THE MARITIME LAW ASSOCIATION (MLA) OF THE UNITED STATES
COMMITTEE ON AUTONOMOUS SHIPS AND SMART MARINE TECHNOLOGY COMMITTEE

Spring 2023 Newsletter

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Greetings Committee Members,

As we enter the Spring season, we write to express our continued appreciation of your support and participation as we undergo our new journey in upgraded Committee status. We are looking forward to hosting you for our New York Spring meeting of Thursday, May 4, 2022 in-person at the Blank Rome offices. We will be holding a joint meeting with the Cruise Lines and Passenger Ships Committee and Our Oceans Committee. RSVPs can be made to the Secretary (allison.skopec@hklaw.com). The meeting agenda is attached as an addendum and available on the MLA portal.

1. Chair’s Thoughts

We are well into our first year of being recognized as a full Standing Committee and our foundation for the future in the MLA if firmly established. We are the flagship maritime committee on the topic of autonomous ships and smart marine technology. Now, we need your ideas, input, and energy more than ever so we can make our efforts meaningful and lasting.

Advanced autonomy and smart marine technologies continue to rapidly develop in the commercial and defense sectors. Engineers and developers are creating programs that may be used to either augment onboard operations with full crews, operate vessels remotely, or operate in an entirely uncrewed status. The Navy and NOAA are actively testing and using fully uncrewed vessels (or “systems”) in international voyages, and commercial operators are exploring novel designs in various business cases. Owners and operators are facing real crewing shortages. Anecdotally, future generations may not be as inclined to go to sea, in particular in dull, dirty, and dangerous jobs. Concepts once considered to “never” be possible are moving closer to reality. One thing is becoming clear – it’s impossible, until it isn’t.

However, advanced autonomy is generating a new era of legal challenges without clear precedent and within a legal regime for ship operations that contemplated humans, including U.S. statutes and regulations that have failed to keep up with technological progress. Issues like seaworthiness, products liability, and the *Pennsylvania* Rule will merit further research and scrutiny. Issues such as this are where we can add value with the collective legal acumen this Committee offers.

Last but certainly not least, we've also added a Young Lawyer Committee Liaison, Elizabeth Strunk of Nicoll Black & Feig PLLC – welcome aboard, Elizabeth! Bridging the practice of law with young lawyers while encouraging diversity in the maritime sector is a focus of the Committee, so I encourage all Members to look for opportunities for mentorship and inclusion.

2. USCG Unmanned Systems Strategic Plan

In March 2023, the USCG released its 2023 Unmanned Systems Strategic Plan.[1] It contains high level strategy and where short on details is, nonetheless, a noteworthy development for our Committee, in particular as it :

STRATEGIC GOAL #2:
Establish a prevention and response framework essential to facilitate the safe use of remotely operated and autonomous vehicles and systems in the Marine Transportation System.
• Objective 2.1. Implement a risk-based regulatory, compliance, and assessment regime for safe use of emerging autonomous and unmanned technologies in the maritime industry, while developing and incorporating international and industry recognized standards.
• Objective 2.2. Develop expertise in remotely operated and autonomous systems to support prevention and response activities.
• Objective 2.3. Collaborate with domestic and international partners, apply lessons learned in development and testing of unmanned systems, and support development of industry standards and international requirements for remotely operated and autonomous vehicles.

3. U.S. Navy Updates

The U.S. Navy plans to use unmanned boats to counter drug smugglers by expanding its unmanned surface vessel program to Central and South America, where it will be integrated into an operational command for the first time.[2] The decision expands on the work of Task Force 59, the special unit set up in the Persian Gulf to try out small unmanned surveillance boats like the MANTAS T-12 and the Saildrone in a maritime security role.

