6.13. The alarm(s) set points shall be defined by the designer and accepted by the Administration or recognized organization acting on its behalf with due consideration of the operational pressure which shall be maintained in the space and flow rate(s) necessary for reliable gas leak detection."

CHAPTER 10
ELECTRICAL INSTALLATIONS

10.2 General requirements

46 Paragraph 10.2.6 is amended, as follows:

"10.2.6 Electrical generation and distribution systems, ~~and associated control systems~~ including their control systems, shall be designed such that a single fault will not result in the loss of ability to maintain cargo tank pressures, as required by 7.8.1, and hull structure temperature, as required by 4.19.1.6, within normal operating limits. Failure modes and effects shall be analysed and documented to a standard not inferior to those acceptable to the Administration.*

* IEC 60812, Edition 2.0 2006-01 "Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)""

47 Paragraph 10.2.8 is amended, as follows:

"10.2.8 Electronic devices which are not of certified safe type, including ~~Electrical~~ depth sounding or log devices, radar and impressed current cathodic protection system anodes ~~or electrodes~~, if located in the hazardous areas, shall be housed in gastight enclosures."

CHAPTER 11
FIRE PROTECTION AND EXTINCTION

11.1 Fire safety requirements

48 Paragraph 11.1.4 is amended, as follows:

"11.1.4 For the purposes of fire-fighting, any weather deck areas above cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space shall be included in the cargo area. For ships constructed on or after [1 July 2028], where F.O. tanks are installed at the after end of the aftermost hold space or at the forward end of the forwardmost hold space instead of cofferdams as allowed for in paragraphs 3.1.2 and 3.1.3, the weather deck area above these tanks shall be regarded as a cargo area for the purpose of applying paragraph 11.3.6."

11.2 Fire mains and hydrants

49 The following new paragraphs are added after existing paragraph 11.2.5:

"11.2.6 For ships constructed on or after [1 July 2028], the maximum capacity of emergency fire pump shall be calculated in accordance with this paragraph.

11.2.6.1 If all the fire pumps (required in accordance with SOLAS regulation II-2/10.2.2.2.2) mentioned in paragraph 11.3.4, supplying the water spray system (for covering the superstructures and deckhouses) are disabled owing to a fire in any one compartment, then the emergency fire pump shall be sized to cover:

.1 the water spray system for the boundaries of the superstructures and deckhouses, and lifeboats, liferafts and muster areas facing the cargo area, (as required in paragraph 11.3.4); and

.2 two fire hydrants (as required in paragraph 11.2).

11.2.6.2 When the ship is also fitted with a fixed high-expansion foam fire-extinguishing system or a fixed pressure water-spraying fire- extinguishing system protecting the engine-room (to comply with SOLAS regulation II-2/10.4.1.1.2 or SOLAS regulations II-2/10.4.1.1.3 and 10.5.1.1) and the emergency fire pump is intended to supply seawater to this system, the emergency fire pump shall also be sized to cover the fixed high-expansion foam fire-extinguishing system or the fixed pressure water-spraying fire-extinguishing system for dealing with an engine-room fire, if the main fire pumps are disabled owing to a fire in any one compartment.

11.2.6.3 On the basis of the principle of dealing with a single fire incident at a time, the emergency fire pump does not need to be sized to cover all systems in paragraph 11.2.6.1 and paragraph 11.2.6.2 above at the same time and shall need only be sized to cover the most demanding area and required systems, as follows:

.1 the fixed high-expansion foam fire-extinguishing system or the fixed pressure water-spraying fire-extinguishing system (as required in paragraph 11.2.6.2) and two hydrants (as required in paragraph 11.2.6.1.2); or

.2 the water spray system and two hydrants (as required in paragraph 11.2.6.1),

whichever is greater."

11.3 Water-spray system

50 The following new sub-paragraph is added after existing sub-paragraph 11.3.1.7, the word "and" at the end of existing paragraph 11.3.1.7 is deleted, and existing sub-paragraph 11.3.1.8 is renumbered as 11.3.1.9:

".8 remote survival crafts facing cargo area, taking into consideration cargo area extension for fire-fighting purposes as stated in paragraph 11.1.4. Remote liferafts located in areas covered by the water-spraying system as required in .6 shall be considered as adequately protected; and"

51 Paragraph 11.3.2.2 is amended, as follows:

"11.3.2.2 On vertical surfaces and for structures not having clearly defined horizontal or vertical surfaces, spacing of nozzles protecting lower areas may take account of anticipated rundown from higher areas. Stop valves shall be fitted in the main supply line(s) in the water-spray system, at intervals not exceeding 40 m, 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 outside the cargo area. A section protecting any area included in 11.3.1.1 and 11.3.1.2 shall cover at least the entire athwartship tank grouping in that area. Any gas process unit(s) included in 11.3.1.3 may be served by an independent section."

52 Paragraph 11.3.3 is amended, as follows:

"11.3.3 The capacity of the water-spray pumps shall be capable of simultaneous protection of the greater of the following:

.1 any two complete ~~athwartship~~ tank groupings, where one group is defined as tanks located in transverse direction from ship side to ship side, representing an area equal to the combined area of the largest tank groupings, including any gas process units within these areas. Where there is only one cargo tank occupying a hold space from ship side to ship side, it will be considered as a grouping for the purpose of the above requirement; or

.2 for ships intended for operation as listed in 1.1.10, necessary protection subject to special consideration under 11.3.1 of any added fire hazard and the adjacent athwartship tank grouping,

in addition to the surfaces specified in 11.3.1.4 to 11.3.1.~~8~~9. Alternatively, the main fire pumps may be used for this service, provided that their total capacity is increased by the amount needed for the water-spray system. In either case, a connection, through a stop valve, shall be made between the fire main and water-spray system main supply line outside the cargo area."

53 Paragraph 11.3.4 is amended, as follows:

"11.3.4 The boundaries of normally manned superstructures and deckhouses, and lifeboats, liferafts and muster areas facing the cargo area, shall also be capable of being served by one of the fire pumps (required in accordance with SOLAS regulation II-2/10.2.2.2.2) or the emergency fire pump, if a fire in one compartment could disable both fire pumps (required in accordance with SOLAS regulation II-2/10.2.2.2.2).

11.3.4.1 For ships constructed on or after [1 July 2028], in cases where the emergency fire pump is used to meet paragraph 11.3.4, its capacity, in addition to being capable of maintaining two jets of water as required by paragraph 12.2.2.1.1 of the FSS Code, shall be increased taking into account the spray application rates stated in paragraph 11.3.2.1, but limiting coverage to boundaries of normally manned superstructures and deckhouses, survival crafts and their muster areas. Also, see paragraph 11.2.6 for requirements regarding maximum capacity calculation for emergency fire pump.

11.3.4.2 For ships constructed on or after [1 July 2028], fire pumps and emergency fire pumps required by SOLAS regulation II-2/10.2.2 and used to comply with 11.3.4 shall be installed outside the space where water-spray pump(s) are located.

11.3.4.3 For ships constructed on or after [1 July 2028], the compartment in paragraph 11.3.4 is a compartment provided with A class boundaries in which the fire pump(s), or the source of power of the fire pump(s), serving the water-spray system in accordance with paragraph 11.3.3, are located."

54 Paragraph 11.3.6 is amended, as follows:

"11.3.6 All pipes, valves, nozzles and other fittings in the water-spray system shall be resistant to corrosion by seawater. Piping, fittings and related components within the cargo area (except gaskets) shall be designed to withstand 925°C. The water-spray system shall be arranged with in-line filters to prevent blockage of pipes and nozzles. In addition, means shall be provided to flush or back-flush the system with fresh water to prevent any blockages."

55 The following new paragraph 11.3.8 is added after existing paragraph 11.3.7 and existing paragraph 11.3.8 is renumbered as paragraph 11.3.9:

"11.3.8 For ships constructed on or after [1 July 2028], when isolating valves are fitted in the water-spray system to maintain the required water supply in the case that the system is fed from the emergency fire pump as indicated by 11.3.4, the operating position of the isolating valves shall be located outside the cargo area, so that they are readily accessible and, for valves that are normally closed, located in accordance with 11.3.7."

11.4 Dry chemical powder fire-extinguishing systems

56 The following new paragraph 11.4.8.1 is added after existing paragraph 11.4.8:

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

CHAPTER 12
ARTIFICIAL VENTILATION IN THE CARGO AREA

12.1 Spaces required to be entered during normal cargo handling operations

57 The following new paragraph is added after existing paragraph 12.1.1, together with the associated footnote:

"12.1.1.1 For ships constructed on or after [1 July 2028], electric motor rooms located outside the cargo area defined by 1.2.7 shall comply with requirements for separation of non-hazardous areas and hazardous areas, including 12.1.10, and be designed in accordance with specifications not inferior to standards acceptable to the Organization.*

* Refer to the recommendations published by the International Electrotechnical Commission (IEC 60092-502:1999)."

58 Paragraph 12.1.8 is amended, as follows:

"12.1.8 Where fans are required by this chapter, full required ventilation capacity for each space shall be available after failure of any single fan, or spare parts shall be provided for at least one entire fan of each type, comprising a motor, starter spares and complete rotating element, including shaft and bearings. Full ventilation capacity shall be restored before use of the space for operational purposes."

12.2 Spaces not normally entered

59 Paragraph 12.2.2 is amended, as follows:

"12.2.2 For permanent installations, the capacity of 8 air changes per hour shall be provided and for portable systems, the capacity of 16 air changes per hour shall be provided. Accessed hold spaces and cofferdams shall be provided with ventilation not less than the capacity of 2 air changes per hour, subject to meeting the requirements of 18.8."

CHAPTER 13
INSTRUMENTATION AND AUTOMATION SYSTEMS

13.2 Level indicators for cargo tanks

60 Paragraph 13.2.2 is amended, as follows:

"13.2.2 Where only one liquid level gauge is fitted, it shall be arranged so that it can be maintained in an operational condition without the need to empty or gas free the tank. Any part of this level gauge, other than components not subject to failure under normal service, shall be capable of being repaired with the tank in service."

13.3 Overflow control

61 Paragraph 13.3.1 is amended, as follows:

"13.3.1 ~~Except as provided in 13.3.4,~~ ~~e~~Each cargo tank shall be fitted with an independent high liquid level alarm ~~operating independently of other liquid level indicators and~~ giving an audible and visual warning when activated."

62 Paragraph 13.3.2 is amended, as follows:

"13.3.2 An additional independent sensor ~~operating independently of the high liquid level alarm~~ shall automatically actuate a shut-off valve in a manner that will both avoid excessive liquid pressure in the loading line and prevent the tank from becoming liquid full."

63 The following new paragraph 13.3.3 is inserted after existing paragraph 13.3.2 and the subsequent paragraphs are renumbered accordingly:

"13.3.3 For ships constructed on or after [1 July 2028], the sensors in 13.3.1 and 13.3.2 shall be independent from other liquid level indicators."

64 Renumbered paragraph 13.3.4 is amended, as follows:

"13.3.4 ~~The~~ An emergency shutdown valve referred to in 5.5.2 and 18.10 may be used for this purpose. If another valve is used for this purpose, the same information as referred to in 18.10.2.1.3 shall be available on board. During loading, whenever the use of these valves may possibly create a potential excess pressure surge in the loading system, alternative arrangements such as limiting the loading rate shall be used."

65 Existing paragraphs 13.3.4 and 13.3.5 are amended as follows:

"13.3.~~4~~9 For ships constructed before [1 July 2028], a~~A~~ high liquid level alarm and automatic shut-off of cargo tank filling need not be required, when the cargo tank:

.1 is a pressure tank with a volume of not more than 200 m^3; or

.2 is designed to withstand the maximum possible pressure during the loading operation, and such pressure is below that of the set pressure of the cargo tank relief valve.

13.3.5 ~~The position of the sensors shall be capable of being verified before commissioning. At the first occasion of full loading after delivery and after each dry-docking, testing of high-level alarms shall be conducted by raising the cargo liquid level in the cargo tank to the alarm point~~. The position of the sensors required by 13.3.1 and 13.3.2 shall be verified at each of the following occasions:

.1 at the first full cargo loading, or after the initial survey required in 1.4.2.1; and

.2 after each renewal survey required in 1.4.2.2.

Function testing of high-level alarms shall be conducted by raising the cargo liquid level in the cargo tank to the alarm point. Alternative equivalent function testing arrangements may be accepted, subject to the satisfaction of the Administration or recognized organization acting on its behalf."

66 The following new paragraph 13.3.8 is added after existing paragraph 13.3.7:

"13.3.8 The override system permitted by 13.3.7 may be used at sea to prevent false alarms or shutdowns. When level alarms are overridden, operation of cargo pumps and the opening of manifold ESD valves shall be inhibited except when high-level alarm testing is carried out in accordance with 13.3.5 (see 18.10.3.6)."

13.6 Gas detection

67 The following new paragraph is added after existing paragraph 13.6.4:

"13.6.4.1 For ships constructed on or after [1 July 2028], two oxygen sensors shall be positioned at appropriate locations in the space or spaces containing the inert gas system, in accordance with paragraph 2.2.4.5.4 in chapter 15 of the FSS Code, irrespective of the carriage of cargo indicated by an "A" in column "f" in the table in chapter 19 of the Code."

68 Paragraph 13.6.17 is amended, as follows:

"13.6.17 For other spaces described by 13.6.2, alarms shall be activated when the vapour concentration reaches 30% LFL and safety functions required by chapter 16 shall be activated before the vapour concentration reaches 60% LFL. Where required by 16.7.3.3, ~~T~~the crankcases of internal combustion engines that can run on gas shall be arranged to alarm before 100% LFL."

13.9 System integration

69 Paragraph 13.9.3 is amended, as follows:

"13.9.3 Key hazards of the integrated system based on combination and of computer-based technologies and interconnection of computer systems used for control, monitoring/alarm and safety systems for carriage, handling and conditioning of cargo liquid and vapours shall be identified using appropriate risk-based techniques. For ships constructed on or after [1 July 2028], such integrated systems shall ensure reliable communication between computer-based system components* and allow centralized access to monitoring/alarm and safety information and/or command/control.

* Refer to the *Guidelines for the onboard use and application of computers* (MSC/Circ.891)."

CHAPTER 15
FILLING LIMITS FOR CARGO TANKS

15.1 Definitions

70 Paragraph 15.1.3.1 is amended, as follows:

".1 when no cargo vapour pressure/temperature control, as referred to in chapter 7, is provided, or for products requiring a type 1G ship, the temperature corresponding to the vapour pressure of the cargo at the set pressure of the PRVs; and"

15.2 General requirements

71 Section 15.2 is amended, as follows:

"**15.2 General requirements**

15.2.1 The default value for the filling limit (FL) of cargo tanks is 98% at the reference temperature. Exceptions to this value shall meet the requirements of 15.3. The maximum filling limit of cargo tanks shall be so determined that the vapour space has a minimum volume at reference temperature allowing for:

.1 tolerance of instrumentation such as level and temperature gauges; and

.2 volumetric expansion of the cargo between the PRV set pressure and the maximum allowable rise stated in 8.4.~~; and~~

~~.3 an operational margin to account for liquid drained back to cargo tanks after completion of loading, operator reaction time and closing time of valves, see 5.5 and 18.10.2.1.4.~~

15.2.2 The ship shall be designed and operated in a manner to ensure the liquid level in the cargo tank shall not exceed the filling limit under all design conditions."

15.3 Default filling limit

72 Section 15.3 (Default filling limit) is deleted.

"~~**15.3 Default filling limit**~~

~~The default value for the filling limit (FL) of cargo tanks is 98% at the reference temperature. Exceptions to this value shall meet the requirements of 15.4.~~"

15.4 Determination of increased filling limit

73 Section 15.4 is renumbered as section 15.3 and amended, as follows:

"~~15.4~~ **15.3 Determination of increased filling limit**

15.3.1 This section does not apply to type C tanks or tanks with MARVS greater than 0.07 MPa except where it is verified and accepted by the Administration or recognized organization acting on its behalf that the risks associated with the higher design pressure of these tanks are properly mitigated taking into account the specific design features, including venting systems required in paragraph 8.2.18, of the individual tank.

~~15.4.1~~ 15.3.2 A filling limit greater than the limit of 98% specified in ~~15.3~~ 15.2.1 may be permitted under the trim and list conditions specified in 8.2.17, providing:

~~.1 no isolated vapour pockets are created within the cargo tank;~~

~~.2~~ .1 the PRV inlet arrangement shall remain in the vapour space; and

~~.3~~ .2 allowances shall be provided for:

.1 volumetric expansion of the liquid cargo due to the pressure increase from the MARVS to full flow relieving pressure in accordance with 8.4.1;

.2 an operational margin of a minimum 0.1% of tank volume; and

.3 tolerances of instrumentation such as level and temperature gauges.

~~15.4.2~~ 15.3.3 In no case shall a filling limit exceeding 99.5% at reference temperature be permitted."

15.5 Maximum loading limit

74 Section 15.5 is renumbered as section 15.4 and amended, as follows:

"~~15.5~~ **15.4 Maximum loading limit**

~~15.5.1~~ 15.4.1 The maximum loading limit (LL) to which a cargo tank may be loaded shall be determined by the following formula:

$$LL = FL \cdot \frac{\rho_R}{\rho_L}$$

where:

LL = loading limit as defined in 15.1.2, expressed in percentage;

FL = filling limit as specified in ~~15.3 or 15.4~~ 15.1.1 expressed in percentage;

ρ_R = relative density of cargo at the reference temperature; and

ρ_L = relative density of cargo at the loading temperature.

~~15.5.2~~ 15.4.2 The Administration or recognized organization acting on its behalf may allow type C tanks to be loaded according to the formula in ~~15.5.1~~ 15.4.1 with the relative density ρ_R as defined below, provided that the tank vent system has been approved in accordance with 8.2.18:

ρ_R = relative density of cargo at the highest temperature that the cargo may reach upon termination of loading, during transport, or at unloading, under the ambient design temperature conditions described in 15.1.4.

This paragraph does not apply to products requiring a type 1G ship."

15.6 Information to be provided to the master

75 Section 15.6 and paragraphs therein are renumbered as section 15.5, and paragraphs 15.5.1, 15.5.2 and 15.5.3.

CHAPTER 16
USE OF CARGO AS FUEL

16.1 General

76 Section 16.1 is amended, as follows:

"**16.1 General**

16.1.1 Except as provided for in 16.9, methane (LNG) (CH_4), ethane (C_2H_6) and LPG ~~is~~ are the only ~~cargo whose vapour or boil-off gas~~ hydrocarbon fuels that may be utilized in machinery spaces of category A, and, in these spaces, they may only be utilized ~~only~~ in systems such as boilers, inert gas generators, internal combustion engines, gas combustion units and gas turbines.

16.1.2 LPG, for the purpose of chapter 16, is composed of propane (C_3H_8), butane (C_4H_{10}), or a propane-butane mixture as listed in chapter 19 and may contain small amounts of other hydrocarbons. It can be in either a liquefied or gaseous state. LPG in the liquefied state is referred to as LPG liquid, and LPG in the gaseous state is referred to as LPG vapour."

16.2 Use of cargo vapour as fuel

77 The title of section 16.2 is amended, as follows:

"**16.2 ~~Use of cargo vapour as fuel~~ General requirements for gas consumers and fuel systems**"

78 Paragraph 16.2.1 is amended, as follows:

"16.2.1 For ~~vaporized LNG~~ all fuels covered by 16.1**,** the fuel supply system shall comply with the requirements of 16.4.1, 16.4.2 and 16.4.3".

79 The following new paragraphs 16.2.3. 16.2.4 and 16.2.5 are added after existing paragraph 16.2.2:

"16.2.3 LPG or ethane fuel consumers and associated systems shall be designed for operation within the possible range of composition of the intended fuel. Information about the range of acceptable compositions shall be provided on board.

16.2.4 The LPG or ethane fuel consumers shall exhibit no external visible flame and shall maintain the uptake exhaust temperature sufficiently below the auto-ignition temperature of the fuel or, if impractical, as practically low as possible, taking into account the auto-ignition temperature. In a mixture of gases, the component with the lowest auto-ignition temperature shall be the appropriate reference. The LPG or ethane fuel consumer exhaust gas temperature shall be continuously monitored. In case of consumer with a turbocharger, the temperature shall be measured after the turbocharger.

16.2.5 A risk assessment using acceptable and recognized risk analysis techniques shall be conducted for LPG or ethane fuel supply arrangements including associated systems demonstrating an equivalent level of safety to utilizing LNG vapour as fuel and the results shall be documented. The scope of the risk assessment shall include aspects of the cargo-handling system that are part of the fuel supply, including consumers. Consideration shall be given to the hazards associated with the arrangement, operation and maintenance of the fuel system, considering reasonably foreseeable failures. The risk assessment shall address the consequences of fuel leakage, considering the properties of LPG or ethane vapour and its accumulation or escape into another space."

16.3 Arrangement of spaces containing gas consumers

80 The title of existing section 16.3 is replaced by the following:

"**16.3 Arrangement of spaces containing gas consumers or gas equipment**"

81 Paragraph 16.3.4 is amended, as follows:

"16.3.4 All vents and bleed lines that may contain or be contaminated by gas fuel shall be routed to a safe location external to the machinery space and be fitted with ~~a~~ flame screens. For ships constructed on or after [1 July 2028], these vent and bleed lines shall be independent from cargo and cargo vent piping systems."

82 The following new paragraphs 16.3.5 and 16.3.6 are added after existing paragraph 16.3.4:

"16.3.5 For spaces outside the cargo area containing LPG or ethane fuel systems, special consideration shall be given to the density and lower flammability limit (LFL) of LPG or ethane vapour. For ships constructed on or after [1 July 2028], ventilation capacity, including ventilation inlet and outlet location, shall be supported by numerical calculations. The numerical calculations shall be performed in accordance with a recognized standard. These may include computational fluid dynamics (CFD), gas dispersion analysis or another method approved by the Administration. Notwithstanding, for enclosed spaces within the cargo area, on the open deck and containing LPG or ethane fuel conditioning equipment, the requirements of paragraph 12.1.3 shall apply.

16.3.6 For spaces outside the cargo area containing LPG or ethane fuel systems, in addition to the requirements of paragraph 13.6.12, gas detection heads shall be fitted in spaces where LPG or ethane vapour may accumulate particularly where air circulation is reduced or near the bottom of the space. For ships constructed on or after [1 July 2028], the suitability of their location shall be supported by numerical calculations. The numerical calculations shall be performed in accordance with a recognized standard. These may include computational fluid dynamics (CFD), gas dispersion analysis, a physical smoke test or another method approved by the Administration. The numerical calculations shall include the possible range of composition of the intended fuel."

16.4 Gas fuel supply

16.4.1 General

83 The following new paragraphs 16.4.1.2 and 16.4.1.3 are inserted after existing paragraph 16.4.1.1 and existing paragraph 16.4.1.2 is renumbered as 16.4.1.4:

"16.4.1.2 LPG or ethane fuel piping outside the cargo area shall be of double wall design or ducted and the outer boundary shall be continuous in the space. In spaces outside the cargo area, non-continuous double barriers shall not be used under the circumstances described in paragraph 16.4.6.2.

16.4.1.3 For LPG fuel supply systems, liquid, vent and purging shall lead to a fuel collection tank, gas-liquid separator or similar device located in the cargo area. Heating of the gas-liquid separator may be necessary for ships operating in cold areas. Fuel supply vent piping systems shall be designed to safely handle any fuel condensate which may occur without restricting the function of the system. Any liquids formed shall be safely disposed. Vent piping associated with the fuel supply system shall be fitted with an inert gas purging interface and shall include a means for preventing condensation of vapour in the system."

84 The following new paragraphs are added after renumbered paragraph 16.4.1.4:

"16.4.1.5 For permanent installations for ships constructed on or after [1 July 2028], the inert gas piping connected to the fuel piping shall be fitted with double-block-and-bleed valves. In addition, a non-return valve shall be installed between the double-block-and-bleed arrangement and the fuel piping. For LPG liquid fuel supply systems, the piping shall have a means of being drained without release of liquid to the atmosphere. LPG liquid trapped in double-block-and-bleed valves or the inert gas system piping shall have a means of being drained without release of liquid to the atmosphere.

16.4.1.6 All safety functions related to gas burning form the Gas Burning Safety System. This system may be a part of the cargo automation and safety system as described in chapter 13.8.1 or a stand-alone system interfacing with the same and built to the same requirements.

16.4.1.6.1 Main functions as described in the subsequent paragraphs as well as in other parts with reference to table 18.1 as guidance.

16.4.1.6.2 A full cargo ESD shall initiate the closure of the Master Valves described in 16.4.6.1."

16.4.3 Routeing of fuel supply pipes

85 Section 16.4.3 is amended, as follows:

"**16.4.3 Routeing of fuel supply pipes**

16.4.3.1 Fuel piping may pass through or extend into enclosed spaces other than those mentioned in 16.4.1, provided it fulfils one of the following conditions:

.1 it is of a double-wall design with the space between the concentric pipes pressurized with inert gas at a pressure greater than the gas fuel pressure. The master gas fuel valve, as required by 16.4.6, closes automatically upon loss of inert gas pressure; or

.2 it is installed in a pipe or duct equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour and is arranged to maintain a pressure less than the atmospheric pressure. The mechanical ventilation is in accordance with chapter 12, as applicable. The ventilation is always in operation when there is fuel in the piping and the master gas fuel valve, as required by 16.4.6, closes automatically if the required air flow is not established and maintained by the exhaust ventilation system. The inlet or the duct may be from a non-hazardous machinery space, and the ventilation outlet is in a safe location.

16.4.3.2 For LPG or ethane fuel systems, the air inlet of the pipe or duct shall not be in a machinery space. In addition, the air inlet of the pipe or duct shall be in a location which would be safe in the absence of the air inlet. Consideration shall be given to the risk of liquid carry-over resulting from a liquid leak. Ventilation outlets of the pipe or duct shall be in the cargo area."

16.4.5 Gas consumer isolation

86 Paragraph 16.4.5 is amended, as follows:

"**16.4.5 Gas consumer isolation**

The supply and return piping of each gas consumer unit shall be provided with ~~gas~~ fuel isolation by automatic double block and bleed, vented to a safe location, under both normal and emergency operation. The automatic valves shall be arranged to fail to the closed position on loss of actuating power. In a space containing multiple consumers, the shutdown of one shall not affect the gas fuel supply to the others. For LPG or ethane liquid fuel supply systems, the piping shall be able to be drained and bleed valves opened without release of liquid to the atmosphere."

16.5 Gas fuel plant and related storage tanks

16.5.2 Remote stops

87 Paragraph 16.5.2.2 is amended, as follows:

"16.5.2.2 ~~The fuel supply equipment shall be automatically stopped in the case of low suction pressure or fire detection. Unless expressly provided otherwise, the requirements of 18.10 need not apply to gas fuel compressors or pumps when~~

~~used to supply gas consumers.~~ Fuel supply equipment shall be included into all safety actions/shutdowns required by any of the cargo system related safety systems insofar as fuel supply is not safe while the respective action is ongoing."

16.7 Special requirements for gas-fired internal combustion engines

16.7.1 Arrangements

88 Paragraph 16.7.1.4 is amended, as follows:

"16.7.1.4 Unless designed with the strength to withstand the worst-case overpressure due to ignited gas leaks, air inlet manifolds, scavenge spaces, exhaust system and crank cases shall be fitted with suitable pressure relief systems. Pressure relief systems shall lead to a safe location, away from personnel. For ships constructed on or after [1 July 2028]:

.1 A suitable pressure relief system for air inlet manifolds, scavenge spaces and exhaust system shall be provided unless designed to accommodate the worst-case overpressure due to ignited gas leaks or justified by the safety concept of the engine. A detailed evaluation regarding the hazard potential of overpressure in air inlet manifolds, scavenge spaces and exhaust system shall be carried out and reflected in the safety concept of the engine.

.2 For crankcases, the explosion relief valves, as required by SOLAS regulation II-1/27.4, shall be considered suitable for the gas operation of the engine. For engines not covered by the said SOLAS regulation, a detailed evaluation regarding the hazard potential of fuel gas accumulation in the crankcase shall be carried out."

16.7.3 Safety

89 The following new paragraphs 16.7.3.3.1 to 16.7.3.3.3 are added after existing paragraph 16.7.3.3:

"16.7.3.3.1 For ships constructed on or after [1 July 2028], for Otto combustion process gas and dual fuel engines where the space below the piston is in direct communication with the crankcase, gas detection shall be provided to the crankcase, sumps (vent space) and charge air manifolds unless otherwise justified by the safety concept of the engine.

16.7.3.3.2 For ships constructed on or after [1 July 2028], for Otto combustion crosshead engine designs, gas detection shall be provided to the piston underspace side unless otherwise justified by the safety concept of the engine.

16.7.3.3.3 For ships constructed on or after [1 July 2028], for all engine types (e.g. 4-stroke, 2-stroke, trunk piston, crosshead, Otto or Diesel combustion process), a detailed evaluation regarding the hazard potential of fuel gas accumulation in the crankcase, sumps, scavenge spaces/charge air manifolds and cooling system vents shall be carried out and reflected in the safety concept of the engine. This may identify alternative means to detect and/or mitigate gas operation fault conditions."

16.8 Special requirements for gas turbines

16.8.1 Arrangements

90 The following new paragraph 16.8.1.2 is inserted after existing paragraph 16.8.1.1 and the subsequent paragraphs are renumbered accordingly:

"16.8.1.2 Each turbine using LPG fuel shall be fitted with a gastight enclosure unless fuel supply piping meets the requirements of paragraph 16.4.3. The consequences of gas leakage shall be evaluated in the risk assessment required by 16.2.5."

16.9 Alternative fuels and technologies

91 Paragraph 16.9.1 is amended as follows:

"16.9.1 If acceptable to the Administration, ~~other~~ cargo gases not covered by 16.1.1 may be used as fuel, ~~providing~~ provided that the same level of safety as natural gas in this Code is ensured."

92 Paragraphs 16.9.3 to 16.9.5 are amended as follows:

"16.9.3 For cargoes ~~other than LNG~~ not covered by 16.1.1, the fuel supply system and gas consumers shall comply with the requirements of ~~16.4.1, 16.4.2, 16.4.3 and 16.5~~ 16.2 to 16.8, as applicable, and shall include means for preventing condensation of vapour in the fuel supply system.

~~16.9.4 Liquefied gas fuel supply systems shall comply with 16.4.5.~~

16.9.~~5~~4 In addition to the requirements of 16.4.3.1.2, both ventilation inlet and outlet shall be located outside the machinery space. The inlet shall be in a non-hazardous area and the outlet shall be in a safe location."

CHAPTER 17
SPECIAL REQUIREMENTS

17.4 Refrigeration systems

93 The following new explanatory sentence is inserted under the title of section 17.4 (Refrigeration systems) before existing paragraph 17.4.1:

"The special requirements in this section listed under column "i" in the table in chapter 19 are applicable only when a refrigeration system is required or used to maintain the cargo tank pressure and temperature within design limits of the containment system and/or within the conditions of carriage of the cargo indicated on the Certificate of Fitness."

17.21 Carbon dioxide: high purity

94 The title of section 17.21 is amended, as follows:

"**17.21 Carbon dioxide**~~**: high purity**~~"

95 Paragraph 17.21.1 is amended, as follows:

17.21.1 Uncontrolled pressure loss from the cargo can cause ~~"sublimation"~~ solidification and the cargo will change from the liquid to the solid state. The precise ~~"~~triple point~~"~~ temperature of a particular carbon dioxide cargo shall be supplied before loading the cargo, and will depend on the purity of that cargo~~, and this shall be taken into account when cargo instrumentation is adjusted~~. The set pressure for the alarms and automatic actions described in this section shall be set to at least 0.05 MPa above the highest triple point pressure of ~~for~~ the ~~specific~~ cargo being carried under all expected conditions. The ~~"~~triple point~~"~~ for pure carbon dioxide occurs at ~~0.5~~ 0.417 MPa gauge and ~~-54.4~~ -56.6°C."

96 Paragraph 17.21.4 is amended, as follows:

"17.21.4 Cargo tanks shall be continuously monitored for low pressure when a carbon dioxide cargo is carried. An audible and visual alarm shall be given at the cargo control position and on the bridge. If the cargo tank pressure ~~continue to~~ falls to ~~within 0.05 MPa of the "triple point" for the particular cargo~~ the set pressure for alarms and automatic actions specified in 17.21.1, the monitoring system shall automatically close all cargo manifold liquid and vapour valves and stop all cargo compressors and cargo pumps. The emergency shutdown system required by 18.10 may be used for this purpose."

97 Paragraph 17.21.6 is replaced by the following:

"17.21.6 Cargo hold spaces, cargo compressor rooms and other enclosed spaces where carbon dioxide could accumulate shall be fitted with continuous monitoring for carbon dioxide build-up. ~~This fixed gas detection system replaces the requirements of 13.6, and hold spaces shall be monitored permanently even if the ship has type C cargo containment.~~ The alarms shall be set to 5,000 ppm."

98 The following new paragraphs 17.21.7 and 17.21.8 are added after existing paragraph 17.21.6:

"17.21.7 The materials of construction used in the cargo system shall also take into account the possibility of corrosion, in case carbon dioxide cargo contains impurities such as water or sulphur dioxide, which can cause acidic corrosion or other problems.

17.21.8 Other requirements

17.21.8.1 The requirements for flammable products may be waived.

17.21.8.2 Carbon dioxide is considered a toxic product for the purpose of the Code. The requirements applicable to carbon dioxide as a toxic product in the Code are limited to those indicated in the following paragraphs and as shown in the table in chapter 19 for carbon dioxide.

17.21.8.3 The requirements of 3.2.5, 3.3.4, 3.6, 5.7.4, 12.1.7, 12.1.9, 13.6.11, 13.6.14, 13.6.15, 13.6.17 and 18.10.3.4, as well as chapters 10 (except for 10.2.6) and 11 do not apply to ships that exclusively carry this cargo.

17.21.8.4 In the application of 3.1.2 and 3.1.3, a single A-0 bulkhead shall be considered sufficient for this cargo.

17.21.8.5 In the application of 3.3.1, the requirement of SOLAS regulation II-2/9.2.3 for cargo spaces shall be applied instead of SOLAS regulation II-2/9.2.4 for cargo pump-rooms.

17.21.8.6 In the application of 3.8, bow or stern loading and unloading may be allowed subject to the approval by the Administration.

17.21.8.7 When flammable or other toxic products are used for fuel or reliquefication systems, due consideration shall be given to the additional risk.

17.21.8.8 In the application of chapter 9, inert gas may be not required based on the specific design. Dry air may be required to prevent condensation in hold space, cargo tanks and piping to gas free tanks.

17.21.8.9 In the application of chapter 13, all requirements (except those exclusively related to flammability) shall be applied except for 13.6.5."

99 Section 17.22 (Carbon dioxide: reclaimed quality) is deleted.

"~~**17.22 Carbon dioxide: reclaimed quality**~~

~~17.22.1 The requirements of 17.21 also apply to this cargo. In addition, the materials of construction used in the cargo system shall also take account of the possibility of corrosion, in case the reclaimed quality carbon dioxide cargo contains impurities such as water, sulphur dioxide, etc., which can cause acidic corrosion or other problems.~~"

CHAPTER 18
OPERATING REQUIREMENTS

18.9 Cargo sampling

100 The following new paragraph is added after existing paragraph 18.9.5:

"18.9.6 The requirements in paragraphs 18.9.1 to 18.9.5 are only applicable if such a sampling system is fitted on board. Connections used for control of atmosphere in cargo tanks during inerting or gassing up are not considered as cargo sampling connections."

18.10 Cargo emergency shutdown (ESD) system

18.10.1 General

101 Paragraph 18.10.1.1 is amended, as follows:

"18.10.1.1 A cargo emergency shutdown system shall be fitted to stop cargo flow in the event of an emergency, either internally within the ship, or during cargo transfer to ship or shore. The ESD system is intended to return the cargo system to a safe static condition so that any remedial action can be taken. The design of the ESD system shall avoid the potential generation of surge pressures within cargo transfer pipe work ~~(see 18.10.2.1.4)~~."

102 Paragraph 18.10.1.3 is amended, as follows:

"18.10.1.3 The ESD system shall be activated by the manual and automatic initiations listed in table 18.1, which is a summary of ESD shutdown related system functions taking into account those required by the relevant sections of the Code, including chapter 16, and may not describe all requirements. The actual enforceable requirements are found in the Code. Any additional initiations shall only be included in the ESD system if it can be shown that their inclusion does not reduce the integrity and reliability of the system overall. A failure of any part of the system shall activate an ESD. Failure of the system includes loss of power for ESD valves and main electric power failure."

18.10.2 ESD valve requirements

103 Paragraph 18.10.2.1.3 is amended, as follows:

"18.10.2.1.3 ESD valves in liquid piping systems shall close fully and smoothly within 30 seconds of ~~actuation~~ initiation of the emergency shutdown. Information about the closure time of the valves and their operating characteristics shall be available on board, and the closing time shall be verifiable and repeatable."

104 Paragraphs 18.10.2.1.4, 18.10.2.2 (Ship-shore and ship-ship manifold connections) and 18.10.2.3 (Cargo system valves) are deleted.

18.10.3 ESD system controls

105 The following new paragraphs 18.10.3.1 and 18.10.3.2 are inserted after the heading "18.10.3 ESD system controls", and the subsequent paragraphs are renumbered accordingly:

"18.10.3.1 The ESD system shall be designed to be activated by the manual and automatic initiations as specified in the Code. Any additional initiations shall only be included in the ESD system if it can be shown that their inclusion does not reduce the integrity and reliability of the system overall.

18.10.3.2 The ESD system shall be fail-safe. If any single part of the system fails, ESD shall be initiated."

106 Renumbered paragraph 18.10.3.5 is amended, as follows:

"18.10.3.~~3~~5 Cargo machinery that is running shall be stopped by activation of the ESD system ~~in accordance with the cause and effect matrix in table 18.1~~ using the causes found in the relevant sections of the Code with reference to table 18.1 as guidance."

107 The title of section 18.10.4 (Additional shutdowns) is amended, as follows:

"**18.10.4 ~~Additional shutdowns~~ Associated safety systems**"

108 Table 18.1 is replaced by the following table:

"Table 18.1 – Shutdown-related system cause and effect functions

Initiation		Shutdown action (See 18.10.1.1)								
		Emergency shutdown system (ESD)						Gas Burning Safety System (GBSS)		
		Cargo Pumps	Compressor used for cargo handling	ESD valves on manifold	Cargo tank ESD valves	ESD link (to terminal)	Reliquefication plant including relevant aux systems and compressor	Pumps used for gas fuel	Compressors used for gas fuel	Master valve
1	ESD System failure (see 18.10.1.3)	√	√	√	√	√	√	√	√	√
2	ESD Push-button (see 18.10.3.3)	√	√	√	√	√	√	√	√	√
3	Fire detection in cargo area. (see 18.10.3.4)	√	√	√	√	√	√	√	√	√
4	ESD link from terminal① (see 18.10.1.4)	√	√	√	√①	√	N/A	N/A	N/A	N/A
5	Overflow protection (See 13.3.2) ②	√	√	√	√	√	√	√	√	√
6	Low pressure protection in cargo tanks ④ (see 8.3.1.1, 18.10.4)	√	√	√	√	√	√	√	√	√
7	Master valve receives shut signal ③ (see 16.4.2, 16.4.3, 16.4.6.2.1, 16.4.6.3.1, 16.4.8)	N/A	N/A	N/A	N/A	N/A	N/A	√	√	√
8	Fuel gas push-button (see 16.4.6.2.2, 16.4.6.3.2, 16.5.2.1)	N/A	N/A	N/A	N/A	N/A	N/A	√	√	√
9	Low suction pressure in gas fuel (see 16.5.2.2) ④	N/A	N/A	N/A	N/A	N/A	N/A	√	√	√
10	Fire detection outside cargo area (see 16.5.2.2)	N/A	N/A	N/A	N/A	N/A	N/A	√	√	√

Note:

① "ESD link (from terminal)" does not trip the gas fuel supply or cargo reliquefication as the emergency is on the terminal, tripping of necessary tank valves is optional.

② The sensors referred to in 13.3.2 may be used to automatically close the individual tank filling valve if this can be done in a manner that will avoid excessive liquid pressure in the loading line. Alternatively full ESD can be initiated as given in the table.

③ "Master valve receives shut signal" refers to main valve required by 16.4.6.1 and not individual consumers. In case several consumers are served by different supply systems, only common equipment needs to be shut down.

④ "Vacuum protection of cargo tanks" and "low suction pressure in gas fuel" can be the same protection.

CHAPTER 19

SUMMARY OF MINIMUM REQUIREMENTS

109 The entries for "Carbon Dioxide (high purity)" and "Carbon Dioxide (Reclaimed quality)" in the table in chapter 19 are replaced by the following single entry:

Product name		***Ship type***	***Independent tank type C required***	***Control of vapour space within cargo tanks***	***Vapour detection***	***Gauging***		***Special requirements***
Carbon Dioxide		3G	'	'	T	C		14.4.2, 14.4.4 and 17.21

110 The following new entry is added after the existing entry of "Vinylidene chloride" in the table in chapter 19.

Product name		***Ship type***	***Independent tank type C required***	***Control of vapour space within cargo tanks***	***Vapour detection***	***Gauging***		***Special requirements***
VOC Condensate		2G/2PG	-	-	F + T †	C		14.4.2, 14.4.3, 17.9, 17.11

"† The toxic vapour detection equipment shall be able to detect "Benzene", "Hexane" and "Toluene"."

APPENDIX 2

MODEL FORM OF INTERNATIONAL CERTIFICATE OF FITNESS FOR THE CARRIAGE OF LIQUEFIED GASES IN BULK

111 The entries under "Particulars of ships" are amended, as follows:

"Name of ship ……….
Distinctive number or letters ……….
IMO number ……….
Port of registry ……….
Cargo capacity (m^3) ……….
Ship type (Code paragraph 2.1.2) ……….
Date of build (all applicable dates shall be completed)
Date of building contract ……….
Date on which keel was laid or on which the ship was at similar stage of construction ~~or in the case of a converted ship, date on which conversion to a gas carrier was commenced~~ ……….
Date of delivery ………
Date on which conversion to a gas carrier was commenced ……….
The ship also complies fully with the following amendments to the Code: ……..
The ship is exempted from compliance with the following provisions of the Code: ……."

112 The table in paragraph 3.3 is amended, as follows:

".3

Tank type and number	Stress factors[5]				Materials[5]	MARVS[6]	Cargo/Fuel
	A	B	C	D			
Cargo piping							
Fuel vapour or liquid piping							

"

113 The following new paragraph 3.5 is added after existing paragraph 3.4:

".5 Mechanical properties of the fuel tank materials were determined at ….°C.[7]"

114 Paragraph 4 is amended, as follows, the following new paragraph 5 is added after existing paragraph 4, and the subsequent paragraphs are renumbered accordingly:

"4 That the ship is suitable for the carriage in bulk of the following products as cargo provided that all the relevant operational provisions of the Code are observed.[8]

Products	Conditions of carriage (tank numbers, etc.)	Minimum temperature
Continued on attachment 1, additional signed and dated sheets. Tank numbers referred to in this list are identified on attachment 2, signed and dated tank plan.		

"

"5 That the ship is suitable for the carriage and use of the following products as fuel provided that all the relevant operational provisions of the Code are observed.[8]

Products	Conditions of carriage and use (tank numbers, etc.)	Minimum temperature
Tank numbers referred to in this list are identified on attachment 2, signed and dated tank plan.		

"

Consequential amendments to referenced figure numbers

115 According to each row of the following table, in the paragraph indicated in the left column, the referenced figure number specified in the second column from the left is replaced with the figure number shown in the third column, following the note specified in the right column.

Paragraph	Existing referenced figure number	Amended referenced figure number	Note
paragraph 3.5.3.5.1	figure 3.1	figure 3.3	
paragraph 3.5.3.5.2	figure 3.2	figure 3.4	
paragraph 3.5.3.5.3	figure 3.3	figure 3.5	
paragraph 3.5.3.5.4	figure 3.4	figure 3.6	
paragraph 3.5.3.5.5	figure 3.5	figure 3.7	twice
paragraph 3.5.3.5.6	figure 3.6	figure 3.8	
paragraph 4.18.2.6.3	figure 4.4	figure 4.5	
paragraph 4.28.1.2 in the text for α_β	figure 4.1	figure 4.2	
paragraph 4.28.1.2 in the text for Z_β	figure 4.2	figures 4.3 and 4.4	
paragraph 8.4.1.2	figure 8.1	figure 8.2	

Consequential amendments to referenced paragraph numbers

116 According to each row of the following table, in the paragraph indicated in the left column, the referenced paragraph number specified in the second column from the left is replaced with the paragraph number shown in the third column.

Paragraph	Existing referenced paragraph number	Amended referenced paragraph number
paragraph 1.4.1.2	1.2.43	1.2.46
paragraph 3.8.2	1.2.53	1.2.57
paragraph 7.4.1	1.2.52	1.2.56
paragraph 7.7	1.2.47	1.2.51
renumbered paragraph 8.2.18	1.2.31	1.2.34
paragraph 17.15	1.2.47	1.2.51
paragraph 17.16.5	1.2.28	1.2.30
paragraph 17.16.5	1.2.47	1.2.51
paragraph 17.18.23	1.2.28	1.2.30
paragraph 18.4.2.2	1.2.47	1.2.51
paragraph 5.6.2	8.2.7	8.2.8
paragraph 5.6.2	8.2.8	8.2.9
renumbered paragraph 8.2.9	8.2.7	8.2.8
renumbered paragraph 8.2.13	8.2.10	8.2.11
renumbered paragraph 8.2.13	8.2.11.1	8.2.12.1
renumbered paragraph 8.2.13	8.2.11.2	8.2.12.2
paragraph 13.4.3	8.2.7	8.2.8
new paragraph 15.3.1	8.2.18	8.2.19
renumbered paragraph 15.3.2	8.2.17	8.2.18
renumbered paragraph 15.4.2	8.2.18	8.2.19
paragraph 17.9	8.2.15	8.2.16
paragraph 17.16.4.3	8.2.10	8.2.11
paragraph 17.16.4.3	8.2.11	8.2.12
paragraph 17.16.4.3	8.2.15	8.2.16
paragraph 17.21.2	8.2.9.2	8.2.16
paragraph 17.21.2	8.2.15	8.2.16
paragraph 17.21.3	8.2.10	8.2.11
paragraph 17.21.3	8.2.15	8.2.16
paragraph 18.2.2.10	8.2.8	8.2.9
paragraph 18.12	8.2.7	8.2.8
paragraph 18.12	8.2.8	8.2.9
paragraph 18.12	8.2.9	8.2.10
paragraph 11.3.2.1	11.3.1.8	11.3.1.9
paragraph 16.4.4.2	16.4.3.2	16.4.3.1.2
paragraph 16.9.5	16.4.3.2	16.4.3.1.2
renumbered paragraph 8.2.i in section starting with the words "THIS IS TO CERTIFY:" in Appendix 2	6	7
renumbered paragraph 8.2.iii in section starting with the words "THIS IS TO CERTIFY:" in Appendix 2	6	7
renumbered paragraph 8.2.iv in section starting with the words "THIS IS TO CERTIFY:" in Appendix 2	6	7

APPENDIX

CHECK/MONITORING SHEET FOR THE PROCESS OF AMENDING THE CONVENTION AND RELATED MANDATORY INSTRUMENTS (PROPOSAL/DEVELOPMENT)

Part III – Process monitoring to be completed during the work process at the Sub-Committee and checked as part of the final approval process by the Committee (refer to paragraph 3.2.1.3)

1	The Sub-Committee, at an initial engagement, has allocated sufficient time for technical research and discussion before the target completion date, especially on issues needing to be addressed by more than one Sub-Committee and for which the timing of relevant sub-committees meetings and exchanges of the result of consideration needed to be carefully examined.	Yes
2	The scope of application agreed at the proposal stage was not changed without the approval of the Committee.	Yes
3	The technical base document/draft amendment addresses the proposal's issue(s) through the suggested instrument(s); where it does not, the Sub-Committee offers the Committee an alternative method of addressing the problem raised by the proposal.	N/A
4	Due attention is to be paid to the *Interim guidelines for the systematic application of the grandfather clause* (MSC/Circ.765).	N/A
5	All references have been examined against the text that will be valid if the proposed amendment enters into force.	Yes
6	The location of the insertion or modified text is correct for the text that will be valid when the proposed text enters into force on a four-year cycle of entry into force, as other relevant amendments adopted might enter into force on the same date.	Yes
7	There are no inconsistencies in respect of scope of application between the technical regulation and the application statement contained in regulation 1 or 2 of the relevant chapter, and application is specifically addressed for existing and/or new ships, as necessary.	Yes
8	Where a new term has been introduced into a regulation and a clear definition is necessary, the definition is given in the article of the Convention or at the beginning of the chapter.	Yes
9	Where any of the terms "fitted", "provided", "installed" or "installation" are used, consideration has been given to clarifying the intended meaning of the term.	Yes
10	All necessary related and consequential amendments to other existing instruments, including non-mandatory instruments, in particular to the forms of certificates and records of equipment required in the instrument being amended, have been examined and included as part of the proposed amendment(s).	Yes
11	The forms of certificates and records of equipment have been harmonized, where appropriate, between the Convention and its Protocols.	N/A
12	It is confirmed that the amendment is being made to a currently valid text and that no other bodies are concurrently proposing changes to the same text.	Yes

Part III – Process monitoring to be completed during the work process at the Sub-Committee and checked as part of the final approval process by the Committee (refer to paragraph 3.2.1.3)

13	All entry-into-force criteria (building contract, keel laying and delivery) have been considered and addressed.	Yes
14	Other impacts of the implementation of the proposed/approved amendment have been fully analysed, including consequential amendments to the "application" and "definition" regulations of the chapter.	Yes
15	The amendments presented for adoption clearly indicate changes made with respect to the original text, so as to facilitate their consideration.	Yes
16	For amendments to mandatory instruments, the relationship between the Convention and the related instrument has been observed and addressed, as appropriate.	Yes
17	The related record format has been completed or updated, as appropriate.	Yes

RECORD FORMAT

The following records should be created and kept updated for each regulatory development.

The records can be completed by providing references to paragraphs of related documents containing the relevant information, proposals, discussions and decisions.

1	**Title (number and title of regulation(s))**
IGC Code chapters 1,2,4,5,8,9,10,11,12,13,15,16,17,18, and the Model Form of the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk	
2	**Origin of the requirement (original proposal document)**
The output was proposed by MSC 102/21/1. The large number of UIs submitted to the CCC Sub-Committee since the entry into force of the IGC Code in 2016 indicates there is a clear need to update the IGC Code, taking account of the experience gained. Additional tasks were added by MSC 103/21, paragraph 18.	
3	**Main reason for the development (extract from the proposal document)**
The amendments include a variety of issues, including application of finite element analysis to type C tanks, carriage of CO_2 cargoes, the use of LPG and toxic cargoes as fuel, the causes and effects of an ESD and cargo tank filling limits.	
4	**Related output**
Amendments to the IGC Code and development of guidelines for ammonia cargo as fuel	
5	**History of the discussion (approval of work programmes, sessions of sub-committees, including CG/DG/WG arrangements)**
CCC 6 endorsed the work plan for the next phase of the development of the IGC Code and endorsed the output on "Review of the IGC Code". CCC 9 developed amendments, for approval at MSC 109 and subsequent adoption at MSC 110. CCC 10 continued development of additional amendments which had not been agreed upon at CCC 9. Having considered the draft amendments to the IGC Code, further progressed by the Drafting Group (MSC 110/WP.7, annex 15), MSC 110 noted the progress made and endorsed the list of substantial proposals to the draft amendments to the IGC Code for further consideration by the CCC Sub-Committee, with a view to reporting to MSC 111 for approval (MSC 110/WP.7, annex 14). In this regard, MSC 110 agreed that an experts group could be established at CCC 11 to consider the aforementioned	

list of substantial proposals concerning the draft amendments to the IGC Code (MSC 110/21, paragraph 3.61). CCC 11 agreed to the draft amendments to the IGC Code prepared by the Experts Group, as set out in annex 9 of document CCC 11/16; and agreed to request the Secretariat to prepare a document containing consolidated draft amendments to the IGC Code with a view to approval at MSC 111 and subsequent adoption at MSC 112.
6 Impact on other instruments (codes, performance standards, guidance circulars, certificates/records format, etc.)
Model Form of the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and the *Interim Guidelines for the safety of ships using ammonia as fuel* (MSC.1/Circ.1687)
7 Technical background
7.1 Scope and objective (to cross-check with items 4 and 5 in part II of the checklist)
The amendments include a variety of issues, including application of finite element analysis to type C tanks; carriage of CO_2 cargoes; the use of LPG and toxic cargoes as fuel; the causes and effects of an ESD; and cargo tank filling limits.
7.2 Technical/operational background and rationale (e.g. summary of FSA study, if available, or engineering challenge posed)
Not applicable
7.3 Source/derivation of requirement (non-mandatory instrument, industry standard, national/regional requirement)
Not applicable
7.4 Short summary of requirement (what is the new requirement – in short and lay terms)
The amendments will enhance safety by regulating a variety of issues, including application of finite element analysis to type C tanks; carriage of CO_2 cargoes; the use of LPG and toxic cargoes as fuel; the causes and effects of an ESD; and cargo tank filling limits.
7.5 Points of discussions (controversial points and conclusion)
Not applicable

APPENDIX 2

CHECKLIST FOR THE IDENTIFICATION OF CAPACITY-BUILDING IMPLICATIONS

1 For Administrations

☐ Is new legislation required? No

☐ Is there a requirement for new equipment and/or systems? Yes

- o Does equipment manufacturing capacity exist internationally? Yes
- o Do equipment repair/servicing facilities exist internationally? Yes
- o Is there capacity to develop new systems? Unknown

☐ Will the implementation require additional financial resources? Yes

☐ Is there a need for additional human resources or new skills? No

☐ Will there be a need to upgrade current infrastructure? No

☐ Is there enough lead time towards implementation? The timeline between adoption and implementation is extremely short – only about 18 months

☐ Will a rapid implementation procedure be adopted? None planned

☐ Is there a substantial modification of existing standards? Yes

☐ Will a guide to implementation be needed? Maybe

2 For the industry

☐ Would the industry require new and/or enhancement of existing systems? Maybe

- o Does capacity exist internationally to develop new systems? Unknown

☐ Is there a need for additional training of seafarers? Additional system-specific training may be required

- o Do related and validated training courses exist?
- o Are sufficient simulation training courses available internationally?

☐ Will there be a requirement for new equipment? Maybe

- o Does manufacturing capacity exist internationally? Unknown

☐ Is there repair/servicing and/or retrofitting and does maintenance capacity exist internationally? Unknown

FORM FOR CAPACITY-BUILDING MEASURES

Capacity-building Measures Form

Instrument IGC Code, chapters 1,2,4,5,8,9,11,12,13,15,16,17,18

Measure number ___1___ of __1____

Required for	☒	Administration
	☒	Industry
Implementation	☒	Prior to adoption
	☒	Once adopted
	☒	Prior to entry into force
	☐	Once ratified
	☐	Phased in

Description of capacity-building activity needed for the implementation of new measures:

Document MSC 111/INF.10 provides an implication analysis of the IGC Code draft amendments. Document MSC 111/INF.10 groups the proposed changes into 97 individual amendment items, of which 39 are considered to have notable design implications for either newbuilds or existing ships. Owing to the short timeline between adoption and implementation, it is recommended that any relevant design implications from MSC 111/INF.10 that remain once the amendments are finalized/adopted be proactively shared with Administrations and industry stakeholders as early as possible to afford the best chance for successful implementation.

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MSC.1/Circ.1700
17 July 2026

GUIDELINES ON THE USE OF REMOTE INSPECTION TECHNIQUES FOR ESP CODE SURVEYS

1 The Maritime Safety Committee, at its 111th session (13 to 22 May 2026), adopted resolution MSC.584(111), containing amendments to the International Code on the Enhanced Programme of Inspections during Surveys of Bulk Carriers and Oil Tankers, 2011 (the 2011 ESP Code) to permit the use of remote inspection techniques (RITs) for 2011 ESP Code surveys, with entry into force on 1 January 2028.

2 The Committee, at its 111th session (13 to 22 May 2026), having considered a proposal by the Sub-Committee on Ship Design and Construction, at its twelfth session (19 to 23 January 2026), with a view to ensuring a standardized and safe approach to the aforementioned use of RITs for ESP Code surveys, approved the *Guidelines on the use of remote inspection techniques for ESP Code surveys*, as set out in the annex.

3 Member States are invited to use the Guidelines when using RITs for ESP Code surveys, and to bring them to the attention of all parties concerned.

4 Member States and international organizations are invited to submit practical experience gained through the application of these Guidelines, in particular on the use of RITs related to image quality and resolution, to the Sub-Committee on Ship Design and Construction under the continuous output "Amendments to the 2011 ESP Code", as appropriate.

5 Member States and international organizations are also invited to submit information, observations, comments and recommendations on the possible use of different innovative RIT technologies outside these Guidelines, notably on their potential future acceptance, with a view to future improvements to the 2011 ESP Code and these Guidelines.