The decision to expand the initiative within 4th Fleet rather than 5th Fleet - where it is currently housed - went unexplored in the announcement. 5th Fleet's Task Force 59 encountered a sophisticated adversary, the Iranian military, which tried to steal U.S. unmanned vessels on several occasions. The attempted seizures (successful in at least one case) confirmed one of the operational concerns about unmanned surface vessels: without hardening, these assets can be boarded or captured by an enemy with limited repercussions when compared with a manned ship. In 4th Fleet, however, the sole opponents will be smugglers, who lack state-level resources to find and interfere with American surface drones. The U.S. Navy plans to release more information about the initiative in the run-up to the multinational UNITAS 2023 exercise, which will be hosted by the Colombian military in July 2023.

Also, in February 2023, the US Navy took delivery of a ship designed to operate autonomously at sea for up to 30 days. Austal USA manufactured the vessel and effectively added autonomous capabilities

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[1] Unmanned Systems Strategic Plan,https://www.dco.uscg.mil/Portals/9/DCO%20Documents/2023%20Unmanned%20Systems%20Strategic%20Plan.pdf?ver=5EALzxVMXI1TAe_FVn_zvQ%3d%3d

[2] https://maritime-executive.com/article/u-s-navy-plans-to-use-unmanned-boats-to-counter-drug-smugglers

to a catamaran-style Spearhead class expeditionary fast transport (EPF) similar to those they have been building for the U.S. Navy since 2012.

4. Autonomous Ships Global Market Report 2023

According to the Autonomous Ships Global Market Report of 2023, major players in the autonomous ships market are General Electric, DNV GL, Rolls-Royce Holding PLC, Kongsberg Gruppen AS, NYK Line, Mitsui E&S Holdings Co Ltd, Wärtsilä Corporation, DSME Co. Ltd, Vigor Industrial LL, and Praxis Automation Technology B.V.[3] The global autonomous ships market is expected to grow from $6.88 billion in 2022 to $7.34 billion in 2023 at a compound annual growth rate (CAGR) of 6.6%. The Russia-Ukraine war disrupted the chances of global economic recovery from the COVID-19 pandemic, at least in the short term. The war between these two countries has led to economic sanctions on multiple countries, surge in commodity prices, and supply chain disruptions, causing inflation across goods and services effecting many markets across the globe. The autonomous ships market is expected to grow to $9.47 billion in 2027 at a CAGR of 6.6%.

5. IMO Updates

During MSC 105, The International Maritime Organization (IMO) met from 20-29 April 2022 provided a roadmap for developing the MASS Code – anticipating a global regulatory framework on the operation of maritime autonomous surface ships (MASS). The roadmap envisages the development of a goal-based instrument in the form of a non-mandatory Code, with a view to adoption in the second half of 2024 as the first stage. It also provides a gentle but much-needed push to start this important work. While not mandatory, it will be used to develop a mandatory version of the code that is planned to enter into force on 1 January 2028. In support, the MSC re-established the MASS Correspondence Group (on which our Vice-Chair Joe Kramek serves) to develop the non-mandatory goal-based MASS code and consider the common potential gaps identified in the RSE conducted between 2017-2021. The MASS Correspondence Group issue its draft MASS code and it can be found on IMO Docs for consideration by MSC 107 (Spring 2023), but it has not been published yet.[4] MSC 107 will have a MASS work group, and it is expected that group will use the Correspondence Groups draft MASS code as a base document to continue drafting the new Code.

As regulatory work progressed last year, further advances in autonomous technology were also made during 2022, including through several real-life trials. For example, Avikus – which was founded by shipbuilding giant Hyundai Heavy Industries and is one of One Sea's newest members – successfully completed the first ever transoceanic voyage of a merchant ship (the LNG carrier Prism Courage) using autonomous navigation technologies in June 2022.

Finally, the IMO's Joint MSC/LEG/FAL Working Group convened in April of this year and expected to reconvene in September, in order to streamline the process of addressing common MASS related issues. The April final report is not out yet but is expected to be released shortly. The processes being followed at the IMO continue to provide an opportunity for our subcommittee to take a supporting role in the development of the future of regulations for MASS. For a more detailed summary, see the IMO website articles on Developing a regulatory framework for autonomous shipping and Joint MSC-LEG-FAL Working Group on Maritime

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[3] https://www.reportlinker.com/p06277721/Autonomous-Ships-Global-Market-Report.html

[4] See USCG draft code as addendum to this Newsletter.

Autonomous Surface Ships (MASS). Sincere thanks to Joe Kramek and Nick Tabori at the WSC for keeping the Committee updated on these developments at IMO and the MASS WG.

6. Comité Maritime International (CMI) International Workgroup on MASS

The IMO has requested the International Working Group on MASS assist with legal input into the IMO joint working group (JWG) on MASS. The JWG is a working group set up by the Maritime Safety Committee (MSC), the Legal Committee (LEG) and the Facilitation Committee (FAL) in order to coordinate the work of IMO in tackling the regulation of MASS. The IWG is preparing a paper which will cover three main subjects. The U.S. is represented in this CMI IWG by Sean Pribyl, Holland & Knight LLP.

First, the IWG will consider the re-allocation of the roles and responsibilities of the Master and Crew in the MASS context. This involves a consideration of the current roles assigned to Master and Crew, and will then consider the changing role when a ship is controlled from a Remote Control Centre, and then the role of the "Master" and "Crew" (if any) when the ship is fully autonomous and how the current responsibilities of the Master and Crew as regulated by IMO can be allocated in these new circumstances. The paper will then consider the subject of enforcement and how the current regime may need to be adapted to accommodate MASS. Such issues as port state control, salvage, towage and pilotage, and arrest are being considered by the IWG. The third issue which the IWG is considering is the question of liability. Who will be liable when an accident occurs in the various possible scenarios. What, for example, will be the situation where a ship with an AI steering system causes a major collision? Will the system manufacturer be liable, or the service company, or the Owner? Will liability to third parties be limited? These issues are complex, and precisely the kind of issues with which the CMI is ideally placed to grapple.

The IWG is aiming to produce a first draft of the paper in time for discussion at the IWG meeting at the Montreal Conference, with an aim to submitting it to IMO prior to the October meeting of the Joint Working Group.

7. MARAD and SOCP

On April 25-26 at MITAGS in Linthicum Heights, Maryland, the Ship Operations Cooperative Program (SOCP) and MARAD co-hosted a 2-day symposium that outlined current governance expectations for autonomous technology in the maritime industry and understand what the industry needs from the regulators and supporting federal agencies to prepare the existing and upcoming workforce for this technology. The USCG was represented by two lawyers from the Office of Maritime and International Law on the panel "Legal Determinations and Considerations of Autonomous Technologies (joined by Sean Pribyl, Holland & Knight LLP).

The events agenda is here:
https://www.socp.us/_files/ugd/8715e3_28706fee819e4d5f8e5f6e3626945ed1.pdf

8. NDAA 2023 – at-sea pilot program

The James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (H.R.7776) provides for as At-sea recovery operations pilot program that, among other authorizations and in certain circumstances, waives the navigation and manning laws for vessels. (See Sec. 11504) as follows:

…the Secretary, in the pilot program established under subsection (a), may—

(1) allow remotely controlled or autonomous vessel operations to proceed consistent to the extent practicable under the proposed title 33, United States Code, and 46, United States Code, including **navigation and manning laws and regulations**;
(2) **modify or waive** applicable regulations and guidance as the Secretary considers appropriate to—
(A) allow remote and autonomous vessel at-sea operations and activities to occur while ensuring navigation safety; and
(B) ensure the reliable, safe, and secure operation of remotely-controlled or autonomous vessels…

https://www.congress.gov/bill/117th-congress/house-bill/7776

9. NASEM Report on "New Coast Guard Authorities" – Coming Soon

An ad hoc study by the National Academies of Sciences, Engineering, and Medicine committee on "New Coast Guard Authorities" was tasked with identifying emerging issues that are likely to demand US Coast Guard services over the next decade and consider whether the Service's existing statutory authorities are sufficient to meet this demand, and if not, where the Service's authority could be expanded to do so. The committee surveyed foreseeable developments that could affect the Coast Guard's missions and authorities, including changes in technological capabilities and industry trends that could affect governance and activities in the maritime domain and how and where the Coast Guard needs to operate.