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ANNEX

GUIDELINES ON THE USE OF REMOTE INSPECTION TECHNIQUES FOR ESP CODE SURVEYS

1 INTRODUCTION

1.1 These Guidelines are intended to provide guidance on technical and operational aspects to be considered when using remote inspection techniques (RITs) as an alternative means of access to support the surveyors during close-up survey and thickness measurements (TM). They provide access to parts of the ship structure which may not be fully accessible by permanent means of access, in accordance with the International Code on the Enhanced Programme of Inspections during Surveys of Bulk Carriers and Oil Tankers, 2011 (the 2011 ESP Code). The Guidelines include a sample form[1] for the RIT inspection plan (appendix 1), a pre-inspection verification procedure and acceptance criteria (appendix 2) and a sample form[1] for the RIT Firm Inspection Report (appendix 3). Additionally, appendix 4 provides technical provisions and details the assessment and certification of RIT systems and associated digital technologies for the detection and sizing of structural defects.[2]

1.2 The 2011 ESP Code defines close-up survey (i.e. normally within reach of hand) requirements for bulk carriers and oil tankers that require significant planning, preparation and execution. Means of access to enable close-up surveys are required by SOLAS regulation II-1/3-6. Permanent means of access, as specified in the *Technical provisions for means of access for inspections* (resolution MSC.133(76), as amended), are the primary enabler for close-up surveys. However, it is recognized that temporary means of access may be necessary to access areas required to be inspected and gauged. Therefore, it is essential that all areas outside the reach of the "permanent means of access" (i.e. normally beyond reach of hand) are accessed by "alternative means" in combination with the "permanent means of access". The use of RIT systems may supplement or replace some of the traditional "alternative means of access", such as scaffolding or rafting, provided that the RIT system can provide information with the same level of assurance as that achieved through a traditional close-up visual inspection. Such equivalency is to be verified to the satisfaction of the Administration (as defined in the 2011 ESP Code), subject to the applicable conditions and limitations as set out in the Code and these Guidelines.

1.3 A RIT may be categorized as "manned" or "unmanned": manned techniques include rope access inspection techniques performed by rope access technicians or hand-operated telescopic poles, while unmanned techniques use unmanned robotic vehicles (URV).[3]

1.4 Both manned and unmanned techniques are largely supported by digital technologies in various aspects, ranging from the control of motions and positioning up to the acquisition, collection and processing of survey information as well as the data presentation to the surveyor in various formats. Video live-streaming of images from a camera is the main element, but other technologies may be used to provide supplementary information.

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1 These are suggested sample forms indicating the minimum content, and the Administration may develop equivalent forms as deemed necessary.

2 A remote inspection technique system is an integrated set of tools, technologies, and procedures intended to enable the survey of any part of the ship's structure without the need for direct physical access by the attending surveyor. These systems typically employ the use of technologies such as cameras, drones, robotic vehicles or sensor-equipped devices to collect visual and other types of data.

3 URV refers to a subset of RIT system technologies that use robotic systems without a human on board the remote vehicle. Common types of URV typically include unmanned aerial vehicles (UAV), robotic crawlers and robotic arms.

1.5 The development of different digital technologies and combinations of multiple sensors may lead to different capabilities. It is therefore essential that the RIT capabilities and limitations are properly known and identified in the RIT firm approval, to:

.1 validate the efficiency of the RIT;

.2 confirm that the RIT system provides information to the surveyor with the same level of assurance as when the surveyor performs a close-up survey; and

.3 identify the situations that require a traditional close-up survey and/or thickness measurement techniques to be applied.

2 GENERAL REQUIREMENTS

2.1 The RIT system should provide information to the surveyor with the same level of assurance as when the surveyor performs a close-up survey, i.e. normally within reach of hand, in accordance with the 2011 ESP Code survey procedures and requirements.

2.2 Video live-streaming technology should be used as the primary means of inspection. The video live-streaming should have sufficient quality to provide the same level of assurance as a traditional close-up visual inspection, i.e. normally within reach of hand. While other technologies may be used to provide supplementary information, their use should not be considered as a replacement for video live-streaming or a justification for a reduction in its quality.

2.3 The RIT system should be provided with a RIT System Statement of Capability issued by the Administration detailing the equipment, capabilities and limitations in accordance with appendix 4.

2.4 An inspection plan for the use of RITs should be submitted together with the survey planning questionnaire required by annex A and annex B of the 2011 ESP Code, as appropriate, for review and acceptance in advance of the survey to the Administration. The inspection plan should also form part of the survey programme documentation, required by annex A and annex B of the 2011 ESP Code. The inspection plan applies to both manned and unmanned techniques. The inspection plan should be prepared in accordance with section 6 (Planning and preparation), following the sample form provided in appendix 1.

2.5 Items to be examined using a RIT should be sufficiently clean to permit a meaningful examination, as required by the 2011 ESP Code. Visibility should be sufficient to allow for a meaningful examination, complemented by illumination as required. These factors may vary in accordance with the RIT system; as such, the information available in the RIT System Statement of Capability should be considered.

2.6 Sufficient live-streamed recording should be made to represent the structural condition of the ship, together with the recording of all identified defects. On completion of the inspection, the RIT firm should provide a report (RIT Firm Inspection Report) including the firm details, the approved service supplier certificate, equipment used, and operators supplemented by records of all live-streamed videos and images with a chapter detailing the areas covered and damages found, if any. The report should be prepared in accordance with section 8 (Reporting), following the sample form provided in appendix 3.

3 CERTIFICATION OF FIRMS ENGAGED IN CLOSE-UP SURVEY OF HULL STRUCTURES USING REMOTE INSPECTION TECHNIQUES

3.1 Remote inspection techniques

The use of RITs in close-up surveys should be carried out by a firm certified by the Administration, in accordance with the *Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)* set out in the applicable annexes of the 2011 ESP Code.

3.2 Thickness measurement using RITs

To take thickness measurements using RITs, the firm should also be certified by the Administration, in accordance with the *Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)* set out in the applicable annexes of the 2011 ESP Code.

4 TRAINING REQUIREMENTS

4.1 General knowledge requirements

4.1.1 The training requirements should be reviewed by the Administration as part of the firm's certification referred to in section 3 (Certification of firms engaged in close-up survey of hull structures using remote inspection techniques). RIT firm personnel should be certified in accordance with the *Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)* as detailed in the 2011 ESP Code.

4.1.2 Personnel involved in remote inspection techniques (i.e. rope access technicians, UAV operators, thickness measurement equipment operators, etc.) should have appropriate knowledge of the following:

.1 marine and/or offshore terminology and nomenclatures;

.2 the structural configuration of relevant ship types, including internal structure;

.3 the remote inspection equipment and its operation;

.4 survey plans for examination of hull spaces of various configurations; including appropriate flight plans if using a UAV or path plans if using crawlers, legged robots or other RIT technologies;

.5 health and safety requirements, including industry guidance to work on ships and in potentially hazardous environments on tankers/bulk carriers and in enclosed spaces;

.6 concurrent operations on board the ship; and

.7 the role and responsibilities of the master and officer in charge (OIC) during RIT operations for effective communication.

4.2 Additional training requirements for rope access technicians

Rope access technicians should be trained in accordance with a national or international standard and certified by a recognized body (e.g. IRAT – Industrial Rope Access Trade Association, SPRAT – Society of Professional Rope Access Technicians).

4.3 Additional training requirements for URV operators

URV operators should be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration. The firm is responsible for ensuring its URV operators are duly licensed in accordance with the requirements of the local authorities (i.e. where the RIT survey will take place).

4.4 Additional training requirements for thickness measurement equipment operators

In addition to the operator training requirements, personnel performing thickness measurements should be certified in accordance with a national or international non-destructive testing (NDT) standard. This applies to both manned and unmanned techniques.

5 CONDITIONS AND LIMITATIONS ON THE USE OF REMOTE INSPECTION TECHNIQUES

5.1 General

5.1.1 In accordance with the 2011 ESP Code requirements, for ships up to and including the third renewal survey, consideration may be given by the Administration to allow the use of a RIT in achieving the objectives of a close-up survey, subject to the requirements in section 5.2 below. Additionally, for periodic surveys after the third renewal survey, the agreement and requirements of the Administration[4] to use a RIT to undertake close-up surveys should be obtained prior to undertaking the survey.

5.1.2 Close-up surveys conducted by using RITs should be completed in any case to the satisfaction of the attending surveyor, in accordance with the 2011 ESP Code requirements and these Guidelines. The 2011 ESP Code also requires that when a RIT is used for a close-up survey, means of taking the corresponding thickness measurements as specified in this section should be provided unless such a RIT is also able to carry out the required thickness measurements.

5.1.3 In addition to the conditions and limitations defined in the 2011 ESP Code, the considerations listed below should be taken into account when deciding on permitting the use of a RIT on a ship:

.1 structural condition of the ship;

.2 survey history of the ship;

.3 Port State and flag State performance of the ship; and

.4 the performance of the company as defined by the ISM Code.

[4] In the context of this paragraph, Administration means the Government of the State whose flag the ship is entitled to fly and not the recognized organization.

5.2 Limitations related to previous findings and conditions

5.2.1 Use of RITs should be restricted or limited where there is a record of abnormal deterioration or damage to the structure to be inspected. Remote inspection techniques should not be used in the following cases:

.1 for close-up survey and thickness measurement of areas where substantial corrosion was previously identified (e.g. during previous renewal or intermediate surveys);

.2 for close-up survey of ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in the 2011 ESP Code, or ballast tanks where a soft or semi-hard coating has been applied, or ballast tanks where a hard protective coating has not been applied from the time of construction;

.3 for areas already identified for repair (e.g. subject to a condition of the Administration); and

.4 in areas which have a recorded significant history of structural failures, defects, damage or deterioration (i.e. corrosion, cracks, and/or buckling), as defined in the 2011 ESP Code.

6 PLANNING AND PREPARATION

6.1 Risk assessment

A risk assessment should be carried out by the approved RIT firm at the planning phase to identify hazards and ensure appropriate risk controls are in place. These controls must be included in the survey programme and verified during the survey planning meeting. The risk assessment should include, as a minimum:

.1 RIT system minor failure (e.g. URV emergency landing/deployment);

.2 RIT system catastrophic failure (e.g. URV crashing and falling);

.3 battery depletion;

.4 loss of communication and signal interference issues;

.5 damage to the RIT system and ships due to collisions;

.6 risks related to tethered and untethered systems;

.7 interference with other works occurring simultaneously in the space or vicinity;

.8 operator(s) and surveyor(s) location during inspection;

.9 operation next to hazardous areas;

.10 involvement of relevant stakeholders (owners/crew/surveyor) in the risk assessment process to identify hazards; and

.11 consideration of the ship's specific structural arrangements and locations to use the RIT.

6.2 RIT inspection plan

The RIT inspection plan (see the sample form in appendix 1) should be submitted together with the survey planning questionnaire required by the 2011 ESP Code and the RIT System Statement of Capability, for review and acceptance in advance of the survey, and should include:

.1 type of survey;

.2 ship type, operational details, and other ship general information;

.3 location and the anticipated time frame for the survey and the operational status of the ship (e.g. shipyard, repair facility or lay-by berth);

.4 preparation of the ship and the spaces associated with the survey, including gas freeing prior to inspection, if applicable;

.5 logistics details, including permissions from local authorities, site permissions and work permits, as applicable;

.6 proposed RIT firm, including approval details;

.7 details of RIT equipment, recording facilities and associated RIT System Statement of Capability;

.8 details of RIT supporting equipment, including battery characteristics (operational time) and spare battery details;

.9 proposed structural locations where the RIT will be used, with details of possible hot spots;

.10 arrangements for the attending surveyor to perform confirmatory inspections by traditional means (e.g. safe access, cleaning/descaling, illumination, ventilation);

.11 a risk assessment, including safeguards to mitigate risk (see section 6.1);

.12 procedure and criteria to validate the use of a RIT for specific structure and conditions (light, humidity, cleanliness) at the start of inspection;

.13 details on how to report identified deficiencies; and

.14 methods for thickness measuring (simultaneously with a RIT). Additionally, when a RIT is able to take thickness measurements, supplementary details should be submitted, including TM firm approval, TM equipment, measuring capabilities (e.g. direction limitations) and operator(s) details/qualifications as per 2011 ESP Code requirements.

6.3 Survey planning meeting

6.3.1 Prior to the commencement of any part of the renewal or intermediate survey, a survey planning meeting should be held between the attending surveyor(s), the owner's representative in attendance, the thickness measurement firm representative, the RIT firm representative, where involved, and the master of the ship or an appropriately qualified representative appointed by the master or company to ascertain that all the arrangements envisaged in the ESP Code survey programme are in place, so as to ensure the safe and efficient conduct of the survey work to be carried out, taking fully into account the ship's safety management system.

6.3.2 The RIT inspection plan (included as part of the approved ESP Code survey programme) together with the RIT Statement of Capability should be reviewed during the survey planning meeting, to:

.1 confirm that the RIT system is suitable for the intended inspections, including certification to operate in hazardous areas (e.g. ATEX, IECEx), if the spaces are not in gas-free condition;

.2 confirm that the equipment on hand matches the RIT Statement of Capability;

.3 review RIT system access limitations and determine alternatives (e.g. provision of access, means to perform traditional close-up survey); and

.4 review RIT system capabilities related to defect quantification/measurment and determine whether further arrangements may be required (e.g. provisions of access, means to detect/identify/quantify/measure/NDT defects).

6.4 Pre-inspection verification

6.4.1 Prior to every survey on board, the RIT system should be verified and tested on-site to validate that under the existing conditions (i.e. light, humidity, structure cleanliness) the system can perform to the required standard and provide information with the same level of assurance as the close-up visual inspection. These verifications and tests should be witnessed by the attending surveyors.

6.4.2 This verification should be carried out using a printed version of the RIT Pre-Inspection Verification Card available in appendix 2.

6.4.3 If the RIT system is capable of undertaking cleaning/surface preparation, these should also be verified and tested on-site before being applied.

6.4.4 If the RIT is able to take thickness measurements, this capability should also be demonstrated on-site to the surveyor, including the calibration of the gauging device(s).

7 CONDUCT OF SURVEYS

7.1 General

7.1.1 When RIT systems are used to support the surveyor during close-up surveys, the attending surveyors should be present, witness the inspection and assess the RIT inspection and results. If the surveyor determines that goals and functional requirements for use of a RIT system (as defined in appendix 4) are not being achieved in a manner that substantially conforms with these Guidelines, the survey should be suspended immediately until or unless the goals can be achieved. The surveyor should be guided by the overarching goal as defined in appendix 4.

7.1.2 Random confirmatory surveys/close-up surveys should be carried out at locations selected by the surveyor for the purpose of verifying the results of the RIT.

7.1.3 The 2011 ESP Code requires that when the RIT reveals damage or deterioration that the surveyor judges to require attention or further investigation, the surveyor should require a traditional survey to be undertaken without the use of a RIT. Such survey should be conducted using the methods proposed by the owner in the survey programme and agreed upon before the surveys.

7.1.4 If the RIT reveals that the coating condition is less than GOOD as defined in the 2011 ESP Code, the surveyor should require a traditional survey to be undertaken without the use of a RIT. Such survey should be conducted using the methods proposed by the owner in the survey programme and agreed upon before the surveys.

7.1.5 The damage or deterioration identified and the surveyors' judgement should be detailed in the RIT report together with records of all live-streaming videos and images.

7.2 Data capture and recording

7.2.1 Video capturing requirements should be agreed with the surveyor prior to commencing the survey. As a minimum, representative video recordings should be made to:

.1 demonstrate the video quality of the RIT;

.2 demonstrate the general condition of the structure; and

.3 record all defects found using the RIT.

7.2.2 When recording, the ship, location on board and items being looked at should be identified. The identification can be done by audio, visual or 3D point cloud means, as well as by markers/labelling suitably placed onto the surfaces of the structures.

7.2.3 The pre-inspection verification process and random confirmatory close-up surveys should be included in the records of the live-streaming video with clear identification as detailed above.

7.2.4 The above guidelines may also be applied to data obtained with other technologies that were used to provide supplementary information (see paragraph 1.4).

7.3 Dealing with findings and deficiencies

7.3.1 Any damage or deterioration identified should be assessed by the surveyor and, if judged to require attention or further investigation, the surveyor should require a traditional survey to be undertaken without the use of a RIT.

7.3.2 Any damage or deterioration should be assessed by the surveyor, taking into consideration the requirements set out in the 2011 ESP Code and by the Administration.

8 REPORTING

8.1 General

8.1.1 The 2011 ESP Code requirements and survey reporting principles should be complied with. When thickness measurements are taken by remote inspection techniques, the results should be reported in accordance with the 2011 ESP Code's requirements and appropriate ESP TM forms.

8.1.2 After completion of the survey, the RIT firm should provide a comprehensive RIT Firm Inspection Report complemented by any relevant video recordings, as agreed with the surveyor, in accordance with the sample form in appendix 3.

8.1.3 The report should also include all supplementary data obtained with other technologies that were used to provide supplementary information (see paragraph 1.4).

8.2 RIT Firm Inspection Report

8.2.1 The RIT Firm Inspection Report should include at least the following:

.1 copy of the firm certificate of approval;

.2 copy of the RIT System Statement of Capability;

.3 general survey details (e.g. survey scope, survey dates);

.4 details of the equipment used (e.g. cameras, drone manufacturer, model, serial number);

.5 details of the spaces and areas examined;

.6 general condition results;

.7 method used for thickness measurements (if applicable);

.8 details of findings and defects, including categorization and size;

.9 any limitations on the scope of the survey or required deviation from the inspection plan;

.10 any spaces or areas unable to be accessed/examined and the reasoning;

.11 index of the video recordings or any other digital data recorded;

.12 records of all live-streaming videos and images used by the surveyor to assess the areas and structure subject to close-up survey with the RIT system; and

.13 records of all supplementary data obtained with other technologies.

APPENDIX 1

SAMPLE FORM

REMOTE INSPECTION TECHNIQUE (RIT) INSPECTION PLAN

This RIT Inspection Plan is prepared in accordance with section 6.2 of the *Guidelines on the use of remote inspection techniques for ESP Code Survey*s. It outlines the necessary details for planning and executing a RIT survey.

1. Basic information and particulars

Ship's name:
IMO number:
Flag State:
Port of registry:
Gross tonnage:
Deadweight (metric tonnes):
Length between perpendiculars (m):
Recognized organization (RO):
RO ship identity:
Date of build of the ship:
Owner:
Thickness measurement (TM) firm:

2. RIT firm and personnel details

Name of the RIT firm:
RIT firm base location (country):
RIT firm approval certificate No.:
RIT firm approval certificate expiry date:
TM approval certificate (when applicable[1]):
TM approval expiry date (when applicable[1]):
Supervisor details (name and relevant qualifications):
Operator(s) details (name and relevant qualifications):

Note 1 *Applicable when the RIT firm is also approved as a TM firm.*

3. Survey details

Type of survey: *e.g. renewal survey no.1, intermediate survey no.3*
Survey location:
Operational status: *e.g. in drydock ABC, alongside in ABC port, anchorage in ABC*
Survey time frame:
Additional information and logistics (when applicable): *e.g. include permissions from local authorities, site permissions, and work permits*
Ship and space preparation: *e.g. describe ship and space preparation associated with the survey, including gas freeing, if applicable*

4. RIT equipment details

RIT equipment details: *e.g. make and model*
RIT System Statement of Capability details: *e.g. issued by, document number, issuing date*
Powering supply arrangements: *e.g. tethered system, batteries*
Battery details (when applicable): *e.g. battery characteristics, operational time, number of backup batteries*
Tethered system details (when applicable): *e.g. external power supply requirements*
Live-streaming viewing screen details: *e.g. manufacturer, model, diagonal size and resolution*
Recording facilities details: *e.g. recording means, video resolution, storage capacity*

5. Areas subjected to close-up survey where it is proposed to use a RIT, with details of possible hot spots

e.g. (i) deck transverse web frame in cargo tanks, (ii) corrugated transverse bulkheads in cargo tanks, except lower stool external structure

6. Thickness measurement

Is the RIT system validated to take thickness measurements? *YES/NO* *(refer to the RIT System Statement of Capability)* *(If YES, the following sections are also to be completed)*
TM description and capabilities: *e.g. (i) unmanned robotic vehicle (URV) fitted with ultrasonic testing (UT) probe able to measure through coated structures, (ii) able to take thickness measurements in horizontal and upward orientations*
TM limitations: *e.g. (i) not able to take thickness measurements where there is coating breakdown, (ii) not able to take thickness measurements in downward and inclined directions*

7. Pre-survey verification procedures

e.g. (i) outline procedure and criteria to validate RIT use for specific structures and conditions, (ii) use of the RIT Pre-Inspection Verification Card

8. Additional arrangements for confirmatory surveys

e.g. safe access, cleaning/descaling, illumination, ventilation

9. Reporting

e.g. (i) written report in accordance with the Guidelines for the RIT for ESP Surveys, appendix 3 sample form will be delivered by the RIT firm within 14 days of completion,
(ii) all video recordings and images will be labelled in accordance with the written report,
(iii) all video recordings and images will be shared for downloading with the Administration (or recognized organization) via a cloud system,
(iv) the report will be supplemented by a copy of the firm approval certificate, RIT Inspection Plan and a RIT System Statement of Capability

10. Risk assessment summary

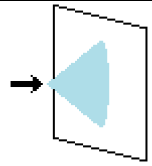
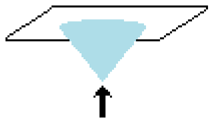
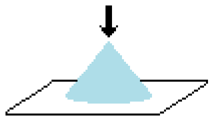
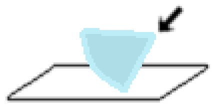
The table below provides an example of a risk assessment methodology (other methodologies may apply). The risk assessment should be in accordance with the RIT firm procedures.

No.	Scenarios	Causes	Consequences	Risk			Mitigation measures
				L	S	R	
1							

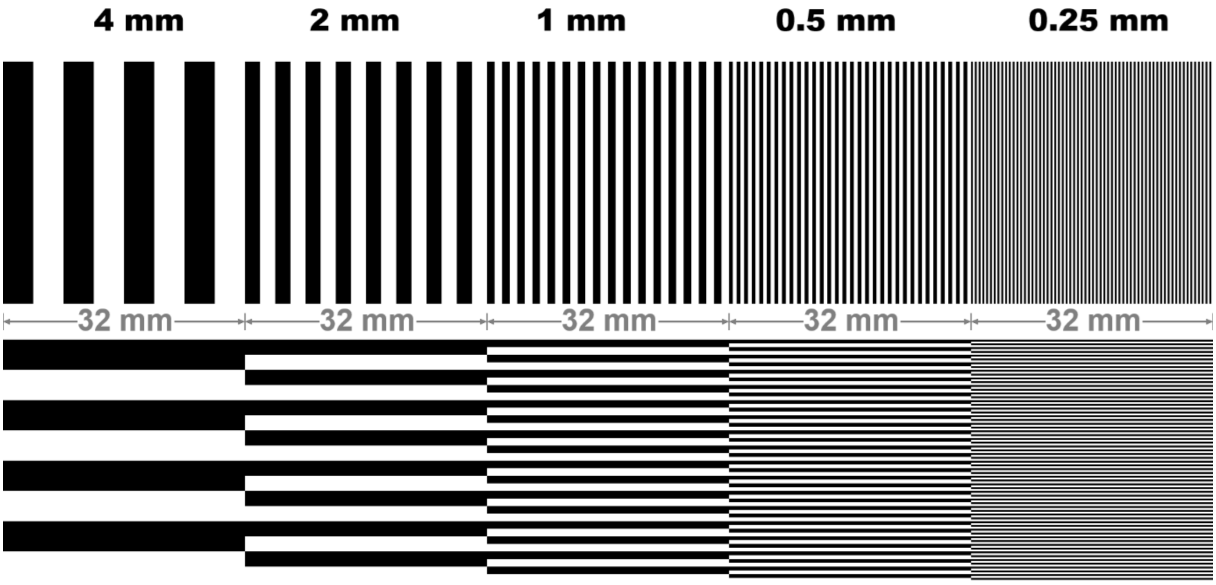
APPENDIX 2

REMOTE INSPECTION TECHNIQUE (RIT) PRE-INSPECTION VERIFICATION CARD

The following two pages should be colour printed on an A4 size paper using a recommended minimum resolution of 600 dpi and placed on a flat structural element in position 1. Confirm equipment is pre-calibrated, and communication tests are carried out prior to the verification, as applicable. The verification should be repeated in positions 2, 3 and 4 when the areas to be inspected require it. The capturing equipment should be deployed (e.g. unmanned aerial vehicles (UAV) should be flying), and the validation tests below (resolution, detail, contrast and colour) should be carried out.

Position 1 Front view	**Position 2** Overhead view	**Position 3** Bottom view	**Position 4** Angle view
			

Resolution verification
All vertical and horizontal stripes should be visible within the five thickness grades:



Detail verification

The following pangrams should be legible down to a size of 1.8 mm:

4.9 mm	"Jinxed wizards pluck ivy from the big quilt."
4.2 mm	"The five boxing wizards jump quickly."
3.9 mm	"Bright vixens jump; dozy fowl quack."
3.5 mm	"The quick onyx goblin jumps over the lazy dwarf."
3.2 mm	"Amazingly few discotheques provide jukeboxes."
2.8 mm	"Crazy Fredrick bought many very exquisite opal jewels."
2.5 mm	"Jovial zookeeper quickly brightens the fun with mixed quizzical antics."
1.8 mm	"Jack quickly vexed the dwarf with his amazing gymnastic skills."

Contrast verification:
All 25 numbers in the rectangles should be readable:

67	940	55	844	124
418	130	311	724	175
659	36	634	71	829
266	423	647	80	446
584	690	281	30	366

Colour verification:
Each colour spectrum should be discernible:

Red	Yellow	Green	Cyan	Blue	Magenta

Red	Red brown	Dark brown	Light brown	Brown orange	Orange yellow

APPENDIX 3

SAMPLE FORM

REMOTE INSPECTION TECHNIQUE (RIT) FIRM INSPECTION REPORT

Ship details:
Name: ....
IMO number: ....
Recognized organization (RO)/Administration identity number: ....
Port of registry: ....
Ship type: ………………………………………………………………………………………….
Gross tonnage: ....
Deadweight: ....
Date of build: ....
Recognized organization (RO): ....

RIT firm details:[1]
Name: ....
Approval certificate no.: ....
Approval certificate valid from: .... to ....

> ***Note 1*** *A copy of the RIT firm certificate of approval to be submitted together with the report.*

Survey details:
Survey: ....
Place of survey: ....
Survey dates from: .... to ....

RIT system details:[2]
RIT method: *e.g. unmanned robotic vehicle (URV) (drone), rope access, etc*............................
URV manufacturer, model and serial number (if applicable):..
Camera manufacturer, model and serial number:...
Screen manufacturer, model and serial number:...

> ***Note 2*** *A copy of the RIT System Statement of Capability to be submitted together with the report.*

Thickness measurement:[3]
Method used for thickness measurement: ……..

> ***Note 3*** *Thickness measurement report to be submitted in accordance with the ESP Code report.*

Report number: .... consisting of .... pages
Name of operator: .... Name of surveyor: ....
Signature of operator: .... Signature of surveyor: ....
Firm official stamp: .... Administration: ....

Spaces and areas subjected to close-up survey using a RIT

e.g. *COT No3P:* - *deck transverse web frame, frame no. 71* - *corrugated transverse bulkheads no 68 and 75*

Spaces and areas subjected to thickness measurement using a RIT (if applicable)

e.g. *COT No3P:* - *deck transverse web frame, frame no. 71* - *corrugated transverse bulkheads no 68 and 75*

RIT survey limitations on the scope of the survey or required deviations from the inspection plan

e.g. (i) limitations on the scope of the survey, (ii) required deviations from the inspection plan, (iii) spaces or areas unable to be accessed/examined and reasoning

Report general condition

e.g. *COT No3P:*

Findings and defects

e.g. *COT No3S:*

Pre-inspection verification details

e.g. Prior to commencing of the survey, the pre-inspection verification was carried out in accordance with <RIT firm procedure reference> using the RIT Pre-Inspection Verification Card, as provided in appendix 2 of the Guidelines on the use of remote inspection techniques for ESP Code Surveys

Index of video recordings and images

All video recordings and images listed below are included in <*storage media name*> which is part of this report. *e.g.* *COT No1P:*

Index of supplementary data obtained with other technologies

Index of other documents

e.g. RIT firm certificate of approval, RIT System Statement of Capability

APPENDIX 4

TECHNICAL PROVISIONS, ASSESSMENT AND CERTIFICATION OF REMOTE INSPECTION TECHNIQUE (RIT) SYSTEMS AND ASSOCIATED DIGITAL TECHNOLOGIES FOR DETECTION AND SIZING OF STRUCTURAL DEFECTS

1 General

1.1 Remote inspection technique (RIT) systems may be based on different technologies, typically either manned (e.g. rope access technicians, telescopic cameras) or unmanned (e.g. using unmanned robotic vehicles (URV)).