In the context of its examination of emerging issues, the committee reviewed the Service's existing authorities and related abilities (such as force levels, asset mix, and training). Informed by consultations with the Coast Guard and other experts and interested parties, the committee identied those issues that it believes are likely to have the greatest relevance to and effect on the Coast Guard's missions and authorities. The committee then considered any adjustments or additions to Coast Guard authorities where it finds potential limitations and shortcomings in these authorities and related abilities. Topics of focus included, inter alia, autonomous vessels, cybersecurity, and smart technology.

The committee will provide its recommendations to Congress and the Coast Guard when the Report is published late Spring/early Summer.

Committee Members: Cary Coglianese, Thad W. Allen, James-Christian B. Blockwood, Annie Brett, Sally Brice-O'Hara, Martha R. Grabowski, Donald Liu, Wen C. Masters, Rodrigo Nieto-Gomez, Sean T. Pribyl, Sandra Stosz, David W. Titley

Full summary of the committee and list of meetings is here:
https://www.nationalacademies.org/our-work/new-coast-guard-authorities

Recent and Notable

- LNG Carrier Completes First Autonomous Ocean Crossing by Large Vessel; An LNG carrier completed what is being called the world's first transoceanic voyage of a large merchant ship employing autonomous navigation technologies. The voyage was carried out as the first demonstration of the advanced technology navigating the 97,500 dwt vessel for roughly half its voyage across the Pacific, or approximately 5,400 nautical miles avoiding over 100 ships and optimizing the voyage. https://maritime-executive.com/article/lng-carrier-completes-first-autonomous-ocean-crossing-by-large-vessel

- U.S. Naval Institute Opinion Piece by Commander Taylor Coss Gazeley on the need for the U.S. to actively shape the policy, legal, and acquisition frameworks to prepare for automated revolution: https://www.usni.org/magazines/proceedings/2023/january/autonomous-merchant-ships-are-coming-are-we-ready

- New Jones Act-compliant autonomous survey vessel revealed: https://www.workboat.com/shipbuilding/safe-boats-to-market-autonomous-hydrographic-survey-vessel

- Samsung Heavy and Kongsberg Maritime move to develop autonomous LNG ships: https://maritime-executive.com/article/samsung-heavy-brings-in-kongsberg-to-work-on-autonomous-ship-program

- Breakthrough year in autonomous shipping as international collaboration ramps up: https://splash247.com/breakthrough-year-in-autonomous-shipping-as-international-collaboration-ramps-up/

As always, please feel free to contact us with any ideas you may have for involvement, research, speakers, or programming - we welcome all your thoughts!

Kindest Regards,
Sean, Joe, and Allison

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THE MARITIME LAW ASSOCIATION (MLA) OF THE UNITED STATES

JOINT MEETING BETWEEN
AUTONOMOUS SHIPS AND SMART MARINE TECHNOLOGY COMMITTEE
CRUISE LINES & PASSENGER SHIPS COMMITTEE
AND
OUR OCEANS COMMITTEE

2023 SPRING MEETING AGENDA

New York, NY
Blank Rome Law Offices
1271 Avenue of the Americas
Room: MPR
Thursday, May 4, 2023 09:00-10:30 a.m. Eastern Time

ATTENDEES MUST RSVP TO THE FOLLOWING BY APRIL 30 TO ARRANGE ACCESS

- **Cruise Lines**: Blythe Daly - bdaly@kbdlegal.com
- **Our Oceans**: Sean Houseal - Sean.Houseal@wbd-us.com
- **Autonomous Ships**: Allison Skopec - Allison.Skopec@hklaw.com