1.2 Different technologies will result in different capabilities (e.g. accessibility, navigation, stabilization, imaging and thickness measurements). Additionally, the continuous innovation and development of new technologies require assessment flexibility; therefore, this document uses a goal-based approach. As such, new RIT systems should be assessed by the Administration (as defined in the 2011 ESP Code) to validate their design and performance against the goals and functional requirements set out in section 2.

1.3 The assessment should include a review of documentation including the intended use, equipment data, types of sensors, automation and conditions, followed by performance testing to the satisfaction of the Administration. A final onboard test should also be carried out before issuing the permanent documentation. The assessment should confirm that the RIT system can provide information with at least the same level of assurance as the traditional close-up visual inspection, i.e. normally within reach of hand (as defined in the 2011 ESP Code).

1.4 On satisfactory completion of the assessment, the Administration should issue a RIT System Statement of Capability (in accordance with the sample form set out in the appendix to this appendix 4), which should include, as a minimum:

.1 RIT system basic details (type of equipment, equipment manufacturer, model, version no., etc.);

.2 types of structure subject to close-up for which the RIT system has been designed to perform (e.g. cargo holds, cargo tanks or ballast tanks);

.3 data capture/collection associated with the sensors, including thickness measurement capability, if provided;

.4 data review and analysis methods associated with the RIT system;

.5 illumination conditions (e.g. external light requirements);

.6 condition of structure/space;

.7 defect type detection/identification capability, if provided;

.8 defect type quantification/sizing capability, if provided;

.9 automation capabilities relating to navigation, data collection and analysis as further specified in the following;

.10 equipment to visualize and record the live-streaming video and images;

.11 certification for electrical equipment capable of operating in hazardous areas (explosive gas atmospheres or in the presence of combustible dusts), if provided; and

.12 power supply concept (e.g. battery capacity and expected lifetime, details of tethered systems).

1.5 The RIT System Statement of Capability is only valid for the assessed design type.

1.6 Any change in the design and capability of the RIT system, which impacts on the performance criteria against which it has been tested, invalidates the RIT System Statement of Capability and retesting may be required. The URV manufacturer or the RIT firm should notify the Administration whenever changes are made and the RIT system should be subjected to reassessment whenever the goals and functional requirements are affected.

2 Goals and functional requirements

The overarching goal of any RIT system is to provide information with the same level of assurance as a traditional close-up visual inspection to ensure that the inspection results are at least equivalent to those obtained by a surveyor conducting a close-up survey, i.e. normally within reach of hand, in accordance with the 2011 ESP Code.

The RIT system should be designed and tested to meet goals related to its:

.1 fitness for purpose (section 2.1);

.2 safety (section 2.2);

.3 efficiency (section 2.3);

.4 data accuracy and integrity (section 2.4);

.5 data retention (section 2.5); and

.6 thickness measurements (when applicable) (section 2.6).

Each goal is supplemented by functional requirements and expected performances (EP) detailing the capabilities and requirements that the RIT system needs to comply with to achieve the applicable goals, which should be taken into account when issuing a RIT System Statement of Capability to a system manufacturer or RIT firm.

The evaluation criteria of each goal and functional requirement are based on the capability of the RIT system to provide information with the same level of assurance as a traditional close-up visual inspection to ensure that the inspection results are at least equivalent to those obtained by a surveyor conducting a traditional survey as mentioned above. Assessment and validation of the capabilities may be obtained by testing protocols comparing the inspection outcomes quantitatively, i.e. on the basis of appropriate parameters and measurements.

2.1 Fitness for purpose

Goal

RIT systems should provide accurate, reliable and consistent performance under the various environmental conditions and in the relevant space/structures for which they are designed.

Functional requirements

2.1.1 The equipment forming part of the RIT system should be able to provide the inspection data in the environment and conditions intended for its use, which should be specified in full detail (e.g. ship type, structure and its location). Transfer of data between components of the RIT system (e.g. between vehicle camera and viewing screen) should not be affected by the ship's surrounding structure, equipment or systems.

2.1.2 Any equipment forming part of the RIT system should not interfere with the operation of equipment on board.

2.1.3 For RIT systems using unmanned robotic vehicles, the URV should possess sufficient manoeuvrability to navigate complex environments and perform inspection tasks.

EP.1 The design should ensure smooth and controlled movements, allowing the URV to access hard-to-reach areas and operate effectively in confined, narrow and/or geometrically complex spaces.

EP.2 Manoeuvrability should be maintained under various operational conditions to ensure consistent performance within different structural arrangements.

EP.3 The URV should have sufficient manoeuvring characteristics to permit inspections on structures with stiffening elements, including collision braking and fall avoidance functions.

EP.4 The URV should have stabilization and hovering capabilities to provide a stable and clear live-streaming video and images.

EP.5 The URV should locate itself onboard accurately determining its position, thus enabling proper data acquisition.

2.1.4 The RIT system should be capable of accessing and examining all structural areas within a space for which it is designed that would otherwise require the provision of temporary or alternative means of access for close-up surveys. This includes the ability to inspect plating and stiffening elements from all required sides and orientations (e.g. frontal, overhead, lateral) via live-streaming video and images.

EP.1 Any inaccessible areas should be explicitly listed in the RIT System Statement of Capability issued by the Administration (e.g. unable to pass through manholes under 800 x 600 mm in size, unable to operate in spaces with less than 2 m width, unable to overcome stiffeners greater than [x] mm in height, unable to acquire data under faceplates of stiffening members if spaced less than [x] mm apart).

2.1.5 The RIT system should be able to provide stable and clear live-streaming video and images of the hull structure area being inspected.

EP.1 Equipment stabilization should be sufficient to address the environmental and working conditions, as well as any disturbances, such as air drafts, humidity, vibrations, etc.

EP.2 The RIT system should be equipped with tools for sensor cleaning sufficient to address the environmental and working conditions, such as wiping fogged lenses, etc.

2.2 Safety

Goal

The design and operation of the RIT system should ensure the safety of all personnel involved in or affected by its use, including operators, surveyors, seafarers and any personnel on board, and prevent any damage to ships and equipment.

Functional requirements

2.2.1 RIT systems should be provided with protection to safeguard persons, the ship's structure, equipment, piping, coatings and the RIT system itself. For URV systems, the vehicle movement (e.g. flying, rolling or crawling) and any securing features (e.g. magnetic gripping, harnesses) should not damage the ship's structure, piping, equipment and coatings.

EP.1 High-speed rotating parts (e.g. UAV propellers) should be provided with cages or protection to avoid direct contact with the structure or persons.

EP.2 UAV design should consider collision avoidance, which may include automatic collision prevention or any other measures to mitigate collision risks.

EP.3 For RIT systems using unmanned robotic vehicles, the URV should be equipped with visual indicators to display the equipment status (e.g. battery status, signal).

EP.4 Any part of the RIT system which generates heat and may become hot (e.g. engines, batteries, spotlights) should be marked, insulated or protected.

2.2.2 For RIT systems using unmanned robotic vehicles, the URVs should have sufficient redundancy to avoid any incident.

2.2.3 For RIT systems using unmanned robotic vehicles, power and communications failures (including low battery) should be mitigated by appropriate technical measures. This may include emergency landing capabilities, fall arrestors or safe return systems and/or other technical solution.

2.2.4 Tethered RIT systems' cables (i.e. for power supply and communications purposes) should comply with applicable national or international standards. Cable construction should be such as to avoid entanglement in structural elements or fittings.

2.3 Efficiency

Goal

The design and operation of the RIT system should ensure operational efficiency under all specified conditions.

Functional requirements

2.3.1 The RIT system should be provided with sufficient power during inspection activities:

EP.1 For battery-powered RIT systems, including battery-powered elements (e.g. URV, screens, remote controllers), measures should be taken to ensure a smooth survey process. This includes but is not limited to:

.1 An individual power management plan should be provided for each inspection activity, including planned duration, number of required batteries, individual battery capacity, recharging means and segregation of charged batteries from depleted batteries, position of charging facility during inspection, etc.

.2 A sufficient number of batteries and charging facilities should be provided in order to ensure that the total charging ratio is higher than the consumption ratio. While interruptions for battery replacement are expected, the objective should be to ensure continuous operation as far as possible, and that any inspection is not prematurely interrupted owing to lack of power.

EP.2 For wireless equipment, the battery status should be available to the operator at all times.

EP.3 For non-electrical RIT systems, the power source should be managed to last the planned duration and replacements should be available following the principles of electrical RIT systems as far as is practicable.

EP.4 Tethered RIT systems should ensure power transmission in any planned situation, including in extended and geometrically complex areas.

2.3.2 URVs should be able to efficiently adjust speed according to the space under survey and the task being performed (e.g. commuting, moving and inspecting, remaining steady in a specific area, even in the case of disturbances).

2.4 Data accuracy and integrity

Goal

The design and operation of the RIT system should ensure at least the same level of accuracy and integrity as a traditional close-up visual inspection (without use of a RIT).

Functional requirements

2.4.1 Adequate procedures should be in place to ensure the reliability and usability of the information gathered during inspections, including calibration, pre-inspection verification and adaptability of their sensors.

EP.1 RIT system sensors should be capable of being calibrated or verified prior to any survey, to confirm their satisfactory performance and data accuracy under real conditions.

EP.2 RIT system sensors should be capable of adjusting to conditions during survey, by either self-adjusting or remote adjusting by operator (URV-based systems).

2.4.2 The RIT system should collect and process data with accuracy and integrity. As a minimum, the equipment should be able to provide live-streaming video that is considered equivalent to a traditional close-up visual inspection.

EP.1 Video cameras should provide live-streaming video and images with a minimum HD resolution (1280 x 720 pixels).

EP.2 The visualization monitors/screens should have a minimum HD resolution (1280 x 720 pixels) and a minimum diagonal size of 12 inches.

EP.3 The RIT system should be able to provide live-streaming video of localized details of the structure inspected (e.g. by zooming function, by being able to stand close to the structure or both).

2.4.3 The RIT system video cameras should be able to adjust to low lighting environments and be sufficiently protected from expected vibrations.

EP.1 Cameras should be provided with image stabilization (either optical, digital, sensor-shift, mechanical or other means).

2.4.4 The RIT system live-streaming video and images should be clear and free of distortion. The colours should yield a meaningful representation of the structural details.

2.4.5 The RIT system should be able to take high-resolution images simultaneously with the live-streaming videos.

2.4.6 The use of other sensors should not replace the required video live-streaming capability and should not affect its performance.

2.4.7 The RIT system should be capable of being used to detect/identify the specified defects in the steel structure of ships, including:

.1 cracking (fractures);

.2 deformation (contact damage, dents or buckling);

.3 corrosion (including general wastage, edge wastage, grooving and pitting); and

.4 coating breakdown.

2.4.8 For the specified structural and lighting conditions, the RIT system should be capable of being used to assess the coating condition in accordance with the 2011 ESP Code.

2.4.9 The surveyor should be able to roughly assess the size of a defect by visual means (e.g. visual comparison with the stiffener spacing or dimensions). When it is specified that the RIT system is capable of being used to quantify/measure identified defects (e.g. crack length, dent depth, corrosion area width and height), the measurement capabilities and accuracy should be assessed and recorded in the RIT System Statement of Capability.

2.5 Data retention

Goal

The design and operation of the RIT system should ensure sufficient and comprehensive evidence retention of data.

Functional requirements

2.5.1 The RIT system should be provided with video recording capability and sufficient storage capacity to retain live-streaming video, images and any other data of the inspected areas, as detailed in the guidelines.

EP.1 Recording and capturing functions should be controlled in real time by the operator (i.e. the operator should be able to start/stop recording or take an image from the local controls).

EP.2 The enabling or disabling of recording should not affect the live-streaming video performance.

2.5.2 All recorded evidence should be tamper-proof and easily retrievable for sharing, review and analysis. Mechanisms should be in place to ensure the integrity and authenticity of the recorded data.

EP.1 The recordings should be exportable using traditional video formats (e.g. mp4) that may be reviewed later.

EP.2 The recording metadata type (e.g. date, time, geolocation) as well as the video quality features should be listed in the RIT System Statement of Capability.

2.5.3 Any other data collected in addition to videos and images should be listed in the RIT System Statement of Capability along with their accuracy and acquisition specifications.

EP.1 The data should include the sampling frequency, geolocation, synchronization with video, etc.

2.5.4 Data transmission and presentation should be efficient and sufficiently accurate for ESP structural assessment, satisfactorily fulfilling the survey scope and information needs, duly considering the survey time frame and their usage in practice on board.

2.6 Thickness measurements (TM)

Goal

The design and operation of RIT systems intended to be used to take thickness measurements should ensure the same accuracy, integrity, and efficiency as traditional manual thickness measurement techniques.

Functional requirements

2.6.1 The URV should be able to maintain a steady position against the structural element while the equipment is taking a thickness reading.

2.6.2 The equipment should be able to take measurements in different orientations.

EP.1 The measuring orientations and the means to adjust them (e.g. remotely controlled by the operator, manual adjustment before URV deployment) should be defined and listed in the RIT System Statement of Capability. The applicable measuring orientations should be defined and specified as in figure 1, and as follows:

a horizontal (e.g. TM gauging of bulkheads, deck transverse web, web frames and similar plating);

b downward (e.g. TM gauging of stringers, horizontal stiffeners and similar plating);

c upward (e.g. TM gauging of deck plating, deck transverse face plate and similar plating);

d inclined downward (e.g. TM gauging of hopper plating); and

e inclined upward (e.g. TM gauging of topside tank plating).

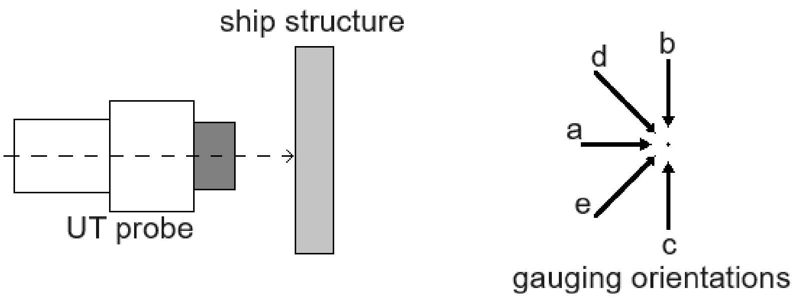


Figure 1: Representation of measuring orientations

2.6.3 The equipment should be able to take readings through coating on coated surfaces.

EP.1 The technique applied to enable thickness measurement on coated surfaces should be listed in the RIT System Statement of Capability (e.g. ultrasonic testing (UT) probes using the pulsed echo technique).

EP.2 Additionally, when the equipment is able to take measurements on corroded surfaces, this should be verified by testing on samples with different levels of corrosion (e.g. light surface rust, moderate corrosion, heavy corrosion, severe corrosion). The technique applied to enable thickness measurement on corroded surfaces should be listed in the RIT System Statement of Capability (e.g. surface cleaning tool).

2.6.4 The equipment should be able to operate continuously, allowing a reasonable number of measurements to be taken before retrieval of the URV.

EP.1 The applicable details of how the system operates continuously (e.g. power source, built-in supply of coupling gel) should be listed in the RIT System Statement of Capability.

2.6.5 The gauging results should be streamed in real time to the operator.

2.6.6 The operator should be able to clearly distinguish consecutive measurement results.

2.6.7 The equipment should provide accurate measurements. A means to assess gauging accuracy and calibration should be available during surveys. Thickness measurement calibration should be carried out before work commences, and the accuracy of measurements should be demonstrated to the surveyor's satisfaction.

EP.1 The thickness measurement readings should have a minimum accuracy of 0.1 mm.

2.6.8 If the RIT system is provided with georeferenced data capture capability (i.e. the ability to associate each thickness measurement reading to a particular location in space), the recording and labelling method should be assessed. The data should be presented in a way that supports the preparation of the thickness measurement report.

3 Information to be submitted

3.1 All RIT systems

When applying for the assessment of RIT systems, at least the information listed below should be submitted.

3.1.1 Information on the cameras and display screens provided to enable live-streaming video and images:

.1 manufacturer details and model designation;

.2 resolution (video and images, if different);

.3 for display screens, size (e.g. 12 in);

.4 for video cameras, frame rate (e.g. 30 fps, 60 fps);

.5 camera sensor type (e.g. CMOS, CCD);

.6 camera lens type (e.g. fixed, interchangeable);

.7 camera lens focal length and aperture (e.g. 17–50 mm, f/2.8);

.8 zoom capabilities (e.g. 10x optical, 10x digital);

.9 image stabilization characteristics (e.g. optical, digital, sensor-shift, mechanical); and

.10 other image quality enhancements (e.g. HDR, low-light performance).

3.1.2 Information on the additional data-collection sensors and their technical features, examples being:

.1 infrared/thermal camera;

.2 stereoscopic (3D) camera;

.3 RGB-D camera;

.4 laser scanning; and

.5 TM probe.

3.1.3 Information on the lighting conditions, illumination minimum requirements and other environmental limitations for the intended inspection use(s), which may be:

.1 daylight, e.g. external or in a cargo hold with hatch covers open;

.2 lit by artificial light separate from the RIT system;

.3 using only RIT system mounted lighting;

.4 moisture, humidity; and

.5 dust and other contaminants.

3.1.4 Information on the data retention details, including:

.1 recording support system (e.g. SD card, in-built drive, external recorder);

.2 video recording format (e.g. mp4, avi, mkv, mov, wmv);

.3 image format (e.g. png, jpeg, tiff); and

.4 file metadata details (e.g. date, time, geolocation).

3.2 URV-based systems

Additionally, when applying for the assessment of RIT systems based on URV technology, the information listed below should be submitted.

3.2.1 Information on:

.1 URV manufacturer details and URV model designation;

.2 URV description and basic drawings;

.3 communication details (wired, wireless and applicable frequency bands);

.4 data presentation details (e.g. data management, visualization); and

.5 copies of any other certificates the URV may have.

3.2.2 Information on intended use:

.1 types of structure subject to close-up survey for which the URV has been designed to perform inspections (e.g. cargo holds, cargo tanks or ballast tanks);

.2 any areas of the specified inspections that the URV has not been designed to examine;

.3 the defect types the URV has been designed to detect/identify (considering the functional requirements as defined in 2.4.7);

.4 the defect types the URV has been designed to quantify/size; and

.5 the lighting and cleanliness requirements necessary for the URV to perform the work properly.

3.2.3 Information on the levels of navigation automation, which may be:

.1 manual control; or

.2 semi-autonomous control (e.g. position hold and collision avoidance).

3.2.4 Information on the levels of sensor automation, which may be:

.1 sensor operation manual; or

.2 sensor operation semi-autonomous.

3.2.5 Information on data presentation details, including:

.1 description of data management system (e.g. storage on board, transmission to base station or to remote servers); and

.2 description of presentation of data to the URV users (e.g. tablet display for videos, spreadsheets for data).

3.2.6 Information specifying what type of training should be undertaken by URV operators.

4 RIT system performance tests

4.1 General requirements

4.1.1 Tests should be performed as specified below to demonstrate that the RIT system meets the goals and functional requirements. Testing protocols should be defined, providing practical approaches to obtain objective evidence that evaluation criteria corresponding to goals and functional requirements are satisfactorily fulfilled.

4.1.2 The testing should be carried out in an environment that replicates the space of the specified survey type(s) for which the RIT system is intended to be used. This includes the environmental and lighting conditions, as well as the structural condition of the space/structure to be surveyed. Alternatively, the testing may be carried out on board a ship. In such a case, adequate environmental and lighting conditions as well as satisfactorily representative structural conditions including comprehensive and reliable information on space/structure to be surveyed should be available for the trials and subsequent assessment of the RIT system.

4.1.3 The test environment, whether real (i.e. a ship) or replicated (i.e. testing laboratory), should contain the specified defects and those defects should be duly detected, identified and characterized in advance and scattered throughout the space. Testing may be undertaken over a series of tests.

4.1.4 The defects to be considered in tests should be in accordance with paragraph 2.4.7.

4.1.5 Prior to testing, a test programme including a detailed description of testing protocols and assessment criteria for each test carried out should be submitted to the Administration for review and acceptance. The test programme should include the location at which the tests are to be held (i.e. a test facility or ship's name and IMO number) and a series of steps that are adequate to assess the intended capabilities of the URV with respect to all the applicable goals and functional requirements.

4.1.6 The tests should be witnessed by, and conducted to the satisfaction of, the attending surveyor of the Administration.

4.1.7 Reports, live-streaming video recordings, and images should be retained by the Administration.

4.2 Onboard testing

4.2.1 The surveyor of the Administration should witness the tests conducted to confirm the compliance with the 2011 ESP Code and these Guidelines.

4.2.2 Once the RIT system is provided with a provisional RIT System Statement of Capability, the RIT system should be tested under real conditions, either during an ESP survey or during an onboard demonstration.

4.2.3 Planning of onboard testing should be done in consultation with the master of the ship to ensure the testing procedure considers each ship's specific safety management system, in particular any interactions among the master, officer in charge, operator(s) and the surveyor(s).

4.2.4 As part of the onboard demonstration, a survey trial in the presence of the surveyor of the Administration should be carried out to demonstrate that the RIT system can be effectively used during an ESP survey. The trial should include a pre-inspection verification in accordance with section 6 (Planning and preparation), by using the RIT Pre-Inspection Verification Card (in appendix 2), followed by a confirmatory survey, in accordance with section 7 (Conduct of surveys), where the results are compared with a traditional close-up survey technique.

4.2.5 Reports, live-streaming video recordings, and images should be retained by the Administration.

5 RIT System Statement of Capability

5.1 Provisional RIT System Statement of Capability

Following the document review and after satisfactory completion of the tests addressed under section 4.1 (General requirements), the Administration may issue a provisional RIT System Statement of Capability.

5.2 Full-term RIT System Statement of Capability

After satisfactory completion of the onboard testing addressed under section 4.2 (Onboard testing), the Administration may issue a full-term RIT System Statement of Capability.

APPENDIX

SAMPLE FORM
<PROVISIONAL*> RIT SYSTEM STATEMENT OF CAPABILITY

This statement is issued to: ……………. *e.g. URV manufacturer or RIT firm*
Address: …………………………………. *e.g. URV manufacturer or RIT firm address*
Date of issue: …………………………… DD/MM/YYYY

The <Administration> has assessed the below RIT system in accordance with the *Guidelines on the use of remote inspection techniques for ESP Code surveys* (MSC.1/Circ.1700), appendix 4, to confirm that the system can be used to support the 2011 ESP Code close-up survey by providing information to the surveyor with the same level of assurance as traditional close-up visual inspection with the characteristics, capabilities and limitations as indicated below.

<*This statement is considered provisional, pending the satisfactory completion of an onboard testing on a ship in accordance with MSC.1/Circ.1700, appendix 4, section 4.2.>

1. System identification

RIT method: *e.g. unmanned or manned*
Method description: *e.g. (i) unmanned aerial vehicle, battery powered and remotely controlled by a pilot, (ii) portable camera transported and manoeuvred by a rope access technician*
Manufacturer:
Model and version:

2. Capabilities

2.1 Fitness for purpose: *e.g. The vehicle may be deployed in enclosed spaces, including cargo holds, cargo tanks, ballast tanks, other tanks, void spaces and on the open deck with light wind conditions. The screen and controllers may be used in the same spaces. The vehicle may access hard-to-reach areas and can pass through manholes and other openings with a minimum radius of 400 mm (see details below).*
2.2 Safety: *e.g. The URV propellers have physical protection, and the vehicle can withstand light contacts with the surrounding structure without damaging itself or the ship's structure, fittings or coating. The system is able to fly with one motor down and is provided with automatic emergency landing which will be initiated whenever there is a low battery warning or failure of one of the motors.*
2.3 Efficiency e.g. *Manoeuvrability functionalities include the ability to hover steadily and move at very low speed. Camera system has independent rotational features that allows it to rotated around the horizontal axis (180º up-down). The system is provided with spare batteries and recharging facilities, as detailed below. Battery state-of-charge is continuously monitored, and information is available to the operator in the remote controller.*

2.4 Data accuracy and integrity e.g. *Live-streaming video with high definition that allows the surveyor to detect all applicable defects, including cracking, deformation, corrosion, and coating breaking. Camera provided with optical stabilization and zoom x10. The system is also provided with LiDAR system that allows 3D mapping of the structure and detection of deformations. (see details below)*
2.5 Data retention *e.g. Live-streaming video may be recorded to a SD card, on request of the operator. High-definition photographs may also be taken on request of the operator. (see details below)*
2.6 Thickness measurements *e.g. Thickness measurement capability not provided.* *e.g. Able to take thickness measurements on smooth surfaces (see details below)*

3. Defect detection and quantification (see note A)

Item	Detection	Quantification
Cracks	Yes	Yes (length)
Deformation	Yes, LiDAR	Yes (height, width and depth)
Corrosion	Yes	No
Coating breakdown	Yes	Yes (height and width)
Note A: As a core requirement, the live-streaming video should have sufficient quality to allow the surveyor to visually identify all defects, including assessing relative position and size. This table refers to RIT system additional capabilities for the machine to independently detect and measure defects which may be used as supplementary information to the surveyor, but it is not a replacement of the live-streaming video core capabilities.		

4. Intended use

Spaces: *e.g. cargo holds, cargo tanks, ballast tanks*
Structure: *e.g. plating, ordinary stiffeners, primary members, brackets, welds*
External illumination requirements (if any): *e.g. minimum lux*
Other pre-inspection requirements: e.*g. cleaning of spaces, labelling of frame numbers, safety ropes*
Level of navigation automation: *e.g. remotely operated, tethered-operated, radio-operated*

5. Limitations

Inaccessible areas, including passage through structure openings and manholes, and structural condition constraints:
Environmental constraints:
Operational constraints:

6. Live-streaming equipment details

Camera manufacturer and model:
Camera specifications: *e.g. image resolution, frame rate, sensor type*
Display screen manufacturer and model:

Display screen specifications: *e.g. resolution, size*
Zoom capabilities:
Image stabilization features:

7. Photography equipment details (if not the same device or details as in 6)

Camera manufacturer and model:
Camera specifications: *e.g. image resolution, sensor type*
Lens specifications: *e.g. focal distance, aperture*
Zoom capabilities:
Image stabilization features:

8. Other sensors details

Additional sensor 1 specifications: *e.g. laser scanning*
Additional sensor 2 specifications:
Additional sensor 3 specifications:

9. Thickness measurement system details (if applicable)

Method: *e.g. ultrasonic, eddy current*
Probe specifications: *e.g. for UT indicate probe frequency*
Measuring orientations: *e.g. horizontal, upward, inclined upward*
Means to change measuring orientation: *e.g. remotely controlled, manual replacement*
Other information: *e.g. provided with coupling gel dispenser, multiple-echo enabled*
Surface condition: *e.g. intact condition only, corrosion to be removed prior to measurements*

10. Data handling details

Recording formats (video, image, database):
Metadata details (date, time, geolocation, annotations):
Storage and export capabilities:
Data integrity and tamper-proof measures:

11. Other details

Power supply: *e.g. battery capacity, expected lifetime, and details of tethered systems*
IP rating:
Hazardous areas certification and rating:

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INTERNATIONAL MARITIME ORGANIZATION

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MSC.1/Circ.1701
6 July 2026

INTERIM GUIDELINES FOR THE SAFETY OF SHIPS USING HYDROGEN AS FUEL

1 The Maritime Safety Committee, at its 111th session (13 to 22 May 2026), having considered a proposal by the Sub-Committee on Carriage of Cargoes and Containers, at its eleventh session (8 to 12 September 2025), recognizing the importance of providing criteria for the safe use of hydrogen fuels on board ships so as to provide at least the same level of safety and reliability as new and comparable conventional oil-fuelled main and auxiliary machinery installations, approved the *Interim guidelines for the safety of ships using hydrogen as fuel* (the Interim Guidelines), as set out in the annex.

2 Member States are invited to bring the Interim Guidelines to the attention of shipbuilders, manufacturers, shipowners, ship managers, masters and ship crews, bareboat charterers and all other parties concerned.

3 Member States are also invited to recount their experience gained through the use of the Interim Guidelines to the Organization for the Committee to keep them under review.

***

ANNEX

INTERIM GUIDELINES FOR THE SAFETY OF SHIPS USING HYDROGEN AS FUEL

1 INTRODUCTION

1.1 The purpose of these Interim Guidelines is to provide an international standard for the safety of ships using hydrogen as fuel.

1.2 The basic philosophy of these Interim Guidelines is to provide provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using hydrogen as fuel in order to minimize the risk to the ship, persons on board and the environment.

1.3 Throughout the development of these Interim Guidelines, it was recognized that the provisions therein must be based on sound naval architectural and engineering principles and the best understanding of operational experience, field data and research and development. These Interim Guidelines address areas identified as needing special consideration for the use of hydrogen as fuel.

1.4 These Interim Guidelines follow the goal-based approach (MSC.1/Circ.1394/Rev.2) by specifying goals and functional requirements for each section forming the basis for the design, construction and operation of ships using hydrogen as fuel.

1.5 The current version of these Interim Guidelines includes provisions to meet the functional requirements for hydrogen as fuel.