PLEASE PLAN TO ARRIVE EARLY AS WE WILL START PROMPTLY AT 09:00

I. Cruise Lines 09:00-09:20	09:00-09:15	Blythe Daly - Opening Remarks - Cruise Lines • Cruise Lines Emerging Decarbonization Issues
	09:15-09:20	Q&A
II. Our Oceans 09:30-09:50	09:20-09:25	Sean Houseal - Opening Remarks - Our Oceans • Scope of Committee • New UN High Seas Treaty
	09:25-09:40	SailPlan - Charlotte Runzel and Steve Bomgardner • Emission Technology in Maritime Operations: How SailPlan helps ships measure, report, and reduce emissions and fuel consumption using high-resolution, real-time data; exemplar with connection to cruise lines industry
	09:40-09:45	Q&A
III. Autonomous Ships 09:30-10:00	09:45-09:55	Rear Admiral Fred Kenney, USCG (ret.), IMO Director, Legal and External Affairs • IMO Updates on MASS

	09:55-10:10	LCDR Lars Okmark, USCG (CG-LMI-P) • USCG updates on MASS
	10:10-10:25	Prof. Martin Davies, Tulane University School of Law • Emerging issues with autonomous shipping: Insurance implications regarding product liability actions against manufacturers and designers, choice of law issues; reference to new book "The Global Insurance Market and Change: Emerging Technologies, Risks, and Legal Challenges"
IV. Closing Remarks/Q&A	10:25-10:30	All Committee Open Q&A

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MARITIME SAFETY COMMITTEE
107th session
Agenda item 5

MSC 107/5
27 February 2023
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DEVELOPMENT OF A GOAL-BASED INSTRUMENT FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

Report of the Correspondence Group

Submitted by the Marshall Islands

SUMMARY

Executive summary:	This document provides the report of the Correspondence Group on Development of a goal-based instrument for Maritime Autonomous Surface Ships (MASS).
Strategic direction, if applicable	2
Output	2.23
Action to be taken:	Paragraph 39
Related document:	MSC 106/WP.8

General

1 The Maritime Safety Committee (MSC), at its 105th session, established the MASS Correspondence Group (the Group) with terms of reference as set out in paragraph 7.31 of document MSC 105/20 and under the coordination of the Marshall Islands, instructed it to provide a verbal status report at MSC 106, and to submit a written report to MSC 107.

2 Based on the prior work of the Group, MSC 106 worked on further development of the draft MASS Code and agreed to revised terms of reference for the Group in its further work, as set out in paragraph 5.32 of document MSC 106/19.

List of participants

3 Representatives from the following Member States participated in the Group:

ARGENTINA
AUSTRALIA
BELGIUM
BRAZIL
CANADA
CHINA
COOK ISLANDS
DENMARK
ETHIOPIA
FINLAND

FRANCE
GERMANY
GHANA
INDIA
IRELAND
ITALY
JAPAN
LIBERIA
MALTA
MARSHALL ISLANDS
MEXICO
MOROCCO
NEW ZEALAND
NORWAY
PAKISTAN
PANAMA
PAPUA NEW GUINEA
PERU
PHILLIPINES
POLAND
REPUBLIC OF KOREA
RUSSIAN FEDERATION
SAUDI ARABIA
SINGAPORE
SOMALIA
SPAIN
SWEDEN
THAILAND
TÜRKIYE
UGANDA
UNITED ARAB EMIRATES
UNITED KINGDOM
UNITED STATES OF AMERICA

a representative from the following intergovernmental organization:

EUROPEAN COMISSION (EC)
INTERNATIONAL MOBILE SATELLITE ORGANIZATION (IMSO)

the following United Nations specialized agency:

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

by the following IMO training institute:

WORLD MARITIME UNIVERSITY (WMU)

and observers from the following non-governmental organizations in consultative status:

INTERNATIONAL CHAMBER OF SHIPPING (ICS)
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
COMITE INTERNATIONAL RADIO MARITIME (CIRM)
BIMCO
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
INTERNATIONAL MARITIME PILOTS' ASSOCIATION (IMPA)
INTERNATIONAL ASSOCIATION OF MARINE AIDS TO NAVIGATION AND LIGHTHOUSE AUTHORITIES (IALA)
INTERNATIONAL FEDERATION OF SHIPMASTERS' ASSOCIATIONS (IFSMA)
INTERTANKO
CRUISE LINES INTERNATIONAL ASSOCIATION (CLIA)
INTERNATIONAL PARCEL TANKERS ASSOCIATION (IPTA)
WORLD SAILING
INTERNATIONAL HARBOUR MASTERS' ASSOCIATION (IHMA)
INTERNATIONAL MARINE CONTRACTORS ASSOCIATION (IMCA)
ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)
INTERNATIONAL TRANSPORT WORKERS' FEDERATION (ITF)
GLOBALMET
WORLD SHIPPING COUNCIL (WSC)
NAUTICAL INSTITUTE
SUPERYACHT BUILDERS ASSOCIATION (SYBASS)

Terms of reference (ToR)

4 Taking into account the comments and decisions made at MSC 105 and MSC 106, the Group was instructed to:

.1 consider key principles and common understanding of the purpose and objectives for the new instrument;

.2 continue the development of the non-mandatory goal-based MASS instrument (MASS Code), based on annex 1 to document MSC 106/WP.8, taking into account the example and associated guidance in annex 2 to document MSC 106/WP.8, as well as potential gaps and themes identified, the scope and framework of the non-mandatory code, and documents MSC 105/7/2, MSC 105/7/3, MSC 105/7/6, MSC 105/7/7, MSC 105/7/8 and MSC 105/7/9;

.3 consider also, as part of the work under sub-paragraph .2, documents MSC 102/5/14, MSC 102/5/16 and MSC 103/5/10, taking also into account document MSC 102/5/2 and ISO/TS 23860;

.4 consider the common potential gaps and/or themes identified during the Regulatory Scoping Exercise (MSC.1/Circ.1638, section 5), focusing on the high priority items (MSC.1/Circ.1638, paragraphs 6.11.1 to 6.11.3);

.5 if time permitted, develop MSC MASS WG positions on the following points with the intention that these were submitted to the Joint MSC/LEG/FAL Working Group in the future (MSC.1/Circ.1638, paragraphs 6.11.1 to 6.11.3), which included, but were not limited to:

.1 consideration, together with relevant documents, whether to amend the definition for MASS and degrees of autonomy (including the respective definition);

.2 meaning of the terms master, crew or responsible person;

.3 remote control station/centre; and

.4 determination of the remote operator as a seafarer,

and advise on a way forward in addressing them;

.6 limit the development of the non-mandatory MASS Code to cargo ships with a view to considering the feasibility for application to passenger ships at a future stage;

.7 keep a list of volunteering Member States and international organizations with consultative status for the development of selected sections of the draft non-mandatory goal-based MASS Code under review and update it, as appropriate (MSC 106/WP.8, annex 3); and

.8 submit a written report to MSC 107.

Method of work

5 Since MSC 105, the Group has held several rounds of correspondence via email and, recognizing that MSC 105 had authorized it to hold virtual meetings as and when considered appropriate by the coordinator, four "virtual meetings" were conducted using the ZOOM platform.

6 As instructed by the Committee, the Coordinator of the Group gave a verbal report to MSC 106 on the status of its work and provided a working paper (MSC 106/WP.10) which included a draft framework for the Code which was subsequently used as the basis of the work of the Working Group established at MSC 106, thereby providing a smooth transition and continuation of the work on development of the Code.

7 In its work, the Group considered the instructions provided by the Committee as laid out in the ToR shown in paragraph 4 above. The following paragraphs give more detail regarding the work of the Group on each element of the ToR.