1.6 These Interim Guidelines have been closely aligned with the International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels (IGF Code), adopted by resolution MSC.391(95), as amended, in particular chapter 3, which is mainly text taken from chapter 3 of the IGF Code, albeit modified to reflect the recommendatory nature of these Interim Guidelines.

2 GENERAL

2.1 Application

Unless expressly provided otherwise, these Interim Guidelines should apply to ships using liquified and/or compressed hydrogen as fuel to which part G of SOLAS chapter II-1 applies.

2.2 Definitions and abbreviations

2.2.1 Reference is made to the definitions provided in the IGF Code, adopted by resolution MSC 391(95), as amended, part A, paragraph 2.2. Additional definitions are provided below.

2.2.2 For the purpose of these Interim Guidelines, the terms used have the meanings defined in the following paragraphs. Terms not defined have the same meaning as in SOLAS chapter II-2 and the IGF Code.

2.2.3 *Cold hydrogen vapour* means hydrogen vapour at a sufficiently low temperature to cause condensation of air, at or below -183°C.

2.2.4 *Compressed hydrogen* means hydrogen in its gaseous state contained at any pressure above atmospheric pressure.

2.2.5 *Condensed air* refers to the phase change of the constituent gases within air into liquid or solid form when air is exposed to cryogenic temperatures.

2.2.6 *Cryo-pumping* refers to a situation in cryogenic systems where air or other gases unintentionally enter a vacuum-insulated space owing to a leak, and are subsequently trapped or immobilized on extremely cold surfaces inside the system.

2.2.7 *Fuel* means hydrogen, either in its liquefied or gaseous state.

2.2.8 *Fuel reformer* is the arrangement of all related fuel reforming equipment for processing gaseous or liquid primary fuels to reformed hydrogen for use as fuel.

2.2.9 *Non-inert* refers to an atmosphere containing more than 3% oxygen.

2.2.10 *Oxygen enrichment/oxygen-enriched* refers to the phenomenon of increase of oxygen concentration above 23.5% by volume in air, caused by the exposure of air to cryogenic temperatures.

2.2.11 *Permeability* is a measure of how easily a material allows a substance (such as a fluid or gas) to pass through it without defect.

2.2.12 *Permeation* is the process by which a gas, liquid, or vapour passes through a solid material (like a membrane, liner, or insulation) on a molecular level.

2.2.13 *Primary fuel* is the fuel supplied to the fuel reformer (e.g. ammonia, methanol, LNG, LOHC) that is reformed to hydrogen in the fuel reformer.

2.2.14 *Reformed hydrogen* is hydrogen or hydrogen-rich gas generated in the fuel reformer.

2.2.15 *Secondary enclosure* is an enclosure providing a gas- and liquid-tight barrier for piping and equipment containing fuel. This includes, but is not limited to, double-wall pipes and ducts.

2.2.16 *Self-ignition* refers to ignition without the presence of any external ignition source. Thisalso includes ignition due to low ignition energy (e.g. electrostatic discharges, diffusion ignition).

2.3 Alternative design

2.3.1 These Interim Guidelines contain functional requirements for all appliances and arrangements related to the usage of hydrogen as fuel.

2.3.2 Appliances and arrangements of hydrogen fuel systems may deviate from those set out in these Interim Guidelines, provided such appliances and arrangements meet the intent of the goal and functional requirements concerned and provide an equivalent level of safety to the relevant sections.

2.3.3 The equivalence of the alternative design should be demonstrated as specified in SOLAS regulation II-1/55, and approved by the Administration. However, the Administration should not allow operational methods or procedures to be applied as an alternative to a particular fitting, material, appliance, apparatus, item of equipment or type thereof which is prescribed by these Interim Guidelines.

3 GOAL AND FUNCTIONAL REQUIREMENTS

3.1 Goal

The goal of these Interim Guidelines is to provide for safe and environmentally-friendly design, construction and operation of ships using hydrogen as fuel, in particular their installations of systems for propulsion machinery, auxiliary power generation machinery and/or other purpose machinery.

3.2 Functional requirements

3.2.1 The safety, reliability and dependability of the systems should be equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery.

3.2.2 The probability and consequences of fuel-related hazards should be limited to a minimum through arrangement and system design. In the event of gas leakage or failure of the risk-reducing measures, necessary safety actions should be initiated.

3.2.3 The design philosophy should ensure that risk-reducing measures and safety actions for the hydrogen fuel installation do not lead to an unacceptable loss of power.

3.2.4 Hazardous areas should be restricted, as far as practicable, to minimize the potential risks that might affect the safety of the ship, persons on board and equipment.

3.2.5 Equipment installed in hazardous areas should be minimized to that required for operational purposes and should be suitably and appropriately certified.

3.2.6 Unintended accumulation of explosive, flammable or harmful gas concentrations should be prevented.

3.2.7 Fuel containment and fuel piping systems should be protected against external damage.

3.2.8 Sources of ignition in hazardous areas should be minimized to reduce the probability of explosions.

3.2.9 Safe and suitable fuel supply, storage and bunkering arrangements should be made, capable of receiving and containing the fuel in the required state without leakage. Other than when necessary for safety reasons, fuel supply, storage and bunkering arrangements should be designed to prevent venting under all normal operating conditions, including idle periods.

3.2.10 Piping systems, containment and overpressure relief arrangements that are of suitable design, construction and installation for their intended application, should be provided.

3.2.11 Machinery, systems and components should be designed, constructed, installed, operated, maintained and protected to ensure safe and reliable operation.

3.2.12 Spaces with a non-inert atmosphere and a source that might release fuel into the space should be arranged and located such that a fire or explosion will not lead to an unacceptable loss of power or render equipment in other compartments inoperable.

3.2.13 Suitable control, alarm, monitoring and shutdown systems should be provided to ensure safe and reliable operation.

3.2.14 Effective means for detecting a leakage, suitable for all spaces and areas concerned, should be arranged.

3.2.15 Fire detection, protection and extinction measures appropriate to the hazards concerned should be provided.

3.2.16 Commissioning, trials and maintenance of fuel systems and gas utilization machinery should satisfy the goal in terms of safety, availability and reliability.

3.2.17 The technical documentation should permit an assessment of the compliance of the system and its components with the applicable rules, guidelines, design standards used and the principles related to safety, availability, maintainability and reliability.

3.2.18 A single failure in a technical system or component should not lead to an unsafe or unreliable situation.

3.2.19 Measures should be taken to prevent the formation of oxygen-enriched or oxygen-depleted atmospheres, as well as the accumulation of solid air deposits or liquid air pools caused by low temperatures.

4 GENERAL REQUIREMENTS

4.1 Goal

The goal of this chapter is to ensure that the necessary assessments of the risks involved are carried out in order to eliminate or mitigate any adverse effect to the persons on board, the environment or the ship.

4.2 Risk assessment

4.2.1 A holistic risk assessment should be conducted to ensure that risks arising from the use of hydrogen affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed. Consideration should be given to the hazards associated with physical layout, operation and maintenance, following any reasonably foreseeable failure.

4.2.2 The risk assessment should specifically consider the hydrogen system integrity with focus on its ability to prevent and isolate leakages and also evaluate potential ignition mechanisms and consequences of ignition. Special consideration should be given, but not be limited to, the following specific hydrogen-related hazards and topics:

- .1 for all systems:
  - .1 hydrogen embrittlement;
  - .2 natural permeability;
  - .3 detection of leaks;
  - .4 ignition sources and self-ignition mechanisms; and
  - .5 jet-fire, flashfire, deflagration, detonation and escalation;
- .2 additionally for liquefied hydrogen fuel systems:
  - .1 effects of low temperatures;

.2 condensation of air and other gases;

.3 oxygen enrichment; and

.4 cryo-pumping;

.3 additionally for pressurized or compressed hydrogen fuel systems;

.1 high-pressure leaks; and

.2 opening of pressure relief device;

.4 additionally for portable fuel containment systems:

.1 lifting operations;

.2 connection and disconnection;

.3 additional leak sources; and

.4 the purging and gas freeing, re-purging and gassing up of hydrogen systems after each portable tank connection and disconnection.

4.2.3 The risk assessment process should demonstrate that the goal in 3.1 and functional requirements in 3.2 have been satisfied.

4.2.4 The risks should be analysed using acceptable and recognized risk analysis techniques. The analysis should ensure that risks are eliminated wherever possible. Risks which cannot be eliminated should be mitigated, as necessary. Details of risks, and the means by which they are mitigated, should be documented to the satisfaction of the Administration.

4.3 Limitation of explosion and fire consequences

4.3.1 An explosion or fire on open deck due to a hydrogen leak, or in a space containing hydrogen leak sources and a non-inert atmosphere, should not:

.1 cause damage to or disrupt the proper functioning of equipment/systems located in any space other than that in which the incident occurs;

.2 damage the ship in such a way that flooding of water below the main deck or any progressive flooding occurs;

.3 damage work areas or accommodation in such a way that persons who stay in such areas under normal operating conditions are injured;

.4 disrupt the proper functioning of control stations and switchboard rooms necessary for power distribution;

.5 damage life-saving equipment or associated launching arrangements;

.6 disrupt the proper functioning of fire-fighting equipment located outside the explosion-damaged space;

.7 affect other areas of the ship in such a way that chain reactions involving, inter alia, cargo, gas and bunker oil, may arise;

.8 prevent persons' access to life-saving appliances or impede escape routes; or

.9 affect the fuel containment system.

4.3.2 Piping and equipment containing fuel protected by secondary enclosures are not considered as potential hydrogen leak sources.

5 SHIP DESIGN AND ARRANGEMENT

5.1 Goal

The goal of this chapter is to provide for safe location, space arrangements and mechanical protection of power generation equipment, hydrogen storage systems, hydrogen supply equipment and refuelling systems.

5.2 Functional requirements

5.2.1 This chapter is related to functional requirements in 3.2.1 to 3.2.3, 3.2.5, 3.2.6, 3.2.8, 3.2.12 to 3.2.15 and 3.2.17 to 3.2.19. In particular, the following provisions should apply:

.1 fuel containment system(s) should be located in such a way as to minimize:

.1 probability of damage following a collision or grounding, taking into account the safe operation of the ship and other hazards that may be relevant to the ship; and

.2 risk of mechanical damage from ship operations, cargo operations and environmental conditions, either by locating the fuel tanks away from such hazards or by providing mechanical protection;

.2 fuel containment systems, fuel piping and other fuel sources of release should be so located and arranged that released hydrogen is led to a safe location in the open air, and on open deck, not accumulating in confined or congested areas;

.3 the access or other openings to spaces containing hydrogen sources of release should be so arranged that flammable or asphyxiating gas cannot escape to spaces that are not designed for the presence of such gases;

.4 fuel piping systems should be located and arranged to minimize:

.1 probability of damage following a collision or grounding, taking into account the safe operation of the ship and other hazards that may be relevant to the ship; and

.2 risk of mechanical damage from ship operations, cargo operations and environmental conditions;

.5 the propulsion and hydrogen supply system should be so designed that safety actions after any hydrogen leakage do not lead to an unacceptable loss of power;

.6 the probability of a hydrogen explosion in spaces containing hydrogen consumers or fuel piping systems should be minimized;

.7 spaces containing fuel piping systems should be arranged to prevent damage from pressure build-up caused by hydrogen leakage;

.8 in spaces containing liquefied hydrogen, fuel leakage, loss of vacuum, or deterioration of insulation of tanks or piping systems should not compromise the integrity of structural materials; and

.9 in spaces containing liquefied hydrogen, fuel leakage, loss of vacuum, or deterioration of insulation of tanks or piping systems should not compromise the functionality of safety systems or components necessary for the ship's safety.

5.3 General provisions

5.3.1 The requirements of 5.3.3 or 5.3.4 of the IGF Code, part A-1, should apply to ships using hydrogen as fuel.

5.3.2 Spaces, compartments and areas on open deck containing hydrogen sources of release, including bunkering stations, should not allow accumulation of hydrogen gas, and an unobstructed dispersion pathway should be arranged.

5.3.3 Muster stations and life-saving appliances and their access routes should not be located in hazardous areas as specified in 12.5.

5.4 Provisions for machinery space arrangement

5.4.1 Machinery spaces containing hydrogen fuel systems and/or hydrogen-fuelled machinery should be arranged such that the spaces may be considered gas-safe under all conditions, normal as well as abnormal conditions, i.e. inherently gas-safe.

5.4.2 In a gas-safe machinery space, a single failure should not lead to the release of fuel gas into the machinery space.

5.4.3 A gas-safe machinery space may be arranged as a conventional machinery space.

5.4.4 All fuel piping within machinery space boundaries should be enclosed in a gastight enclosure in accordance with the provisions of chapter 9.

5.4.5 Access to machinery spaces should not be arranged from hazardous areas.

5.4.6 Notwithstanding provisions above, other machinery space concepts may be permitted provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

5.5 Arrangement principles for fuel cell power installations

Fuel cell power installations should be arranged in accordance with the *Interim guidelines for the safety of ships using fuel cell power installations* (MSC.1/Circ.1647).

5.6 Provisions for location and protection of fuel piping

5.6.1 Fuel piping should not be located less than 800 mm from the side shell, which includes the aft end of the ship.
5.6.2 Fuel piping should not be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations, as defined in the SOLAS Convention, even though the piping is protected by secondary enclosures.

5.6.3 Fuel piping led through ro-ro spaces, special category spaces and on open decks, should be protected against mechanical damage.

5.7 Provisions for fuel preparation arrangements

5.7.1 The equipment for fuel preparation should be located in an area on the open deck providing natural ventilation and unobstructed relief of leakages.

5.7.2 Notwithstanding 5.7.1, vaporizers, heat exchangers, and motors for pumps submerged in tanks may also be located in tank connection spaces, if any, or other spaces meeting the provisions in 5.8.

5.7.3 Notwithstanding 5.7.1, fuel preparation equipment may be permitted in enclosed or semi-enclosed space provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

5.8 Provisions for tank connection spaces for liquefied hydrogen

5.8.1 Unless located on the open deck providing natural ventilation and unobstructed relief of leakages, fuel tank connections, flanges and tank valves should be enclosed in a tank connection space arranged in accordance with these provisions.

5.8.2 All parts of the piping systems in tank connection spaces should be arranged with secondary enclosures designed to safely contain any leakage from the fuel system.

5.8.3 Tank connection space boundaries should be gastight towards other spaces in the ship.

5.8.4 The material of the bulkheads of the tank connection space should have a design temperature corresponding with the lowest temperature it can be subject to.

5.8.5 A loss of vacuum insulation in tanks or piping systems for liquid hydrogen should not render necessary safety functions in the tank connection space out of order owing to low temperatures.

5.8.6 Unless the tank connection space access is independent and direct from the open deck, it should be provided through a bolted hatch. The bolted hatch should be located in a protective entry space of gastight construction accessed through an airlock.

5.9 Provisions for tank connection enclosures for compressed hydrogen

5.9.1 Unless located on the open deck providing natural ventilation and unobstructed relief of leakages, fuel tank connections, flanges and tank valves should be placed in a tank connection enclosure in accordance with these provisions.

5.9.2 Tank connection enclosures should be designed to prevent ignition of leaked gas within the enclosure by maintaining an inert atmosphere at all times.

5.9.3 Tank connection enclosures should be arranged to minimize the volume of the enclosure as far as possible.
5.9.4 Tank connection enclosures should be gastight.

5.9.5 Tank connection enclosures should be able to withstand the highest pressure that may arise in a leakage scenario.

5.9.6 Tank connection enclosures should be provided with continuous effective means of leak detection.

5.9.7 Tank connection enclosures should be arranged with a pressure relief device with a vent system that directs leaked gas to a safe location on the open deck.

5.10 Provisions for bilge systems

5.10.1 Bilge systems installed in areas where hydrogen can be present should be segregated from the bilge system of spaces where hydrogen cannot be present.

5.10.2 Bilge systems for fuel storage hold spaces not considered hazardous but arranged with inerted atmosphere should be segregated from the bilge system for other spaces.

5.10.3 The bilge system should have bilge well high-level alarms. Low-temperature alarms should be fitted if liquid hydrogen leakage is possible.

5.11 Provisions for drip trays

5.11.1 Drip trays should be fitted where condensation of air may occur that can cause damage to the ship structure, or where condensate air due to a cold gas release otherwise may impinge on ship structures.

5.11.2 Drip trays should be made of materials suitable to collect liquid oxygen.

5.11.3 The drip tray should be thermally insulated from the ship's structure so that the surrounding hull or deck structures are not exposed to unacceptable cooling.

5.11.4 Each drip tray should be fitted with a drain valve to enable rainwater to be drained over the ship's side.

5.11.5 Each drip tray should have a sufficient volume and thermal capacity to ensure that the maximum amount of potential air condensate according to the risk assessment can be handled. Active heating arrangements could also be considered.

5.11.6 Where capturing condensed air in drip trays, it should be ensured through design that liquid hydrogen leaks cannot combine with condensed oxygen in any scenario.

5.12 Provisions for arrangement of entrances and other openings in enclosed spaces

5.12.1 Direct access should not be permitted from a non-hazardous area to a hazardous area. Where such openings are necessary for operational reasons, an airlock that complies with 5.13 should be provided.

5.12.2 If the fuel preparation room is approved to be located below deck, the room should, as far as practicable, have an independent access direct from the open deck. Where a separate access from deck is not practicable, an airlock that complies with 5.13 should be provided.

5.12.3 Unless access to the tank connection space is independent and direct from the open deck, it should be arranged as a bolted hatch. The space containing the bolted hatch will be a hazardous space.

5.12.4 For inerted spaces, access arrangements should be such that unintended entry by personnel can be prevented. If access to such spaces is not from an open deck, sealing arrangements should ensure that leakages of inert gas to adjacent spaces are prevented.

5.13 Provisions for airlocks

5.13.1 An airlock is a space enclosed by gastight bulkheads with two substantially gastight doors spaced at least 1.5 m and not more than 2.5 m apart. Unless subject to the requirements of the International Convention on Load Lines, the sill height of the door leading to the hazardous area should not be less than 300 mm in height. The doors should be self-closing without any hold-back arrangements.

5.13.2 Airlocks should be mechanically ventilated at an overpressure relative to the adjacent hazardous area or space.

5.13.3 The airlock should be designed in such a way that no gas can be released from the gas-dangerous space to safe spaces, even in the case of the most critical event in the hazardous space separated by the airlock. The events should be evaluated in the risk assessment according to 4.2.

5.13.4 Airlocks should have a suitable geometrical form to prevent hydrogen accumulation.

5.13.5 Airlocks should provide free and easy passage of personnel, and should have a deck area not less than 1.5 m^2. Airlocks should not be used for other purposes, for instance as store rooms.

5.13.6 An audible and visual alarm system to give a warning on both sides of the airlock should be provided to indicate if more than one door is moved from the closed position.

5.13.7 For non-hazardous spaces with access from hazardous spaces below deck where the access is protected by an airlock, upon loss of underpressure in the hazardous space, access to the space should be restricted until the ventilation has been reinstated. Audible and visual alarms should be given at a manned location to indicate both loss of pressure and opening of the airlock doors when pressure is lost.

5.13.8 Where an airlock is arranged for access to small spaces serving as a staging area for the hatch to an inerted space, such as a tank connection space, the small space should be arranged with ventilation and oxygen deficiency detection.

5.13.9 Essential equipment required for safety should not be de-energized and should be of a certified safe type. This may include lighting, fire detection, public address and general alarm systems.

5.14 Storage arrangements for compressed hydrogen

5.14.1 The fuel containment system and associated connections and equipment for compressed hydrogen should be located in an area on the open deck providing natural ventilation and unobstructed relief of leakages.

5.14.2 Notwithstanding 5.14.1, hydrogen storage may be permitted in an enclosed or semi-enclosed space provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

5.15 Storage arrangements for liquified hydrogen

5.15.1 The fuel containment system and associated connections and equipment for liquified hydrogen should be located in an area on the open deck providing natural ventilation and unobstructed relief of leakages.

5.15.2 Notwithstanding 5.15.1, hydrogen storage may be permitted in an enclosed or semi-enclosed space provided that the provisions of 2.3 are met. The approval of such arrangements should at a minimum, take into account the hazards and topics listed in 4.2.2.

6 FUEL CONTAINMENT SYSTEM

6.1 Goal

The goal of this chapter is to provide that hydrogen storage is adequate so as to minimize the risk to persons on board, the ship and the environment, to a level that is equivalent to a conventional oil-fuelled ship

6.2 Functional requirements

6.2.1 This chapter relates to functional requirements in 3.2.1 to 3.2.19. In particular, the following provisions should apply.

6.2.2 The fuel containment system should be so designed that a leak from the tank or its connections does not endanger the ship, persons on board, or the environment. Potential risks to be avoided include:

.1 formation of ice from moisture in the air;

.2 formation of frozen or liquified air;

.3 exposure of ship materials to temperatures below acceptable limits;

.4 fuel leaking to form a flammable or explosive atmosphere;

.5 oxygen deficiency due to fuel and inert gases;

.6 flammable fuels spreading to locations with ignition sources;

.7 restriction of access to muster stations, escape routes and life-saving appliances (LSA); and

.8 reduction in availability of LSA.

6.2.3 Fuel containment systems should be designed to keep the fuel temperature and pressure within the design limits.

6.2.4 Fuel containment systems for liquefied hydrogen should be designed to minimize operational discharges by providing adequate insulation, and/or through systems handling boil-off-gas.

6.2.5 The fuel containment system arrangement should be designed to ensure that automatic safety actions after any gas leakage do not lead to an unacceptable loss of power.

6.2.6 If portable tanks are used for fuel storage, the design of the fuel containment system should provide equivalent safety to that of permanently installed tanks.

6.2.7 Fuel containment systems should be manufactured from materials suitable for hydrogen service.

6.2.8 Fuel containment systems for compressed hydrogen made of composite materials should be designed to provide an equivalent level of safety to that provided for fuel tank types defined by the IGF Code, taking into account fire resistance, impact resistance, pressure relief arrangements and isolation of connected systems.

6.2.9 The fuel containment system should be arranged with a pressure relief system designed to safely discharge hydrogen to a safe location in the open air.

6.2.10 Fuel containment systems should be capable of absorbing thermal expansion or contraction caused by extreme fuel temperatures, as well as movements and deflections of the fuel tank and hull structure, without developing substantial stresses.

6.2.11 Loss of vacuum insulation should not lead to an unsafe condition.

6.3 General provisions for fuel containment systems

6.3.1 For type C independent tanks, piping between the tank and the first valve should have equivalent safety as the type C independent tank, with dynamic stress not exceeding the values given in 6.4.15.3.1.2 of the IGF Code, part A-1.

6.3.2 Means should be provided whereby the storage tanks can be safely emptied.

6.4 Provisions for liquefied gas fuel containment

6.4.1 Unless expressly provided otherwise, the requirements of 6.4 of the IGF Code should apply to ships using hydrogen as fuel.

6.4.2 The provisions for liquefied hydrogen fuel containment in these Interim Guidelines are for vacuum-insulated type C independent tanks only. The requirements of 6.4 of the IGF Code, part A-1, related to other tank types, should not apply to ships using liquefied hydrogen as fuel.

6.4.3 Notwithstanding 6.4.2, liquefied hydrogen storage in other tank types than vacuum-insulated type C may be permitted provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

6.4.4 The dynamic membrane stress in 6.4.15.3.1.2 of the IGF Code should be assessed taking into account the exposure of the material of the tank shell to hydrogen and the intended temperature of application.

6.4.5 In addition to 6.4.8 of the IGF Code, the following provisions regarding thermal insulation should apply:

.1 When deterioration of insulation capability by single damage is possible, appropriate safety measures should be adopted taking into account the deterioration. For vacuum-insulated tanks, the pressure relief valves' capacity and associated piping should be dimensioned for a simultaneous fire heat load, and loss of insulation. When it is justified by the risk assessment, the pressure relief valves' capacity and associated piping may be dimensioned for a fire heat load or loss of vacuum insulation, whichever is greater.

.2 Thermal insulation should prevent liquefaction and solidification of ambient air, i.e. oxygen, nitrogen, etc.

.3 Thermal insulation should be resistant to the effects of high oxygen concentrations caused by air condensation and subsequent evaporation at low temperatures.

.4 Vacuum jacket systems should be designed to accommodate the thermal flexibility of the inner boundary and allow for the jacket to follow its natural thermal displacement.

.5 The fuel containment vacuum jacket systems should be separate from the piping vacuum jacket system.

6.4.6 In place of 6.4.14.1.1 of the IGF Code, all welded joints of the shells of fuel tanks should be of the in-plane butt weld full penetration type. For dome-to-shell connections only, tee welds of the full penetration type may be used depending on the results of the tests carried out at the approval of the welding procedure.

6.4.7 Piping connected to the tank should be protected by a secondary enclosure including within the vacuum insulation space and up to the first valve.

6.4.8 It should be possible to empty, purge and vent fuel storage tanks using the fuel piping systems. Instructions for carrying out these procedures should be available on board. Inerting should be performed with an inert gas prior to venting with dry air to avoid an explosion hazardous atmosphere in tanks and fuel pipes. See detailed provisions in 6.10.

6.5 Provisions for portable liquefied hydrogen tanks

6.5.1 Provisions for portable liquefied hydrogen tanks are not included in these Interim Guidelines. The requirements of 6.5 of the IGF Code, part A-1, related to portable liquefied gas fuel tanks, should not apply to ships using liquefied hydrogen as fuel.

6.5.2 Notwithstanding 6.5.1, liquefied hydrogen storage in portable tanks may be permitted provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

6.6 Provisions for compressed hydrogen containment

6.6.1 Tanks for compressed hydrogen should be constructed according to a recognized international standard[1] and accepted by the Administration for the intended application.

6.6.2 Each compressed hydrogen cylinder should be arranged with an automatic, fail-safe, shut-off valve mounted directly on or within the hydrogen cylinder.

[1] Examples of standards considered suitable for composite tanks (type 4 pressure vessels): EN 17339, ISO 11119-3, EN 12245.

6.6.3 Adequate means should be provided to depressurize the tank in case of a fire which can affect the tank. This may include temperature-actuated safety relief systems, e.g. thermally activated pressure relief devices (TPRDs). The relieving capacity and area of the safety relief devices should be designed and calculated to ensure the rated capacity.

6.6.4 Tanks and tank supports should be designed to withstand design loads as defined in 6.4.9 of the IGF Code, part A-1. Additionally, the following load cases should be considered:

.1 temperature changes due to pressure reduction or increase when the tank is depressurized or pressurized; and

.2 fatigue loading as defined in 6.4.12.2 of the IGF Code, part A-1.

6.6.5 Portable compressed hydrogen containment

6.6.5.1 In addition to 6.6.1 to 6.6.4, the following provisions should apply for portable compressed hydrogen containment.

6.6.5.2 Portable tanks containing compressed hydrogen may be designed either as a multiple-element gas container (MEGC) or a tank container, or a similar containment system.

6.6.5.3 The tank support and/or container frame should be designed for the intended purpose.

6.6.5.4 Portable tanks arranged for lifting on board should be designed for the worst-case drop scenario during loading and offloading, to be considered under the risk assessment of 4.2.2.

6.6.5.5 Portable fuel tanks should be located in dedicated areas arranged in accordance with the provisions of these Interim Guidelines.

6.6.5.6 Portable fuel tanks should be secured to the deck while connected to the ship systems. The arrangement for supporting and fixing the tanks should be designed for design loads, taking into account the ship characteristics and the position of the tanks.

6.6.5.7 The pressure relief system of portable tanks should be connected to a fixed venting system complying with 6.7.

6.6.5.8 Connections to the ship's fuel piping systems should be made by means of approved flexible hoses or other suitable means designed to provide sufficient flexibility.

6.6.5.9 The connections at the tank should be arranged in order to achieve a dry-disconnect operation.

6.6.5.10 Arrangements should be provided to minimize the quantity of fuel released in case of inadvertent disconnection or rupture of the non-permanent connections.

6.6.5.11 Means should be provided to verify the loading condition (fuel temperature and pressure) of the portable storage tank and cylinders before connection to the ship's fuel system.

6.6.8.12 Control and monitoring systems for portable fuel tanks should be integrated into the ship's control and monitoring system. The safety system for portable fuel tanks should be integrated into the ship's safety system (e.g. shutdown systems for tank valves, leak/gas detection systems).

6.6.8.13 Safe access to tank connections for the purpose of inspection and maintenance should be ensured.

6.6.8.14 After connection to the ship's fuel piping system, each portable tank should be capable of being isolated at any time, with the exception of the pressure relief system. Isolation of one tank should not impair the availability of the remaining portable tanks.

6.6.8.15 The design life of portable fuel tanks should not be less than 20 years.

6.7 Provisions for pressure relief systems

6.7.1 Unless expressly provided otherwise, the requirements of 6.7 of the IGF Code should apply to ships using hydrogen as fuel.

6.7.2 The vent mast height and distance requirements for tank vents, compressed and liquefied, should be considered as minimum values, to be validated by dispersion analysis and heat radiation analysis, taking into account 6.7.3. If shown to provide equivalent safety, vent mast height and distance could be limited to a lower value according to special consideration by the Administration.

6.7.3 The consequences of vented hydrogen being ignited should be subjected to dispersion analysis and heat radiation analysis to verify that they are at an acceptable level with respect to the effect on people, the ship structure and exposed equipment, including life-saving appliances and escape routes.

6.7.4 The vent mast and connected vent lines should be designed to minimize the risk of self-ignition in the vent line.

6.7.5 The vent mast and connected vent lines should be designed to withstand the maximum expected explosion pressure in all foreseeable scenarios.

6.7.6 Where the potential for explosions damaging masts and systems exists, inert gas systems should be installed to prevent the formation of explosive clouds.

6.7.7 Vent masts and connected vent lines for liquefied hydrogen fuel containment should be arranged to prevent accumulation of condensate air constituent in or on the vent lines and be suitably designed and constructed to prevent blockage due to formation of ice.

6.7.8 Vent masts should generally not be fitted with flame arrestors. However, prevention of ingress of foreign objects should be arranged.

6.7.9 Each liquefied fuel containment system relief valve should be designed for 100% capacity, and relief lines should be dimensioned for simultaneous release of all connected tanks.

6.7.10 Each compressed hydrogen cylinder should have an individual pressure relief device or emergency relief valve that is connected to a vent mast, and is capable of manual initiation from a safe location.

6.7.11 Compressed hydrogen cylinders should be fitted with temperature-actuated safety relief systems, e.g. thermally activated pressure relief devices (TPRDs), or a similar system, that automatically reduces tank pressure in case of external fire.

6.7.12 The effect of environmental elements, such as rain, ice, etc., on the performance of TPRDs (where provided), should be evaluated and suitable or alternative measures be provided.

6.7.13 The pressure relief devices should be capable of fully venting the cylinder content, also during emergency venting scenarios. A multiple cylinder arrangement should be possible to be vented either individually or simultaneously during a controlled blowdown or emergency venting scenario.

6.7.14 High-pressure gas relief systems and low-pressure gas relief systems should not be combined.

6.7.15 Pressure relief device discharges on secondary enclosures should be directed to the vent mast.

6.7.16 The vent mast and connected vent lines should be electrically bonded to prevent build-up of static electricity.

6.7.17 The requirements of 6.7.2.3 of the IGF Code do not apply to ships using hydrogen as fuel, unless accepted by the Administration as specified in 6.4.3.

6.8 Provisions on loading limit for liquefied hydrogen tanks

6.8.1 Unless expressly provided otherwise, the requirements of 6.8 of the IGF Code should apply to ships using hydrogen as fuel.

6.9 Provisions for maintaining the fuel storage condition for liquefied hydrogen

6.9.1 Unless expressly provided otherwise, the requirements of 6.9 of the IGF Code should apply to ships using hydrogen as fuel.

6.10 Provisions on atmospheric control within the fuel containment system for liquefied hydrogen

6.10.1 A piping system should be arranged to enable each fuel tank to be safely gas-freed with an inert gas, and to be safely filled with fuel from a gas-free condition. The system should be arranged to minimize the possibility of pockets of gas or air remaining after changing the atmosphere.

6.10.2 The system should be arranged to avoid inert gas condensing or solidifying in the system when cooling down and filling with liquefied hydrogen.

6.10.3 Gas sampling points should not be fitted unless necessary for safe gas freeing.

6.10.4 The inert gas composition used to purge hydrogen from the tank should be of sufficient purity to prevent an ignitable atmosphere in the tank.

6.10.5 Inert gas utilized for gas freeing of fuel tanks may be provided externally to the ship.

6.11 Provisions on atmosphere control within fuel storage hold spaces (fuel containment systems other than type C independent tanks)

6.11.1 The provisions for liquefied hydrogen fuel containment in these Interim Guidelines are for vacuum-insulated type C independent tanks only. The requirements of 6.11 of the IGF Code, part A-1, related to other tank types, should not apply to ships using liquefied hydrogen as fuel.

6.11.2 Notwithstanding 6.11.1, hydrogen storage in other tank types than vacuum-insulated type C, may be permitted provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

6.12 Provisions on environmental control of spaces surrounding vacuum-insulated type C independent tanks in case of vacuum loss

6.12.1 The impact/consequences of loss of vacuum insulation on the atmosphere within the fuel storage hold (for tanks fitted with vacuum insulation) should be assessed within the holistic risk assessment required by 4.2.2.

6.12.2 The spaces or areas surrounding hydrogen tanks should be configured to withstand potential vacuum loss outcomes, such as:

.1. generation of liquid air;

.2 oxygen enrichment; and

.3 activation of relief mechanisms in case of a sudden loss of vacuum.

6.13 Provisions on inerting

6.13.1 Arrangements to prevent back-flow of fuel vapour into the inert gas system should be provided as specified below.

6.13.2 To prevent the return of flammable gas to any non-hazardous spaces, the inert gas supply line should be fitted with two shut-off valves in series with a venting valve in between (double block and bleed valves). These valves should be located outside non-hazardous spaces.

6.13.3 Where the connections to the fuel piping systems are non-permanent, two non-return valves may be substituted for the valves required in 6.13.2.

6.13.4 The arrangements should be such that each space being inerted can be isolated and the necessary controls and relief valves, etc., should be provided for controlling pressure in these spaces.

6.13.5 In addition, purge gases should be suitable for the system operating temperatures, considering the respective boiling point of the purge gases. Arrangements should be provided to safely monitor the purging effectiveness.

6.14 Provisions on inert gas production and storage on board

6.14.1 Unless expressly provided otherwise, the requirements of 6.14 of the IGF Code should apply to ships using hydrogen as fuel.

6.14.2 Instead of 6.14.1 of the IGF Code, the following provisions should apply:

.1 the equipment should be capable of producing inert gas with oxygen content at no time greater than 3% by volume; and

.2 a continuous-reading oxygen content meter should be fitted to the inert gas supply from the equipment and should be fitted with an alarm set at a maximum of 3% oxygen content by volume.

6.14.3 In addition to 6.14 of the IGF Code, the following provisions should apply:

.1 for hydrogen secondary enclosure inerting, inert gas supply should be redundant and with sufficient capacity, and the system should monitor and warn in case of excessive contamination with hydrogen; and

.2 for high-pressure hydrogen system secondary enclosures, the capacity of the inert gas system should be suitable for purging of the enclosures after a high-pressure leak and subsequent loss of containment integrity (e.g. burst discs rupturing).

6.15 Provisions on vacuum

6.15.1 Piping vacuum jacket spaces should be segregated to limit the area affected by vacuum loss as far as possible.

6.15.2 Pressure relief devices for vacuum systems should provide separate discharge to a vent mast capable of handling cryogenic hydrogen.

6.15.3 Pressure relief devices on vacuum spaces should be designed to prevent cryo-pumping of air.

7 MATERIAL AND GENERAL PIPE DESIGN

7.1 Goal

The goal of this chapter is to ensure the safe handling of fuel, under all operating conditions, to minimize the risk to the ship, persons on board and the environment, having regard to the nature of the products involved.

7.2 Functional requirements

7.2.1 This chapter relates to functional requirements in 3.2.1, 3.2.5, 3.2.6, 3.2.8, 3.2.9 and 3.2.10. In particular, the following provisions should apply.

7.2.2 Fuel piping should be capable of absorbing thermal expansion or contraction caused by extreme temperatures of the fuel without developing substantial stresses.

7.2.3 Provision should be made to protect the piping, piping system and components and fuel tanks from excessive stresses due to thermal movement and from movements of the fuel tank and hull structure.

7.2.4 Provisions should be made to minimize the likelihood and size of a leak from the piping system.

7.2.5 Fuel piping systems for liquefied hydrogen should be thermally isolated from the adjacent hull structure, where necessary, to prevent the temperature of the hull from falling below the design temperature of the hull material.

7.2.6 Materials used in all components in contact with hydrogen should withstand phenomena such as, but not limited to, hydrogen embrittlement and hydrogen attack.

7.2.7 Materials used in components that may come into contact with oxygen-rich atmosphere should be resistant to the effects of high oxygen concentration.

7.2.8 The temperature of the outer surface of secondary enclosures should in normal operation not be less than -183°C (oxygen boiling point at atmospheric pressure).

7.2.9 The thermal insulation efficiency of secondary enclosures should be sufficient to minimize condensation of moisture, and the enclosures should be arranged for collection and handling of condensed air-constituent gases, in case of any single failure.

7.2.10 Components in the fuel containment systems and piping systems with low surface temperatures should be so installed and protected as to reduce to a minimum any danger to persons on board, and to prevent operational problems due to icing.

7.3 General

7.3.1 Unless expressly provided otherwise, the requirements of 7.3 of the IGF Code should apply to ships using hydrogen as fuel.

7.3.2 Expansion joints and bellows should be avoided, as far as practicable, in hydrogen fuel piping systems. Engine-mounted expansion bellows could be accepted based on evaluation, as reflected in the safety concept of the engine.

7.4 Materials

7.4.1 General

7.4.1.1 The materials to be used in hydrogen systems should be suitable for the medium and service for which the system is intended. This should be proven, either by selection of materials according to a recognized standard specifying the suitability of the material for the medium and service intended, or by adequate qualification testing. Test scope for qualification of a material should be acceptable to the Administration.

7.4.1.2 Requirements for materials whose design temperature is lower than -165°C should be agreed with the Administration.

7.4.1.3 Typical properties to be considered during qualification testing are, as a minimum, yield stress, tensile strength, ductility, fracture toughness, fatigue properties, hydrogen embrittlement, hydrogen permeation properties, corrosion resistance (as relevant) and coefficient of thermal expansion.

7.4.1.4 Matters including, but not limited to, the following should also be considered and addressed during the special consideration review and acceptance of materials:

.1 resistance of materials to the chemical and physical action of hydrogen under the operating conditions, including considerations of permeability and porosity, strength and toughness (i.e. ductile-to-brittle transition), effects of high oxygen concentrations experienced at low working temperatures, hydrogen embrittlement effects and high-temperature hydrogen attack;

.2 suitability of materials for the intended application, including low- and/or high-temperature effects, thermal expansion and contraction, thermal gradients, compatibility of dissimilar metals in intimate contact and electrostatic charge build-up/discharge in non-conductive materials; and

.3 if materials are subjected to laboratory qualification testing, with respect to the possible variation of the chemical composition between the laboratory test samples and the production material, the chemistry of the tested material should be recorded in the qualification test report and the difference in chemistry for the steels actually used should not exceed the "permissible difference" as per recognized standards.

7.4.1.5 A material should not be used for hydrogen service unless data is available to show that the material is suitable for the intended service conditions, or a suitable laboratory testing regime is agreed to demonstrate that materials in a hydrogen-charged atmosphere will retain the required properties for the foreseeable operational scenarios. Materials that have been used successfully with hydrogen should be preferred over materials with little or no history of use within a hydrogen environment.

7.4.1.6 All materials to be used in the construction of bunkering stations, the fuel containment system (including piping), the fuel supply system and consumers, should be identified and considered, as appropriate, in the risk assessment.

7.4.2 Metallic materials

7.4.2.1 Metallic materials to be used in hydrogen systems should be suitable for their intended use.

7.4.2.2 The base metal of clad materials used for hydrogen tank construction should be an acceptable material for liquid hydrogen service. The thickness used in pressure design should not include the thickness of the clad or lining.

7.4.2.3 The allowable stress used should be that for the base metal at the design temperature.

7.4.2.4 Test scope for qualification of a material should be acceptable to the Administration. The qualification of metallic materials by testing should address:

.1 the degradation of the material properties due to exposure to hydrogen, where degradation is expected to increase with increasing temperature and pressure;

.2 the degradation of the material properties due to cryogenic temperature, where degradation is expected to increase with decreasing temperature; and

.3 the combined effect of these.[2]

[2] See Susceptibility of materials to embrittlement in hydrogen at 10,000 psi and 72°F (~22°C) in the ANSI/AIAA G-095-2004 Guide to Safety of Hydrogen and Hydrogen Systems.

7.4.2.5 Where materials are intended to be further processed/fabricated by forming or welding, the impact of the processing on the relevant properties should be considered.

7.4.3 Non-metallic materials

7.4.3.1 Non-metallic materials to be used in hydrogen systems should be suitable for their intended use.

7.4.3.2 Coefficients of thermal expansion (CTE), thermal conductivity and permeation by hydrogen should be considered when choosing materials.

7.4.3.3 Fire resistance properties should be considered for use in gaskets, packing or other sealing elements.

8 BUNKERING

8.1 Goal

The goal of this chapter is to provide for suitable systems on board the ship to ensure that bunkering can be conducted without causing danger to persons, the environment or the ship.

8.2 Functional requirements

8.2.1 This chapter relates to functional requirements in 3.2.1 to 3.2.11, 3.2.13 to 3.2.17 and 3.2.19. In particular, the following provisions should apply.

8.2.2 The piping system for transfer of fuel to the storage tank should be designed such that any leakage from the piping system cannot cause danger to persons, the environment or the ship.

8.2.3 Bunkering systems should be protected from mechanical damage.

8.2.4 The bunkering station should be arranged to safely handle leakages during bunkering operations.

8.2.5 Bunkering systems should be arranged with the possibility of remote and local emergency stop of fuel transfer.

8.2.6 The piping between the bunkering manifold and the fuel containment system should be designed to prevent fuel containment system damage in case of collision impact on the bunkering manifold.

8.2.7 The bunkering system should be designed to minimize the amount of hydrogen released to air during filling of the fuel tanks.

8.2.8 Formation of oxygen-enriched environments should be prevented or at least mitigated.

8.2.9 In bunkering stations, the accumulation of gas should be prevented.

8.3 Bunkering stations

8.3.1 Bunkering stations should be located on open deck providing natural ventilation and unobstructed relief of leakages. The bunkering station should be designed to minimize the risk from leaks to persons, the environment and the ship.

8.3.2 Notwithstanding 8.3.1, bunkering stations arranged in an enclosed or semi-enclosed space may be permitted provided that the requirements of alternative design (SOLAS regulation II-1/55) are met to the satisfaction of the Administration. Such bunkering stations should be arranged to minimize the consequence of leakage by:

.1 minimizing the volumes where a flammable atmosphere caused by leakage can accumulate;

.2 optimizing the geometry of the space and ship-side openings to relieve explosion pressure;

.3 minimizing congestion, including but not limited to the elimination of non-essential machinery and equipment, to reduce the risk of severe explosion pressures;

.4 minimizing the probability of ignition; and

.5 providing gastight bulkheads towards adjacent spaces.

8.3.3 Arrangements should be made for safe management of any leaked fuel or condensed air.

8.3.4 Control of bunkering should be possible from a safe location. At this location, the tank pressure and automatic and manual shutdown should be indicated. In addition, the following should be provided:

.1 for liquefied hydrogen bunkering, monitoring of level of filling and overfill alarm and shutdown;

.2 for compressed hydrogen bunkering, high temperature alarm.

8.3.5 Bunkering lines should not pass through accommodation spaces, control stations or service spaces.

8.3.6 Bunkering lines should be arranged with secondary enclosures in accordance with 9.5 and 9.6 up to the bunkering manifold.

8.3.7 Bunkering manifold connections and piping should be so positioned and arranged that any mechanical impact damage to the fuel piping does not cause damage to the ship's fuel containment system resulting in an uncontrolled gas discharge.

8.3.8 Suitable means should be provided to depressurize and remove liquid contents from bunkering lines. Liquid should be discharged to the liquefied fuel tanks or other suitable location.

8.3.9 Bunkering stations should be arranged to prevent surrounding hull or deck structures from being subjected to unacceptable cooling in the event of a leakage of fuel and/or condensation of air.

8.3.10 The ship's fuel hoses and associated fittings should be in accordance with the requirements of 8.3.2 of the IGF Code.

8.4 Bunkering manifolds

8.4.1 The ship's bunkering manifold should be designed to withstand the external loads it may be subjected to during bunkering, including in a drift-off scenario.

8.4.2 The bunkering coupling should be according to a recognized standard, appropriate for fuel bunkering operations and capable of withstanding the design temperature and design pressure.

8.4.3 The connections at the bunkering station should be arranged in order to achieve a dry-disconnect operation. The dry-disconnect operation should be arranged by the use of a dry-disconnect/connect coupling.

8.4.4 Notwithstanding 8.4.3, the following alternative means for achieving dry-disconnect operation may be permitted provided that the provisions of 2.3 are met to the satisfaction of the Administration:

.1 a manual connect coupler or hydraulic connect coupler, used to connect the bunkering system to the receiving ship's bunkering manifold presentation flange; or

.2 a bolted flange-to-flange assembly.

8.4.5 When it is intended to use either of the connections specified in 8.4.3 and 8.4.4, these should be combined with operating procedures that ensure a dry-disconnect is achieved. The arrangement should be subject to special consideration informed by a bunkering arrangement risk assessment conducted at the design stage and considering dynamic loads at the bunkering manifold connection to a recognized standard acceptable to the Administration, the safe operation of the ship and other hazards that may be relevant to the ship during bunkering operation. The fuel-handling manual required by 18.2.1.3 should include documentation that the bunkering arrangement risk assessment was conducted, and that special consideration was granted under this requirement.

8.4.6 An Emergency Release Coupler (ERC)/Emergency Release System (ERS) or equivalent means should be provided, unless installed on the bunkering supply side of the bunkering line, and the said means should be in accordance with a standard equivalent to that acceptable to the Administration. It should enable a quick physical disconnection "dry break-away" of the bunkering system in an emergency event.

8.5 Bunkering systems

8.5.1 Compressed hydrogen fuel tanks should not exceed the maximum design temperature during bunkering operations.

8.5.2 A manually operated stop valve and a remotely operated shutdown valve in series, or a combined manually operated and remotely operated valve should be fitted in every bunkering line close to the connecting point. It should be possible to operate the remote valve in the control location for bunkering operations and/or from another safe location.

8.5.3 Bunkering lines should be arranged for inerting and gas freeing for shutdown and maintenance.

8.5.4 When not engaged in bunkering, the remaining gaseous hydrogen pressure in the bunkering lines should be lowered to a suitable pressure above atmospheric pressure, to prevent ingress of air and reduce the risk of high-pressure leakages.

8.5.5 Where bunkering pipes are arranged with a crossover, suitable isolation arrangements should be provided so that fuel cannot be transferred inadvertently to the ship side not in use for bunkering.

8.5.6 A bunkering safety link or an equivalent means for automatic and manual emergency shutdown (ESD) communication to the bunkering source should be fitted.

9 FUEL SUPPLY TO CONSUMERS

9.1 Goal

The goal of this chapter is to ensure the safe and reliable distribution of fuel to consumers.

9.2 Functional requirements

9.2.1 This chapter is related to functional requirements in 3.2.1 to 3.2.6, 3.2.8 to 3.2.11 and 3.2.13 to 3.2.17 and 3.2.19. In particular, the following provisions should apply.

9.2.2 The fuel supply system should be so arranged that the consequences of any release of fuel will be minimized.

9.2.3 The fuel supply system should be arranged to provide safe access for operation, maintenance, testing and inspection.

9.2.4 The piping system for fuel transfer to the consumers should be designed in a way that a failure of one barrier cannot lead to a leak from the piping system into the surrounding area causing danger to the persons on board, the environment or the ship.

9.2.5 Fuel lines should be installed and protected so as to minimize the risk of injury to personnel and damage to the ship in case of leakage.

9.2.6 Piping systems supplying fuel to consumers should be designed to minimize the amount of hydrogen released after a leak has occurred.

9.3 General hydrogen piping design and arrangement

9.3.1 Fuel piping systems located in enclosed spaces should be arranged with secondary enclosures designed to safely contain leakages.

9.3.2 Hydrogen piping systems should as far as practicable be joined by welding.

9.3.3 It should be possible to detect leakages in a fuel piping system and automatically isolate the leakage from the source.

9.3.4 It should be possible to automatically isolate the piping systems for fuel at the tank boundary.

9.3.5 The arrangement and installation of fuel piping should provide the necessary flexibility to maintain the integrity of the piping system in the actual service situations, taking the potential for fatigue into account.

9.3.6 Where tanks or piping are separated from the ship's structure by thermal insulation, provision should be made for electrically bonding to the ship's structure both the piping and the tanks. All gasketed pipe joints and hose connections should be electrically bonded.

9.4 Regulations on redundancy of fuel supply

9.4.1 For single fuel installations, the fuel supply system should be arranged with redundancy and segregation, so that a leakage in one system, or failure of one of the essential auxiliaries of the fuel supply, does not lead to an unacceptable loss of power. In the event of a leakage or failure, and in accordance with SOLAS regulation II-1/26.3, the Administration, having regard to overall safety considerations, may accept a partial reduction in propulsion capability from normal operation.

9.4.2 For single fuel installations, the fuel storage should be divided between two or more tanks. The tanks should be arranged to provide redundancy in order to achieve the provisions of 4.3.

9.4.3 For type C independent tank only, one tank may be accepted if two completely separate tank connection spaces are installed for the one tank.

9.5 Fuel piping systems containing liquefied hydrogen and cold hydrogen vapour

9.5.1 Fuel piping systems for liquefied hydrogen and cold hydrogen vapour should be arranged with secondary enclosures designed to provide insulation and safely contain leakages.

9.5.2 The secondary enclosure should be made of a material that can withstand the pressure and temperature of a potential leak. Means of pressure relief led to the vent mast should be provided for the secondary enclosure.

9.5.3 The outer surface of the secondary enclosures should in normal operation not cause condensation of air-constituent gases and should be arranged for collection and drainage of such condensation, or equivalent solutions, in case of any single failure.

9.5.4 A complete stress analysis, taking into account all the stresses due to the weight of pipes, including acceleration loads if significant, internal pressure, thermal contraction and loads induced by hog and sag of the ship, should be carried out for each branch of the piping system.

9.5.5 Sections of hydrogen piping that can be isolated should be protected by a suitable pressure relief device venting to a safe location, to prevent pressure build-up from trapped hydrogen.

9.6 Fuel piping systems containing gaseous fuels

9.6.1 The piping and its components containing gaseous hydrogen should be provided with:

- .1 an inerted secondary enclosure, such as a double-walled system; or
- .2 ventilated secondary enclosure, such as a double-walled pipe, except the enclosures described in 5.9, where the ventilation has sufficient capacity to prevent an explosion that can exceed the design pressure of the enclosure, to be demonstrated according to the provisions in 4.3, 12.3 and chapter 13.

9.6.2 Single-wall piping can be accepted for open deck installations subject to dispersion analysis, and explosion analysis if needed according to 12.3, if an ignitable cloud which may affect adjacent structures or persons cannot be excluded.

9.6.3 Fuel piping systems should be designed to minimize the size, pressure and duration of a leak. This should be obtained by:

.1 keeping the operating pressure as low as possible by applying pressure reduction devices where practicable; and

.2 providing automatically operated shutdown valves controlled by the safety system.

9.6.4 The consequences of leakage should be further reduced by use of flow restrictors or excess flow valves or similar devices.

9.7 Valve arrangements

9.7.1 Valves in the fuel piping system should be remotely operated to minimize personnel exposure. This does not apply to normally closed and locked valves not operated during normal service. Valves should be automatically operable when action is required by the safety system as per chapter 15.

9.7.2 Valves should be easily accessible for inspection and maintenance.

9.7.3 The main fuel supply line to each gas consumer or set of consumers should be equipped with a remotely operated stop valve and an automatically operated master gas fuel valve coupled in series or a combined remotely and automatically operated valve. The valves should be situated in the part of the piping that is outside the machinery spaces containing gas consumers and placed as near as possible to the consumer. The master gas fuel valve should automatically cut off the gas supply when activated by the safety system as required in 15.2.2.

9.7.4 The gas supply line to each consumer should be provided with double block and bleed valves. These valves should be arranged for automatic shutdown as given in chapter 15.

9.7.5 The two shut-off valves should be in series in the gas fuel pipe to the gas consuming equipment. The bleed valve should be in a pipe that vents to a safe location in the open air that portion of the gas fuel piping that is between the two valves in series.

9.7.6 The two shut-off valves should be of the fail-to-close type, while the bleed valve should be fail-to-open. Except in case of loss of operating power, the bleed valve should only remain open until the pressure is relieved and be kept closed to prevent ingress of air in the system. Means to detect a leakage in the stop valves should be arranged.

9.7.7 Notwithstanding 9.7.6, other means for prevention of ingress of air in the system when the bleed valve is operated, such as inerting, may be permitted.

9.7.8 An alarm for faulty operation of the valves should be provided. In this context, block valves open and bleed valve open is an alarm condition; block valves closed and bleed valve closed is an alarm condition if leakage in the block valve is detected. Similarly, internal combustion engines stopped and block valves open is an alarm condition.

9.7.9 The double block and bleed valves should also be used for normal stop of internal combustion engines.

9.7.10 When a leakage in the fuel system is detected by the safety system followed by automatic shutdown of the master gas fuel valve, the complete fuel system downstream of the master valve should be automatically de-pressurized and purged with inert gas.

9.7.11 There should be one manually operated shutdown valve in the gas supply line to each consumer upstream of the double block and bleed valves to ensure safe isolation during maintenance of the engine.

9.7.12 For single-engine installations and multi-engine installations, where a separate master valve is provided for each engine, the master gas fuel valve and the double block and bleed valve functions can be combined.

9.7.13 The automatic master fuel valve(s) should be operable from safe locations on escape routes inside a machinery space containing a gas consumer, the engine control room if applicable, outside the machinery space, and from the navigation bridge.

9.7.14 All automatic and remotely operated valves should be provided with indications for open and closed valve positions at the location where the valves are remotely operated.

10 POWER GENERATION, INCLUDING PROPULSION AND OTHER FUEL CONSUMERS

10.1 Goal

The goal of this chapter is to provide safe and reliable delivery of mechanical, electrical or thermal energy.

10.2 Functional requirements

10.2.1 This chapter is related to functional requirements in 3.2.1, 3.2.3, 3.2.11, 3.2.13, and 3.2.16 to 3.2.19. In particular, the following provisions should apply.

10.2.2 The exhaust systems should be configured to prevent any accumulation of unburnt gaseous fuel.

10.2.3 Engine components or systems containing or likely to contain ignitable hydrogen should be designed with the strength to withstand the worst-case overpressure due to ignited gas leaks.

10.2.4 All fuel consumers should have separate exhaust systems. This does not apply to fuel cell power installations.

10.2.5 Hydrogen consumers should be arranged to prevent hydrogen from leaking into auxiliary systems.

10.3 Provisions for internal combustion engines of piston type

10.3.1 Unless expressly provided otherwise, the requirements of 10.3 of the IGF Code should apply to ships using hydrogen as fuel.

10.3.2 The arrangements for the purging of the engine and engine exhaust gas system should be considered in the safety concept for the engine.

10.3.3 The safety concept should specifically demonstrate safe fuel supply changeover due to reasonably foreseeable failure modes (e.g. overspeed, gas leakage).

10.4 Provisions for gas consumers other than internal combustion engines of piston type

10.4.1 Fuel cells should be arranged in accordance with the *Interim guidelines for the safety of ships using fuel cell power installations* (MSC.1/Circ.1647).

10.4.2 Other gas consumers, such as main and auxiliary boilers or gas turbines, may be permitted provided that the provisions of 2.3 are met to the satisfaction of the Administration.

10.5 Provisions for fuel reforming equipment

10.5.1 The primary fuel system should be designed and arranged in accordance with the requirements or provisions of existing codes or interim guidelines covering the primary fuel. Other primary fuels may be permitted, provided that the provisions of 2.3 are met to the satisfaction of the Administration.

10.5.2 Fuel reforming equipment for processing gaseous or liquid primary fuels to reformed hydrogen for use in the fuel cells should be arranged in accordance with the *Interim guidelines for the safety of ships using fuel cell power installations* (MSC.1/Circ.1647).

10.5.3 Fuel reforming equipment for processing gaseous or liquid primary fuels to reformed hydrogen for use in internal combustion engines may be permitted provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2.

11 FIRE SAFETY

11.1 Goal

The goal of this chapter is to provide for fire protection, detection and fighting for all system components related to the storage, conditioning, transfer and use of hydrogen as fuel.

11.2 Functional requirements

11.2.1 This chapter is related to functional requirements in 3.2.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.12, 3.2.14, 3.2.15, 3.2.17 and 3.2.19.

11.2.2 Fuel containment systems should be located and arranged to minimize the risk of excessive heat input from a fire.

11.2.3 It should be possible to cool down fuel containment systems on open decks in a fire scenario.

11.2.4 It should be possible to detect a hydrogen fire, recognizing the potential for invisible hydrogen flames.

11.2.5 It should be possible to extinguish a fire caused by the hydrogen system.

11.2.6 Fixed fire-extinguishing systems should be installed having due regard to the fire growth potential of the protected spaces.

11.2.7 The ignition of operational and accidental fuel releases should not expose structural elements, equipment and people on board to unacceptable heat radiation levels.

11.2.8 Isolation devices should be positioned in fuel systems to stop the hydrogen flow in case of a leak-fuelled fire.

11.3 Fire protection

11.3.1 Unless expressly provided otherwise, the requirements of 11.3 of the IGF Code should apply to ships using hydrogen as fuel.

11.3.2 Fire insulation should be appropriate for hydrogen fires and the identified fire scenarios. Fire protection for any boundary facing vent mast outlets should also be considered, taking into account the heat radiation analysis specified in 6.7.3.

11.4 Fire-extinguishing

11.4.1 Hydrogen fire-extinguishing should be based on the isolation and shutdown of hydrogen supply to the fire by automatic action by the hydrogen safety system.

11.4.2 The hydrogen safety system should ensure the safe isolation of the relevant hydrogen source of release, i.e. shutdown of tank valves, master gas fuel valves, bunkering connection valve and isolation valves, before activating any fire-extinguishing method.

11.4.3 Fire-extinguishing system for secondary fires caused by the hydrogen fire should adequately consider the potential fire loads involved including the credible fire scenarios identified from the holistic risk assessment. The fixed fire-extinguishing system medium, and concentration/application rate, including the possible use of local application systems as required by SOLAS, should be considered and documented as suitable for extinguishing and control of the secondary fire as relevant, and effective use on naturally-ventilated open deck if applicable.

11.5 Provisions for water spray cooling systems

11.5.1 A water spray cooling system should be installed to cool down fuel containment systems on the open deck in case of a fire.

11.5.2 The water spray cooling system should also provide cooling to surfaces being exposed to heat radiation from sustained hydrogen fires from the vent mast opening.

11.5.3 The water spray cooling system should have an application rate of 10 L/min/m^2 for horizontal projected surfaces and 4 L/min/m^2 for vertical surfaces.

11.5.4 The capacity of the water spray pump should be sufficient to deliver the required amount of water to the hydraulically most demanding area to be protected.

11.5.5 If the water spray system is not part of the fire main system, a connection to the ship's fire main through a stop valve should be provided.

11.5.6 The remote start for the pumps that supply the water spray system and the remote operation valves to the system should be positioned in a readily accessible location that is unlikely to be rendered inaccessible in the event of a fire in the protected areas.

11.5.7 The nozzles should be of an approved full-bore type, and they should be arranged to ensure an effective distribution of water throughout the area being protected.

11.5.8 If a water spray system is installed for cooling and fire prevention for exposed parts of fuel tanks located on open deck, this system should be designed not to interfere with the function of other hydrogen safety systems, e.g. heat radiation monitoring (such as temperature activated safety relief systems).

11.5.9 For liquefied hydrogen systems, solidification of water caused by the water spray system contacting low-temperature areas of the pressure relief system, including pressure relief system outlet(s), should be assessed. Water should not be sprayed into vent masts and freeze pressure relief valves.

11.5.10 If deemed necessary by the risk assessment, water spray protection should be provided to protect any boundary of accommodation spaces, service spaces, control stations, machinery spaces, and escape routes, embarkation stations and survival craft facing fuel tanks and fuel equipment on open deck, in addition to fuel arrangement and equipment on open deck.

11.6 Fire detection and fire alarm systems

11.6.1 A fixed fire detection and fire alarm system complying with the Fire Safety Systems Code should be provided for the fuel storage hold spaces and the ventilation trunk for fuel containment system below deck, and for all other rooms of the fuel gas system where fire cannot be excluded.

11.6.2 Smoke detectors alone should not be considered sufficient for rapid detection of a fire.

12 EXPLOSION PREVENTION

12.1 Goal

The goal of this chapter is to provide for the prevention of explosions and for the limitation of effects from explosion.

12.2 Functional requirements

12.2.1 This chapter is related to functional requirements in 3.2.2 to 3.2.5, 3.2.6,3.2.7, 3.2.8, 3.2.12 to 3.2.14 and 3.2.17. In particular, the following provisions should apply.

12.2.2 The probability and consequence of explosions should be reduced to a minimum by:

.1 reducing the number of sources of ignition;

.2 reducing the probability of formation of ignitable mixtures;

.3 optimizing layout and design to limit explosion severity and consequences; and

.4 minimizing segment volumes that can leak, maximum leak rates, and duration of leak.

12.3 Explosion risk analysis

12.3.1 An explosion risk analysis (ERA) of the ship should be carried out to evaluate the risks of explosions. The objective of the analysis is to inform on the suitability of the design and arrangement with respect to the likelihood and consequences of hydrogen explosions to humans, equipment and structure as listed in 4.3.

12.3.2 All reasonably foreseeable operational and failure scenarios associated with the hydrogen fuel system should be considered in the ERA. This should include normal operation, start-up, normal shutdown, non-use and emergency shutdown of the fuel gas system, taking into account ship operations (e.g. under way, under way in restricted waters, manoeuvring, alongside, maintenance/inspection).

12.3.2.1 For systems fully protected by inerted and/or vacuum secondary enclosures, the explosion risk analysis should consider, as a minimum, the following reasonably foreseeable scenarios:

.1 release from liquefied hydrogen storage through the tank vent system due to loss of insulation;

.2 release from compressed hydrogen storage through the tank vent system due to the need for depressurization;

.3 release of hydrogen due to leakages into enclosures from a separate vent outlet other than the tank vent system; and

.4 release of hydrogen due to unintended events during bunkering.

12.3.2.2 In addition, for systems designed with single-walled fuel piping, release(s) due to the reasonably foreseeable leakage scenario(s) should be included.

12.3.2.3 In addition, for systems designed with ventilated double-wall piping, the release due to the reasonably foreseeable leakage scenario(s) in the annular space should be included, including release from vent outlet if relevant.

12.3.3 The ERA should provide, as a minimum, the following information for the scenarios being evaluated:

.1 initiating hazardous event causing the leak;

.2 process conditions (e.g. temperature, pressure);

.3 leakage location;

.4 leak size (e.g. geometry, coefficient of discharge);

.5 leakage duration;

.6 phase (i.e. gas, liquified, two-phase);

.7 leak orientation (e.g. vertical, vertical down);

.8 ignition mechanisms and characteristics (timing/location); and

.9 space/area ventilation conditions.

12.3.4 The following leakage scenarios, as a minimum, should be taken into account as an input to the ERA in 12.3.1:

Component	**Leakage size to be considered**
Pipe[3]	0.01 D^2 (mm^2) for $D \le 100$ mm, 100 mm^2 for D >100 mm
Flange	Blow-out of gasket: π Dt/4
Valve	Bonnet failure when bolts are used for fastening: bonnet area = π DBt/4 Valve flanges to be considered under flanges
Flexible hose	Full-bore rupture: π D^2 /4
Pipe coupling and screwed connections	Full-bore rupture: π D^2 /4
D = pipe diameter, t = thickness of gasket, DB = flow diameter through bonnet	

12.3.5 In addition, leakage scenarios in accordance with a recognized standard acceptable to the Administration could also be applied.

12.4 Provisions on area classification

12.4.1 Area classification is a method of analysing and classifying the areas where explosive gas atmospheres may occur. The object of the classification is to allow the selection of electrical apparatus able to be operated safely in these areas.

12.4.2 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zones 0, 1 and 2.

12.4.3 Ventilation ducts should have the same area classification as the ventilated space it serves.

12.4.4 Hazardous areas on open deck and other spaces not addressed in this chapter should be classified in accordance with a recognized standard. The electrical equipment fitted within hazardous areas should be in accordance with the same standard.

12.4.5 Electrical equipment and wiring should, in general, not be installed in hazardous areas unless essential for operational purposes based on a recognized standard.[4]

12.4.6 Equipment groups and temperature classes should be determined according to a recognized standard[5] acceptable to the Administration considering the categories of the flammable gases which may occur and accumulate in a hazardous area.

3 The possibility of a full-bore rupture, if indicated by the risk assessment, should not be excluded.

4 Refer to IEC standard 60092-502: IEC 60092-502:1999 Electrical Installations in Ships – Tankers – Special Features and IEC 60079-10-1:2020 Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres, according to the area classification.

5 Refer to IEC 60079 series standards, as applicable.

12.5 Hazardous area zones

12.5.1 Hazardous area zone 0: This zone includes, but is not limited to, the interiors of fuel tanks, any pipework for pressure relief or other venting systems for fuel tanks, pipes and equipment containing fuel.

12.5.2 Hazardous area zone 1: This zone includes, but is not limited to:

.1 tank connection spaces, tank connection enclosures, secondary enclosures around piping systems, fuel storage hold spaces[6] and the Gas Valve Unit (GVU) space;

.2 fuel preparation room;

.3 enclosed or semi-enclosed spaces in which pipes containing fuel are located, e.g. ducts around fuel pipes, semi-enclosed bunkering stations; and

.4 a space protected by an airlock is considered as non-hazardous area during normal operation, but will require equipment required to operate following loss of differential pressure between the protected space and the hazardous area to be certified as suitable for zone 1.

12.5.3 Hazardous area zone 2: This zone includes, but is not limited to:

.1 areas within 1.5 m surrounding open or semi-enclosed spaces of zone 1;

.2 space separated from a zone 1 area with a bolted hatch; and

.3 airlocks between a zone 1 area and a non-hazardous area.

12.5.4 With regard to hazardous areas on open deck and in semi-enclosed spaces, the classification and extent of hazardous areas for the following locations may be determined using IEC 60079-10-1 with special consideration of the Administration. However, as a minimum, the hazardous zones should follow those prescribed for natural gas in 12.5 of the IGF Code. The aforementioned locations are the following:

.1 areas on open deck, or semi-enclosed spaces on deck, surrounding any fuel tank outlet, gas or vapour outlet, bunkering manifold valve, other fuel valve, fuel pipe flange, fuel preparation room ventilation outlets, fuel tank pressure release valve outlets and ventilation outlets from zone 1 spaces;

.2 areas on open deck or semi-enclosed spaces on deck, surrounding any fuel preparation room entrances, fuel preparation room ventilation inlets and other openings into zone 1 spaces;

.3 spaces on the open deck within and surrounding drip trays for bunkering manifold valve; and

.4 an area on deck or semi-enclosed space surrounding a bolted hatch to tank connection space.

[6] Fuel storage hold spaces for type C independent tanks are normally not considered as zone 1.

13 VENTILATION

13.1 Goal

The goal of this chapter is to provide for the ventilation and atmospheric control of enclosed spaces required for safe operation of hydrogen-fuelled machinery and equipment, except fuel cell power installations.

13.2 Functional requirements

13.2.1 This chapter is related to functional requirements in 3.2.2, 3.2.5, 3.2.6, 3.2.8, 3.2.10, 3.2.12 to 3.2.14, 3.2.17 and 3.2.19. In particular, the following provisions apply.

13.2.2 Ventilation systems, where installed, should be arranged to avoid generation of a flammable hydrogen-air mixture in enclosed spaces and ducting with explosion pressure exceeding the enclosure design pressure.

13.2.3 Ventilation systems, where installed, should be arranged to avoid stratification of oxygen-rich atmosphere in all reasonably foreseeable scenarios.

13.3 General provisions

13.3.1 Enclosed hazardous spaces with a potential source of release should be inerted or arranged with vacuum.

13.3.2 Notwithstanding 13.3.1, ventilation arrangements may be permitted provided that the provisions of 2.3 are met. The approval of such arrangements should, as a minimum, take into account the hazards and topics listed in 4.2.2, and the following:

.1 The enclosure or space should have sufficient strength to withstand the effects of a local gas explosion in the space, as established in the provisions under 12.3.

.2 The ventilation capacity should be sufficient to reduce the explosive force in compliance with 13.3.2.1, or dilute the average gas/vapour concentration below 25% of LEL, whichever is greater.

.3 The ventilation system should provide effective ventilation of the complete space, also taking into consideration the density of the leaking fuel gases and any internal obstructions, e.g. piping, equipment, valves, structures.

.4 Any ducting used for the ventilation of hazardous spaces should be separate from that used for the ventilation of non-hazardous spaces. The ventilation should function at all temperatures and environmental conditions the ship will be operating in.

.5 Ventilation ducts from hazardous spaces should be vertical or steadily ascending and without sharp bends to avoid any possibility for gas to accumulate.

.6 Electric motors for ventilation fans should not be located in ventilation ducts for hazardous spaces unless the motors are certified for hydrogen use and are certified for the same hazard zone as the space served.

.7 Two fans should be installed for the ventilation of the hazardous space with 100% capacity each. Both fans should be supplied from separate circuits. The ventilation fans should be operated in an alternating cycle to test that all fans are operable at all times. Loss of ventilation should cause automatic shutdown of all tank valves and master fuel valves required to isolate the hydrogen supply to the hazardous space.

.8 The required capacity of the ventilation plant is normally based on the total volume of the room. An increase in required ventilation capacity may be necessary for rooms having a complicated form.

.9 Air inlets for hazardous enclosed spaces should be taken from areas that, in the absence of the considered inlet, would be non-hazardous. Where the inlet duct passes through a more hazardous space, the duct should be gastight and have overpressure relative to this space.

.10 Air inlets to hazardous enclosed spaces should be close to the floor and the air extraction should be placed close to the ceiling of said space. Additional extraction outlets will be required to be placed in areas where there is a risk of formation of gas pockets from ceiling configurations (e.g. structural beams, cable trays and pipe racks). The space geometry should also be taken into account when locating the air inlets and air extraction.

.11 Air outlets from hazardous enclosed spaces should be located in an open area that, in the absence of the considered outlet, would be of the same or lesser hazard than the ventilated space.

.12 The arrangement of the ventilation system should eliminate or at least minimize areas where gas may accumulate.

.13 Localized ventilation should be provided with gas detection at locations where a fuel release is reasonably foreseeable (i.e. flange, valve, seals, etc.) or where gas may accumulate (i.e. structural beams, cable trays and pipe racks).

13.3.3 Air inlets for non-hazardous enclosed spaces should be taken from non-hazardous areas at least 1.5 m away from the boundaries of any hazardous area.

13.3.4 Air outlets from non-hazardous spaces should be located outside hazardous areas.

14 ELECTRICAL INSTALLATIONS

14.1 Goal

The goal of this chapter is to provide for electrical installations that minimize the risk of ignition in the presence of a flammable atmosphere.

14.2 Functional requirements

14.2.1 This chapter is related to functional requirements in 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.7, 3.2.8, 3.2.11, 3.2.13 and 3.2.16 to 3.2.18. In particular, the following provisions should apply.

14.2.2 Electrical installations should not be installed in areas where a flammable hydrogen atmosphere may occur, unless they are essential for safety or operational reasons.

14.2.3 Electrical installations installed in areas where a flammable hydrogen atmosphere may occur should be designed to minimize the risk of igniting a flammable hydrogen atmosphere.

14.2.4 Electrical equipment should function as intended for all normal and reasonably foreseeable abnormal environments.

14.3 Provisions – general

14.3.1 Unless expressly provided otherwise, the requirements of 14.3 of the IGF Code should apply to ships using hydrogen as fuel.

14.3.2 Electrical equipment installed in hazardous areas should be in compliance with IEC 60079 series or a standard acceptable to the Administration.

14.3.3 Electrical equipment fitted in areas with potential of oxygen enrichment should consider excluding all possible ignition sources as far as practicable and be in compliance with recognized standards where relevant.

14.3.4 The de-energizing of electrical equipment is not accepted as a safety barrier, except for spaces protected by airlocks.

15 CONTROL, MONITORING AND SAFETY SYSTEMS

15.1 Goal

The goal of this chapter is to provide for the arrangement of control, monitoring and safety systems that support the efficient and safe operation of the hydrogen installations.

15.2 Functional requirements

15.2.1 This chapter is related to functional requirements in 3.2.1, 3.2.2, 3.2.11, 3.2.13 to 3.2.15, 3.2.17 and 3.2.18 and 3.2.19. In particular, the following provisions should apply.

15.2.2 The control, monitoring and safety systems of the hydrogen installation should be so arranged as to ensure that a single failure in these systems does not lead to an unacceptable loss of power.

15.2.3 A hydrogen safety system should be arranged to close down the gas supply system automatically, upon failure in systems as described in table 1 and upon other fault conditions which may develop too fast for manual intervention.

15.2.4 The safety functions should be arranged in a dedicated hydrogen safety system that is independent of the gas control system, in order to avoid possible common cause failures. This includes power supplies and input and output signals.

15.2.5 The safety systems including the field instrumentation should be arranged to avoid spurious shutdown or unintended release, e.g. as a result of a faulty gas detector or a wire break in a sensor loop.

15.2.6 Where there are two or more hydrogen supply systems, each system should be fitted with its own set of independent hydrogen control and hydrogen safety systems.

15.2.7 It should be possible to detect any fuel leakage in enclosed or semi-enclosed spaces and on the open deck.

15.2.8 It should be possible to detect the failure of any safety function required to operate the ship safely.

15.3 General arrangement

15.3.1 Suitable instrumentation devices should be fitted to allow effective monitoring of essential parameters to ensure safe management of the whole fuel gas equipment including bunkering.

15.3.2 For tanks not permanently installed in the ship, a monitoring system should be provided as is the case for permanently installed tanks.

15.3.3 The safety system should be independent of the control and monitoring system.

15.3.4 Tank connection spaces should be arranged with level indicators in bilge wells providing a high-level alarm. Low temperature indication in the space should activate the safety system.

15.4 Provisions for fuel containment system monitoring

15.4.1 Fuel containment systems for liquefied gas should be fitted with liquid level gauging devices that continuously monitor the liquid level. If only one liquid level gauge is installed, it should be designed to be maintained in operational condition without emptying or gas-freeing the tank.

15.4.2 Overflow control should be as follows:

.1 Each liquefied gas fuel tank should be fitted with a high liquid level alarm operating independently of other liquid level indicators and giving an audible and visual warning when activated.

.2 An independent sensor, functioning separately from the high liquid level alarm, should stop the filling of the tank by automatically activating a shut-off valve in a way that prevents both excessive liquid pressure in the bunkering line and the liquefied gas fuel tank from becoming completely full.

.3 All components of the level alarm system, including the electrical circuit and sensor(s) for the high and overfill alarms, should be capable of functional testing.

.4 Where arrangements are provided for overriding the overflow control system, they should be such that inadvertent operation is prevented. When this override is operated, a continuous visual indication should be provided at the navigation bridge, the continuously manned central control station or the onboard safety centre.

15.4.3 The vapour space of each fuel tank should be provided with a direct pressure reading gauge. Additionally, an indirect pressure indication should be provided on the navigation bridge, the continuously manned central control station or the onboard safety centre.

15.4.4 The pressure indicators should be clearly marked with the highest and lowest pressure permitted in the liquefied gas fuel tank.

15.4.5 A high-pressure alarm and, if vacuum protection is required, a low-pressure alarm, should be provided on the navigation bridge and at the continuously manned central control station or the onboard safety centre. Alarms should be activated before the opening pressure of the safety valves is reached.

15.4.6 A local-reading manifold pressure indicator should be provided to indicate the pressure between the ship's manifold valves and the hose connections to the shore.

15.4.7 For submerged fuel-pump motors and their supply cables, arrangements should be made to alarm in low liquid level and automatically shut down the motors in the event of low-low liquid level. The automatic shutdown may be accomplished by sensing low pump discharge pressure, low motor current, or low-low liquid level. This shutdown should give an audible and visual alarm on the navigation bridge, the continuously manned central control station or the onboard safety centre.

15.5 Compressed hydrogen bunkering and fuel tank monitoring

15.5.1 The control location for bunkering should be in a safe location remote from the bunkering operations. At this location, the information relevant to safe bunkering operation should be available.

15.5.2 Alarm for high pressure, temperature and any other leakage detection method should be indicated at this location and on the navigation bridge, as well as leakage detection alarms for the secondary enclosure, if fitted.

15.6 Gas detection

15.6.1 Permanently installed gas detectors should be fitted in:

.1 the tank connection spaces;

.2 fuel preparation spaces;

.3 secondary enclosures around pipes containing gaseous fuels;[7]

.4 gas-safe machinery spaces above engine;

.5 bunkering station;

.6 secondary circuits where hydrogen crossover is credible (e.g. cooling/heating circuits);

.7 airlocks;

.8 fuel storage hold spaces (not relevant for tanks located on open deck area providing natural ventilation and unobstructed relief of leakages); and

.9 other spaces if identified by the risk assessment.

15.6.2 The number of detectors in each space should be considered taking into account the leakage scenario, size, layout and ventilation of the space.

15.6.3 The detection equipment should be located where gas may accumulate and in the ventilation outlets. Gas dispersal analysis should be used to find the best arrangement for complex geometries.

7 Appropriate means for detecting leakage into the annular space should be accepted as an alternative, e.g. pressure monitoring.

15.6.4 The detection strategy for leakage should be based on diversity and a combination of different detection principles should be considered to ensure adequate coverage for the variety of leakage scenarios in the relevant spaces.

15.6.5 Gas detection equipment should be designed, installed and tested in accordance with a recognized standard, such as IEC 60079-29.

15.6.6 An audible and visible alarm should be activated at a gas vapour concentration of 20% of the lower explosion limit (LEL). The safety system should be activated at 40% of LEL at two detectors (see footnote 1 in table 1).

15.6.7 Audible and visible alarms from the gas detection equipment should be located on the navigation bridge or in the continuously manned central control station.

15.6.8 Gas detection required by this section should be continuous without delay.

15.7 Fire detection

15.7.1 Required safety actions upon fire detection in the machinery space containing gas consumers and for fuel storage hold spaces are given in table 1 below.

15.7.2 Fire detectors should be suitable for detection of hydrogen fires (i.e. flame, smoke, heat).

15.8 Loss of vacuum, inert atmosphere, or ventilation

15.8.1 The following scenarios should give an audible and visual alarm on the navigation bridge or in the continuously manned central control station or the safety centre:

.1 loss of vacuum or inert atmosphere for tank connection space;

.2 loss of vacuum or inert atmosphere for fuel preparation space;

.3 loss of vacuum or inert atmosphere for secondary enclosures around hydrogen piping where fitted;

.4 loss of the required ventilating capacity; and

.5 loss of vacuum in vacuum-insulated liquefied hydrogen containment system.[8]

15.8.2 Vacuum monitoring equipment on vacuum spaces should be designed to prevent cryo-pumping of air.

15.9 Cryogenic monitoring

15.9.1 Pressure or low temperature detection for vacuum enclosures containing cryogenic systems should result in automatic closing of all valves necessary to isolate the leakage from the inner pipes.

15.9.2 Piping in the fuel system containing cryogenic liquids should be provided with means for detection of leakages from the inner pipes into the secondary enclosure. Detection of

[8] Notwithstanding normal vacuum integrity indications, cryo-pumping of air in vacuum spaces cannot be excluded.

leakages should result in automatic closing of all valves required to isolate the leakage. Leakage detection in the secondary enclosure of the bunkering line should immediately result in automatic closing of the bunkering valve.

15.10 Safety functions of fuel supply systems

15.10.1 If the fuel supply is shut off owing to activation of an automatic valve, the fuel supply should not be opened until the reason for the disconnection is ascertained and the necessary precautions taken. A readily visible notice giving instruction to this effect should be placed at the operating station for the shut-off valves in the fuel supply lines.

15.10.2 Safe shutdown of compressors, pumps and fuel supply should be arranged for manual remote emergency stop from the following locations, as applicable:

.1 navigation bridge;

.2 cargo control room;

.3 onboard safety centre;

.4 engine control room;

.5 fire-control station; and

.6 adjacent to the exit of fuel preparation rooms.

15.10.3 The gas compressor should also be arranged for manual local emergency stop.

Table 1: Monitoring of gas supply system to gas consumers

Parameter	Alarm	Automatic shutdown of tank valve[6]	Automatic shutdown of gas supply to machinery space containing gas-fuelled engines	Comments
Loss of vacuum for liquefied hydrogen fuel tank	X	X		
Loss of vacuum or inert gas for tank connection spaces and enclosures	X			
Loss of vacuum or inert gas for fuel preparation room	X			
Loss of vacuum or inert gas for secondary enclosure	X			
Loss of vacuum or inert gas for fuel piping	X			
Gas detection in tank connection spaces and enclosures at 20% LEL	X			
Gas detection on two detectors[1] in tank connection spaces and enclosures at 40% LEL	X	X		
Fire detection in fuel storage hold space	X	X		
Fire detection in ventilation trunk for fuel containment system below deck	X			
Bilge well high level in tank connection space	X			
Bilge well low temperature in tank connection space	X	X		
Gas detection in duct between tank and machinery space containing gas-fuelled engines at 20% LEL	X			
Gas detection on two detectors[1] in duct between tank and machinery space	X	X[2]		

Parameter	**Alarm**	**Automatic shutdown of tank valve**[6]	**Automatic shutdown of gas supply to machinery space containing gas-fuelled engines**	**Comments**
containing gas-fuelled engines at 40% LEL				
Gas detection in fuel preparation room at 20% LEL	X			
Gas detection on two detectors[1] in fuel preparation room at 40% LEL	X	X[2]		
Loss of ventilation in duct between tank and machinery space containing gas-fuelled engines	X		X[2]	
Loss of ventilation in duct inside machinery space containing gas-fuelled engines[5]	X		X[3]	If double pipe fitted in machinery space containing gas-fuelled engines
Fire detection in machinery space containing gas-fuelled engines	X			
Abnormal gas pressure in gas supply pipe	X			
Failure of valve control actuating medium	X		X[4]	Time delayed as found necessary
Automatic shutdown of engine (engine failure)	X		X[4]	
Manually activated emergency shutdown of engine	X		X	
Compressed hydrogen tank/cylinder high internal temperature	X	X		
Compressed hydrogen tank/cylinder high internal pressure	X	X		
Fire in the compressed hydrogen tank area/hold	X	X		

Parameter	Alarm	Automatic shutdown of tank valve[6]	Automatic shutdown of gas supply to machinery space containing gas-fuelled engines	Comments

1. Two independent gas detectors located close to each other are required for redundancy reasons. If the gas detector is of self-monitoring type, the installation of a single gas detector can be permitted.

2. If the tank is supplying gas to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected should close.

3. If the gas is supplied to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct and outside of the machinery space containing gas-fuelled engines, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected should close.

4. Only double block and bleed valves to close.

5. If the duct is protected by inert gas (see 9.6.1.1), then loss of inert gas overpressure should lead to the same actions as given in this table.

6. Valves referred to in 9.4.1 of the IGF Code.

16 MANUFACTURE, WORKMANSHIP AND TESTING

16.1 Goal

The goal of this chapter is to provide for adequate standards for manufacture, workmanship and testing to ensure the safe handling of hydrogen under all operating conditions and to minimize the risk to the ship, the people and the environment.

16.2 General

16.2.1 Chapter 16 of the IGF Code should be taken into account, where applicable, in order to fulfil the functional requirements.

16.2.2 For materials whose design temperature is lower than -165°C, the toughness tests should be carried out in accordance with recognized standards.

16.2.3 Any microsection and/or hardness test requirements should be in accordance with the agreed project specification.

16.2.4 The requirements for liquefied gas fuel containment are applicable to IMO type C independent tanks only. All other tank types should be considered on a case-by-case basis.

16.2.5 For vacuum-insulated type C vessels and piping, the welding of metallic materials and non-destructive testing should be in accordance with recognized standards.

16.2.6 The leak tests for hydrogen installations, such as fuel tanks and piping systems, should use helium or a mixture of 5% hydrogen and 95% nitrogen as the tightness test medium.

16.2.7 Expansion joints and bellows should be avoided, as far as practicable, in hydrogen fuel piping systems. Engine-mounted expansion bellows could be accepted based on evaluation, as reflected in the safety concept of the engine.

16.2.8 The overall performance of the fuel containment system should be verified for compliance with the design parameters during the first liquefied hydrogen bunkering, when steady thermal conditions of the liquefied gas fuel are reached, in accordance with the requirements of the Administration. Records of the performance of the components and equipment, essential to verify the design parameters, should be maintained on board and be available to the Administration.

16.2.9 The fuel containment system should be inspected for cold spots during or immediately following the first liquefied hydrogen bunkering, when steady thermal conditions are reached. Inspection of the integrity of thermal insulation surfaces that cannot be visually checked should be carried out in accordance with the requirements of the Administration.

17 DRILLS AND EMERGENCY EXERCISES

17.1 Goal

The goal of this chapter is to ensure that people on board ships using hydrogen as a fuel are adequately prepared for their tasks.

17.2 General

17.2.1 Drills and emergency exercises on board should be conducted at regular intervals.

17.2.2 Such hydrogen-related exercises could include, for example:

.1 tabletop exercise;

.2 review of fuelling procedures based on the fuel-handling manual;

.3 responses to potential contingencies;

.4 tests of equipment intended for contingency response; and

.5 reviews that assigned seafarers are trained to perform assigned duties during fuelling and contingency response.

17.2.3 Hydrogen-related exercises may be incorporated into periodical drills required by SOLAS.

17.2.4 The response and safety system for hazards and accident control should be reviewed and tested.

18 OPERATION

18.1 Goal

The goal of this chapter is to ensure that operational procedures for the loading, storage, operation, maintenance and inspection of systems for hydrogen minimize the risk to persons on board, the ship and the environment.

18.2 Functional requirements

18.2.1 This chapter relates to the functional provisions in 3.2.1 to 3.2.3, 3.2.9, 3.2.11, 3.2.14, 3.2.15 and 3.2.16 of these Interim Guidelines. In particular, the following provisions should apply:

.1 a copy of these Interim Guidelines, or national regulations incorporating the provisions of the same, should be on board every ship covered by these Interim Guidelines;

.2 maintenance procedures and information for all hydrogen-related installations should be available on board;

.3 the ship should be provided with operational procedures including a suitably detailed fuel-handling manual, such that trained personnel can safely operate the fuel bunkering, storage and transfer systems, including, but not limited to, the provisions of 6.3.2 and 6.4.8;

.4 the ship should be provided with suitable emergency procedures; and

.5 all documentation specified in 18.2 should be in a working language of the ship.

18.2.2 If a fuel leak leading to a fuel supply shutdown occurs, the fuel supply should not be operated until the leak has been found and dealt with. Instructions to this effect should be placed in a prominent position in the machinery space.

18.2.3 A caution placard or signboard should be permanently fitted in the machinery space containing gas consumers, stating that heavy lifting, implying danger of damage to the fuel pipes, should not be done when the engine(s) is running on gas.

18.2.4 Chapter 18 of the IGF Code should be taken into account, where applicable, in order to fulfil the functional requirements.

18.2.5 For liquefied hydrogen, an appropriate procedure should be established for warm-up, inert gas purge, gas-free, hydrogen purge and pre-cooling. The procedure should, as a minimum, include:

.1 selection of inert gas in relation to temperature limit;

.2 measurement of gas concentration;

.3 measurement of temperature;

.4 rates of supply of gases;

.5 conditions for commencement, suspension, resuming and termination of each operation;

.6 treatment of return gases; and

.7 discharge of gases.

18.2.6 For liquefied hydrogen, the fuel-handling manual as referred to in 18.2.1.3, should take into account, as a minimum, that during warm-up of vacuum-protected tanks and piping, cryo-pumped nitrogen and oxygen in the insulation space should be assumed to be present, as evaporation of these can occur, creating potential hazards.

19 TRAINING

19.1 Goal

The goal of this chapter is to ensure that seafarers on board ships are adequately qualified, trained and experienced, to safely operate a hydrogen-fuelled ship.

19.2 Functional requirements

19.2.1 The company should ensure that seafarers on board ships using hydrogen as fuel have completed training to attain the abilities that are appropriate to the capacity to be filled, and duties and responsibilities to be taken up, especially in emergency situations.

19.2.2 The master, officers, ratings and other personnel on ships using hydrogen fuel should have received training and be qualified in the use of gaseous fuel in accordance with the STCW Convention and the STCW Code, taking into account the specific hazards of hydrogen.

20 PERSONNEL PROTECTION

20.1 Goal

The goal of this chapter is to ensure that protective equipment is provided for persons, considering both routine operations and emergency situations and possible effects of hydrogen exposure.

20.2 Functional requirements

This chapter relates to functional requirements in 3.2.1, 3.2.11 and 3.2.15. In particular, the following provisions should apply:

.1 for the protection of crew members who are engaged in the operation and maintenance of hydrogen fuel systems, and emergency response, the ship should have on board protective equipment suitable for hydrogen exposure, taking the exposure risk of different operations into account; and

.2 for the protection and treatment of crew members affected by contact with hydrogen, the ship should have on board suitable emergency equipment.

20.3 Protective equipment

20.3.1 Suitable protective equipment should be provided for the protection of personnel engaged in normal operations related to the hydrogen fuel system, considering the specific hydrogen-related hazards specified in 4.2.2 and the ship's operational procedures.

20.3.2 Personal protective and safety equipment required in this section should be kept in suitable, clearly marked lockers located in readily accessible places.

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MSC.1/Circ.1702
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INTERIM GUIDELINES FOR USE OF AMMONIA CARGO AS FUEL

1 The Maritime Safety Committee (MSC), at its 111th session (13 to 22 May 2026), having considered a proposal made by the Sub-Committee on Carriage of Cargoes and Containers at its eleventh session (8 to 12 September 2025), approved the *Interim guidelines for use of ammonia cargo as fuel* (the Interim Guidelines), as set out in the annex, with a view to providing guidance for safe use of ammonia cargo as fuel in relation to the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), as amended.

2 In doing so, the Committee recognized the importance of providing guidance for the safe use of ammonia cargo as fuel on board ships to provide at least the same level of safety as comparable LNG-fuelled main and auxiliary machinery installations.

3 The Committee notes MSC.1/Circ.1681, which allows voluntary early implementation of the amendment to 16.9.2 of the IGC Code to allow the use of ammonia cargo as fuel.

4 Member States are invited to bring the Interim Guidelines to the attention of shipbuilders, manufacturers, shipowners, ship managers, masters and ship crews, bareboat charterers and all other parties concerned.

5 Member States are also invited to recount their experience gained through the use of these Interim Guidelines to the Organization, for the Committee to keep the Interim Guidelines under review.

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ANNEX

INTERIM GUIDELINES FOR USE OF AMMONIA CARGO AS FUEL

1 PREAMBLE

1.1 The purpose of these Interim Guidelines is to provide unified and specific guidance for gas carriers, as defined in SOLAS regulation VII/11.2, using ammonia cargo as fuel and complying with the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk as amended (the IGC Code).

1.2 Chapter 16 of the IGC Code provides specific provisions for the use of liquefied natural gas (LNG) cargo as fuel. For the use of other cargo gases as fuel, 16.9 of the IGC Code requires that the same level of safety as natural gas is ensured.

1.3 These Interim Guidelines are a supplement to the existing provisions of chapter 16 of the IGC Code.

1.4 The provisions in these Interim Guidelines take into account the goal-based approach contained in MSC.1/Circ.1394/Rev.2, as 16.9 of the IGC Code allows for an alternative fuel and technologies on this basis. Therefore, the goals and functional requirements are specified, forming the basis for the design, construction and operation. Equivalencies should be established in accordance with 1.3 of the IGC Code and SOLAS regulation II-1/55.

2 GUIDANCE

2.1 Application and definitions

2.1.1 These Interim Guidelines, referenced in 16.9 of the IGC Code, apply to gas carriers complying with the requirements of the IGC Code using ammonia as fuel. They are applicable outside the cargo area in accordance with 16.4.1.1 of the IGC Code, except where required as a result of a risk assessment or where specifically required.

2.1.2 For the purposes of these Interim Guidelines and application of chapter 16 of the IGC Code, ammonia fuel consists of anhydrous ammonia as listed in chapter 19 of the IGC Code. It can be in either a liquefied or gaseous state. Ammonia in the liquefied state is referred to as ammonia liquid, and ammonia in the gaseous state is referred to as ammonia vapour. References to "gas" in the requirements in chapter 16 of the IGC Code are to be taken as referring to ammonia, in liquid or gaseous state.

2.1.3 The ammonia fuel storage and distribution systems' design and arrangements should be in accordance with the general requirements of the IGC Code and the special requirements for ammonia as given in 17.12 of the IGC Code. The requirements of 14.4, 17.2.1 and 17.12 of the IGC Code, indicated as required for carriage of anhydrous ammonia by chapter 19 of the IGC Code, should also be applicable for the carriage, containment, distribution and use of ammonia as fuel.

2.1.4 An ammonia fuel consumer is any unit within the ship using cargo ammonia vapour or liquid as a fuel.

2.1.5 An ammonia fuel preparation room means any space containing pumps, compressors, treatment systems or vaporizers for ammonia fuel preparation purposes and should be considered as a cargo machinery space in accordance with 1.2.10 of the IGC Code.

2.1.6 An ammonia release mitigation system (ARMS) is a system that processes ammonia released from the fuel supply system.

2.2 Goal

The goal of these Interim Guidelines is to ensure safe and reliable operation of fuel supply systems and consumers for use of ammonia cargo as fuel.

2.3 Functional provisions

2.3.1 All ammonia fuel storage and processing equipment should be located within the cargo area as defined in 1.2.7 of the IGC Code.

2.3.2 A single failure in the ammonia fuel system(s) should not lead to a release of ammonia outside the cargo area.

2.3.3 Ammonia fuel preparation rooms may be combined with cargo machinery spaces subject to a risk assessment taking into account any high-pressure fuel preparation equipment leakage.

2.3.4 Effectiveness of the ventilation and detection for ammonia leakage should be ensured taking into account the characteristics and physical properties of ammonia.

2.3.5 The ammonia fuel characteristics and physical properties should be suitable for operation of the fuel consumer.

2.3.6 Fuel supply systems should be designed to prevent fuel from unintended phase changes in the processing of the fuel supply to consumers, considering temperature and pressure at the design conditions.

2.3.7 The uncontrolled and direct release of ammonia may only occur in emergency situations in accordance with 7.1.3 of the IGC Code.

2.3.8 Fire detection, protection and extinction measures appropriate to the hazards concerned should be provided.

2.4 Supplementary guidance to the provisions of chapter 16 of the IGC Code

2.4.1 In addition to the requirements of 18.7 of the IGC Code, the crew should receive appropriate ship- and equipment-specific familiarization.

2.4.2 In accordance with the principles of 16.9 of the IGC Code,[1] ammonia cargoes may be consumed in machinery spaces of category A. In these spaces, they may be consumed only in boilers, internal combustion engines, gas combustion units, gas turbines or other devices designed to consume ammonia as fuel.

2.4.3 The ammonia fuel supply systems and ammonia fuel consumers should be designed for operation considering the characteristics and physical properties of all possible specified compositions of the ammonia. Information about the range of acceptable specifications for ammonia fuel should be available on board.

[1] Refer to MSC.1/Circ.1681 on *Voluntary early implementation of the amendments to chapter 16 of the IGC Code, adopted by resolution MSC.566(109).*

2.4.4 The exposed exterior surfaces of ammonia fuel supply piping, including double-wall piping, should be coloured in a distinguishable way.

2.4.5 Each ammonia fuel consumer should have a separate exhaust system and exhibit no external visible flame.

2.4.6 The supply piping and, if applicable, return piping of each consumer should be provided with an isolation valve in accordance with 16.4.5 of the IGC Code. With regard to valves:

.1 the function of one of the shut-off valves in series and the bleed valve can be incorporated into one valve body, so arranged that the flow to the consumer will be blocked and the ventilation opened; and

.2 the two shut-off valves should be of the fail-to-close type, while the bleed valve should be fail-to-open.

2.4.7 The ammonia fuel consumers should be designed to prevent the unintended accumulation of ammonia. A design assessment of the ammonia fuel consumer should be carried out using a Failure Mode and Effects Analysis (FMEA) or equivalent engineering methods.

2.5 Additional provisions

2.5.1 Risk assessment[2]

With regard to risk assessment:

.1 a risk assessment should be conducted for the entire ammonia fuel system design and arrangements to document that the same level of safety as natural gas is achieved. The risk assessment should also cover the ammonia fuel arrangements installed in the cargo area to document the same level of safety as when utilizing ammonia as cargo. Consideration should be given to the hazards associated with the arrangement, operation and maintenance of the fuel system, considering all reasonably foreseeable failures;

.2 the risk assessment should address the consequences of fuel leakage, considering the properties of ammonia, taking into account ammonia toxicity and corrosivity and its accumulation or escape into adjacent areas and spaces. The risk assessment should specifically consider the ammonia fuel system integrity with focus on its ability to prevent and isolate leakages and also evaluate potential toxicity hazards, ignition mechanisms and consequences of ignition. Special consideration should be given, but not be limited, to the following specific ammonia-related hazards and topics:

[2] Refer to MSC.1/Circ.1455 on *Guidelines for the approval of alternatives and equivalents as provided for in various IMO Instruments.*

.1 toxic ammonia releases, leakages or spills from a single failure of the ammonia fuel supply system or operation of the ARMS and their consequences, including, but not limited to, dispersion of emergency toxic releases to the atmosphere, the accumulation of ammonia vapours and their spreading throughout the ship's spaces via openings, access to life-saving appliances, muster stations and access to escape routes or the formation of alkaline solutions when in contact with water;

.2 gas detector locations, sample points and suitability for detecting required toxicity levels;

.3 ventilation arrangements, particularly the relative density and dispersion of any potential ammonia releases, since ammonia readily reacts with moisture and may form vapours that are heavier than air;

.4 the location of double-wall fuel piping ventilation inlets and outlets;

.5 risks associated with any ammonia fuel storage tank locations, such as the open deck;

.6 the impact of reactions of ammonia with water and mitigation provided by water spray systems;

.7 risks associated with drip trays, bilge systems or holding tanks for ammonia-contaminated water;

.8 the location for leak detection in the ammonia fuel system is to be assessed by means of a gas dispersion analysis where gas could be present outside the cargo area. The gas dispersion analysis should consider the implications for both toxicity and flammability;

.9 fuel supply system vent arrangements, including the possibility of two-phase release from any pressure relief system and the requirement for blowdown vessels;

.10 arrangements for closed fuel return and vent systems, together with associated arrangements for ammonia capture and treatment;

.11 arrangements for purging and inerting, including proposed alternatives to nitrogen as the inerting media;

.12 control, monitoring and safety system failure modes and conditions, considering criticality and safety requirements;

.13 fail-safe positions of all remotely operated valves in the ammonia fuel system;

.14 risks associated with the chosen exhaust gas abatement technology and piping between the consumers and such equipment;

.15 risk of mechanical damage to the fuel piping and fuel supply system in accordance with 16.4.1.1 of the IGC Code; and

.3 risks that cannot be eliminated should be mitigated, as necessary. Details of risks, and the means by which they are mitigated, should be documented.

2.5.2 Arrangements of spaces containing ammonia fuel consumers

With regard to arrangements of spaces containing ammonia fuel consumers:

.1 machinery spaces with ammonia-fuelled machinery should be gas-safe machinery spaces;

.2 a single failure of fuel systems in the machinery space should not lead to a gas release in the machinery space;

.3 fuel piping should be of double-wall design or ducted, and the outer boundary should be continuous and gastight in the space. Non-continuous double barriers should not be used in the machinery space; and

.4 in accordance with 3.2 of the IGC Code, direct access from a space containing ammonia fuel consumers to an ammonia fuel supply system space or ammonia fuel preparation room should not be permitted.

2.5.3 Ammonia fuel supply

With regard to ammonia fuel supply:

.1 where fuel supply systems supply ammonia liquid, the venting and purging systems should drain to dedicated tanks, gas-liquid separator or similar device. Heating arrangements for the gas-liquid separator may be required when the ship is operating in cold areas;

.2 the use of expansion joints and bellows should be kept to a minimum outside the cargo area. Engine-mounted expansion joints may be accepted based upon evaluation, as reflected in the safety concept of the engine;

.3 where gaseous ammonia fuel is supplied to an ammonia fuel consumer, provisions should be made to prevent ammonia condensate from entering the consumer;

.4 except in an emergency, the release of ammonia directly to the atmosphere from the ammonia fuel supply system should be avoided;

.5 the fuel supply system should include ARMS capable of collecting and handling ammonia releases, including but not limited to:

  .1 bleed from double-block and bleed valves; and

  .2 releases from purging and draining operations of fuel pipes;

.6 where dedicated ammonia fuel tanks or service tanks are installed, the pressure and temperature of ammonia should be maintained within the tank design range at all times in accordance with chapter 7 of the IGC Code. Venting of fuel vapour for control of the tank pressure should not be acceptable, except in emergency situations;

.7 in application of 16.4.3 of the IGC Code, the ventilation inlets for the double-wall piping or ducts should be in a safe location outside the engine-room. Ventilation outlets for the double-wall piping or ducts should be in a safe location in the cargo area. Inerting of the annular space may be accepted as an alternative to ventilation;

.8 the ammonia fuel treatment or ARMS should be arranged to be independent of any other water treatment or bilge systems and arranged to collect residues or ammonia-contaminated water in appropriate holding tanks for further processing; and

.9 ARMS should be capable of reducing the ammonia vapour concentrations to a level that does not present a health hazard as identified by the risk assessment, to the satisfaction of the Administration. The capacity and operating conditions should be established as part of the risk assessment, considering the operating profile of the ship.

2.5.4 Fuel plant ventilation and liquid/gas detection

With regard to fuel plant ventilation and liquid/gas detection:

.1 the ammonia fuel preparation room should, as far as practicable, have an independent access direct from the open deck. Where a separate access from the deck is not practicable, an airlock that complies with 3.6 of the IGC Code should be provided;

.2 the access or other openings to spaces containing fuel sources of release should be arranged so that flammable, asphyxiating and/or toxic gas cannot escape into spaces that are not appropriately zoned;

.3 in addition to the requirements of 16.3.1 and 16.5.1 of the IGC Code, special consideration should be given to the density, toxicity, corrosivity and lower explosion limit (LEL) of ammonia vapour. Ventilation capacity, including the ventilation inlet and outlet locations, should be supported by numerical calculations, such as a computational fluid dynamics (CFD) analysis. Ammonia fuel preparation rooms should be fitted with ventilation arrangements ensuring that the space can withstand any pressure or vacuum caused by vaporization of the liquefied fuel;

.4 for ammonia fuel preparation room(s), the requirements of chapter 12 of the IGC Code should apply;

.5 the arrangements and ventilation of ammonia fuel preparation rooms should be designed to minimize the accumulation of gases or formation of gas pockets;

.6 a fixed ammonia gas detection system should be installed at the locations specified in 13.6.2 of the IGC Code. In addition, fixed ammonia gas detection should be provided in the following locations:

  .1 enclosed spaces containing fuel piping or other fuel-handling equipment;

.2 ventilation inlets to accommodation and machinery spaces based on a risk assessment required by 2.5.1.2; and

.3 ventilated annular spaces of double-wall piping identified in 2.5.2.3;

.7 portable detection equipment, permitted by 13.6.5 of the IGC Code, should not be used as an alternative to a permanently installed system;

.8 in addition to the requirements of 14.4.3 of the IGC Code, decontamination showers and eyewash stations should be available in the following locations:

.1 near the exits from ammonia fuel preparation rooms; and

.2 in machinery spaces containing ammonia fuel consumers; and

.9 the ammonia fuel preparation room should be provided with bilge wells incorporating a high-level alarm. The bilge system should be segregated from other bilge systems.

2.5.5 Alarms and shutdowns

With regard to alarms and shutdowns:

.1 remote stops should be provided in accordance with 16.5.2 of the IGC Code. In addition to the locations specified in 16.5.2, remote stops should be provided adjacent to ammonia fuel preparation rooms;

.2 enclosed spaces containing ammonia fuel equipment, where personnel can be present, should be monitored by continuous gas detection. An audible and visual alarm should be provided in the space, in accordance with 13.6.13 of the IGC Code, to indicate the presence of ammonia vapour. The alarm setpoint, in accordance with a recognized standard, should be approved by the Administration and stated in the document required by 18.2 of the IGC Code;

.3 the leak detection system required by 16.4.2 of the IGC Code should be described in a safety concept and enable continuous monitoring of the fuel piping system to provide suitable information to the crew; and

.4 the alarm and shutdown required by 16.4.8 of the IGC Code should be determined by a risk assessment that includes the health and safety of the crew. The setpoint for alarm and shutdown, in accordance with a recognized standard, should be approved by the Administration.

2.5.6 Combustion equipment

With regard to combustion equipment:

.1 a safety concept should be developed for all ammonia fuel consumers and approved by the Administration;

.2 the ammonia concentration of fuel consumers' exhaust gases released to atmosphere should not present a health hazard at the point of release. The explosion venting of ammonia fuel consumers should be led away from where persons may normally be present;

.3 in addition to demonstrating that the potential explosion hazards have been considered, the safety concepts for the ammonia fuel consumers should also take account of the toxic injury potential and should document the arrangements to prevent toxic injury;

.4 the ammonia fuel supply system to each consumer, downstream of the master gas fuel valve, should be purged automatically outside the cargo area when the master gas fuel valve is shut by a safety action. The purged gas should be led to the ARMS;

.5 for the purpose of maintenance of the ammonia consumers or ammonia fuel supply systems, a suitable purging system should be provided to ensure that they are purged to a level that does not present a health hazard. Compatibility of the purging medium with ammonia should be demonstrated. Arrangements for fuel purging and venting should be in accordance with 2.3.6, 2.4.6 and 2.5.3.1; and

.6 gas turbines should be fitted within a gastight enclosure, unless fuel supply piping meets the requirements of 16.4.3 of the IGC Code and the additional requirements indicated in these Interim Guidelines. The consequences of gas leakage should be evaluated based on the risk assessment in 2.5.1.

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7 July 2026

UNIFIED INTERPRETATIONS OF THE IGC CODE AND THE 1983 IGC CODE

1 The Maritime Safety Committee, at its 111th session (13 to 22 May 2026), with a view to providing more specific guidance for the application of the relevant requirements of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) and the 1983 International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (1983 IGC Code), approved unified interpretations of the IGC Code and the 1983 IGC Code prepared by the Sub-Committee on Carriage of Cargoes and Containers, at its eleventh session, as set out in the annex.

2 Member States are invited to use the annexed unified interpretations as guidance when applying the relevant provisions of the IGC Code and the 1983 IGC Code and to bring the unified interpretations to the attention of all parties concerned.

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ANNEX

INTERPRETATIONS OF PARAGRAPHS 4.4.1, 4.5, 4.6.2.1 AND 4.6.2.4 OF THE IGC CODE AND PARAGRAPHS 4.7.1, 4.7.3, 4.7.4.1 AND 4.7.7 OF THE 1983 IGC CODE

Application

These unified interpretations apply to all gas carriers provided with membrane containment systems as defined in paragraph 4.1.5 of the IGC Code and in paragraph 4.2.2 of the 1983 IGC Code, except as otherwise explicitly indicated.

Interpretations

The following five (5) interpretations should apply in relation to the content of the above-listed paragraphs of the IGC Code and the 1983 IGC Code.

1 "Any envisaged leakage of liquid cargo"

1.1 The expression "any envisaged leakage of liquid cargo" (paragraph 4.6.2.1 of the IGC Code and paragraphs 4.7.1 and 4.7.4.1 of the 1983 IGC Code) should be interpreted as a leakage which may have resulted from a failure of the primary barrier, resulting in filling of the inter-barrier space with liquid until a static equilibrium state is reached between the tank space and the inter-barrier space.

1.2 For ships in service equipped with containment systems where potential failure modes to the primary barrier tightness have been identified and documented through in-service experience, envisaged leakage scenarios may be determined by suitable engineering and risk analyses carried out by the cargo containment system designer. The envisaged leakage scenario calculations should demonstrate the probability of tightness failures of the primary barrier, cargo flow and thermal analysis within the inter-barrier space and thermal effects to the inner hull structure. The flow and thermal analyses should determine the cargo liquid filling level of the inter-barrier space at the end of a 15-day period. The studies leading up to the conclusion should be to the satisfaction of the Administration or the recognized organization acting on its behalf.

2 "Capable of being periodically checked"

2.1 The expression "capable of being periodically checked" (paragraph 4.6.2.4 of the IGC Code and paragraph 4.7.7 of the 1983 IGC Code) means that the design arrangement of the containment system and the secondary barrier should be such that the effectiveness of the secondary barrier may be reliably confirmed by a suitable test and/or inspection programme specified in the approved "inspection and survey plan" required by paragraph 4.3.6 of the IGC Code. The effectiveness of the secondary barrier should be checked at the initial survey during the time of construction, as required by paragraph 1.4.2.1 of the IGC Code, and no less than at each renewal survey when the Certificate of Fitness is due to be renewed, as required by paragraph 1.4.2.2 of the IGC Code or paragraph 1.5.2 of the 1983 IGC Code. Additionally:

.1 for containment systems with glued secondary barriers:

.1 at the time of construction, a tightness test should be carried out in accordance with the approved system designer's procedures to demonstrate compliance with the acceptance criteria before and after initial cool down, to verify the effectiveness of the secondary barrier;

.2 the initial cargo tank cool down could be achieved during gas trial or could be carried out prior to proceeding with gas trial with limited amount of cargo or another refrigerating medium inside the tank. In case there is a refrigerating medium inside the tank, details of the minimum average temperature and cooling time to be achieved at the secondary barrier during tank cool down should be agreed between the cargo containment designer and the Administration or the recognized organization acting on its behalf; and

.3 the values recorded should be used as reference for future assessment of secondary barrier tightness; and

.2 for containment systems with welded metallic secondary barriers, a tightness test after initial cool down, at the time of construction, should not be required.

3 "Full secondary liquid-tight barrier"

The expressions "full secondary liquid-tight barrier" (paragraph 4.4.1 of the IGC Code) and "Complete secondary barrier" (table 4.5 of the IGC Code and paragraph 4.7.3 of the 1983 IGC Code) should be interpreted as a secondary barrier forming a liquid-tight secondary containment capable of containing any envisaged leakage from the tank through its primary barrier, as interpreted in paragraph 1.1 above.

4 "Effectiveness"

4.1 The expression "effectiveness" (paragraphs 4.6.2.4, 4.6.2.5.1 and 4.6.2.5.4 of the IGC Code and paragraph 4.7.7 of the 1983 IGC Code), in the context of the secondary barrier being "capable of containing any envisaged leakage of liquid cargo" (paragraph 4.6.2.1 of the IGC Code and paragraphs 4.7.1 and 4.7.4.1 of the 1983 IGC Code), should mean the ability of the secondary barrier to prevent passage of liquid cargo in ways and quantities likely to cause unsafe cold spots to the ship structure. The effectiveness of the secondary barrier should be verified by an approved method described in the "inspection/survey plan" required by paragraph 4.3.6 of the IGC Code, such as but not limited to:

.1 a tightness test, in accordance with the approved system designer's procedure and acceptance criteria. If the approved threshold values are exceeded, an investigation should be carried out, along with additional testing, such as thermographic or acoustic emissions testing, to locate any secondary barrier indications exceeding threshold values as per approved method;

.2 a thermographic examination of the cargo tank boundaries in accordance with the approved system designer's procedure and the approved designer's acceptance criteria, in combination with acoustic emission testing in areas, such as the domes, where thermographic examination cannot be performed effectively; or

.3 other equivalent methods suitable for the specific cargo containment system design.

4.2 At each renewal survey, all detected indications should be evaluated to confirm whether or not they preclude the function of the secondary barrier. When evaluating whether the detected indications compromise the secondary barrier "liquid-tight effectiveness" as defined in paragraph 4.6.2.5.1 of the IGC Code, the primary barrier leakage scenario described in interpretation 1.1 above should be taken into account to confirm that the result of such leakages will not result in filling the inter-barrier space with cargo liquid above the position of the detected indication. The interpretation given in 1.2 above may be applied in the evaluation if this is demonstrated to represent an equivalent level of safety considering the probability and extent of tightness failures of the primary barrier. The evaluation should take into consideration the requirements of paragraphs 4.6.2.5.1 and 4.6.2.5.2 of the IGC Code. All indications identified as compromising the function of the secondary barrier should be repaired.

4.3 Special considerations, in concurrence with the Administration, may be given when the detected indication or indications are confirmed to be located above the anticipated highest liquid level accumulated inside the inter-barrier space. In such cases, the owners, in collaboration with the cargo containment system designer, should submit to the Administration or the recognized organization acting on its behalf suitable documentation to demonstrate the equivalent level of safety and describe the necessary mitigating measures to be implemented to ensure that the function of the cargo containment system is not compromised. In addition:

.1 arrangements should be made for owners to submit an annual health monitoring report to confirm that the cargo containment system remains satisfactory for the service for which the ship is intended, as required by paragraph 1.4.2 of the IGC Code, or by paragraph 1.5.2 of the 1983 IGC Code;

.2 the monitoring arrangements and procedures should be documented and endorsed by the cargo containment system designer, and submitted to the Administration or the recognized organization acting on its behalf;

.3 verification of the continued effectiveness of the monitoring arrangements and procedures should be carried out at each annual survey;

.4 those indications under special considerations should be documented, and information should be made available to the surveyor attending the next survey; and

.5 at renewal surveys, tightness test, as indicated in 4.1.1 above, is not considered to be an acceptable test method to determine the effectiveness of the secondary barrier. Approved testing procedures capable of localizing the indications should be used.

5 "Other suitable means" and "another suitable method"

The expressions "other suitable means" (paragraph 4.6.2.4 of the IGC Code) and "another suitable method" (paragraph 4.7.7 of the 1983 IGC Code) should be interpreted to mean that any other suitable means or another suitable method should be described within the "inspection and survey plan" required by paragraph 4.3.6 of the IGC Code.

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