Consideration of key principles and common understanding of the purpose and objectives for the new instrument (ToR 1)

8 As instructed, the Group considered key principles and common understanding of the purpose and objectives of the new instrument. While the Group recognized that, as the Code is further developed, it is expected that there will be further refinement of these items, the draft of the MASS Code (see annex 1) includes an initial proposal for the Purpose, Principles and Goals/Objectives.

Development of the non-mandatory goal-based MASS instrument (MASS Code) (ToR 2 and 3)

9 Building on the previous work of the Committee regarding MASS and taking into account the instructions of the Committee, the Group continued the development of a non-mandatory goal-based MASS Code with the basic premise that it should:

.1 be non-mandatory but developed such as to facilitate its eventual transfer to a mandatory code;

.2 be complementary to existing instruments (not "stand-alone") and only address matters that are either not addressed in existing instruments or that require alternative approaches due to the nature of the MASS mode of operation;

.3 be goal-based and take account of the *Generic guidelines for developing IMO Goal-based Standards* (MSC.1/Circ.1394/Rev.2) and the *Principles to be considered when drafting IMO instruments* (resolution A.1103(29)); and

.4 address the impact of autonomy on critical "functions" rather than attempting to address the ship as a whole.

10 In developing the Code, the Group initially considered proposals for possible Code structures as made in submissions to MSC 105 as well as suggestions included in the report of the Working Group at MSC 105 (MSC 105/WP 8). The Group, noting that the Code should be goal-based, also took note of recently developed goal-based IMO instruments including the Polar Code, the IP Code, and recent work on revising the Diving Code.

11 Noting that MSC.1/Circ.1394/Rev.2 proposes a structure that includes "Goals, Functional Requirements, and Regulations" while the Code is intended to be non-mandatory, the Group considered that the inclusion of "Regulations" would be inappropriate in this case. Accordingly, the Group considered words which would be more appropriate and, as an interim solution, agreed that the term "Provisions" could be used, with the understanding that this would be open to consideration during further development of the Code.

12 After due consideration, the Group agreed on the following draft structure for the Code:

Preamble
Laying out the background to the development of the Code including the compelling need and intent.

Part 1 – General
Including the Principles, Purpose and Objectives (or Goals) along with Code Structure, Application, Terminology and Definitions.

Part 2 – Main principles for MASS and MASS Functions
Addressing the Operational Context, High Level Functional Requirements, and Safe States.

Part 3 – Goals, Functional Requirements and Provisions
Addressing the Goals, Functional Requirements and Provisions for the functions of a ship and structured very much along the lines of the SOLAS Convention including sections covering Navigation, Fire Safety, Life Saving, etc but also including other areas that could be considered as requiring specific attention in the context of MASS, such as Remote Operations.

Part 4 – Specific Provisions for Remote Control of Ship Functions
While it was proposed that this part be added to the Code, there was subsequent general agreement that it will be covered by section(s) in part 3 and so it is anticipated that the Working Group at MSC 107 will move to delete it.

13 Regarding the issue of whether the Code should only address SOLAS-related issues or be a cross-cutting instrument which covers other conventions such as STCW and COLREG (and other areas), further consideration will be required during the ongoing work on development of the Code.

14 At MSC 106, the Working Group further developed the Code in general and agreed on a method and example for the development of goals and functional requirements for Part 3 of the Code (annex 2 to document MSC 106/WP.8).

15 Following agreement at MSC 106 and as instructed in the revised ToR, the Group continued development of the draft Code with particular emphasis on part 3 and an initial focus on developing Goals and Functional Requirements for each section of part 3. To enable efficiency of the work, groups of interested Member States and international organizations were formed to develop selected sections of Part 3 of the Code with each section being coordinated by a lead volunteer. As instructed by MSC 106, the Group has maintained the list of Member States and international organizations involved in the development of selected sections of part 3 of the Code (see annex 2).

16 The work of the Group on the development of the Code, including input from the groups of interested parties as listed in annex 2, has been consolidated and is included in annex 1. It should be noted that what is shown in annex 1 is a work in progress and is expected to be further developed in the ongoing work on the Code.

Consideration of the common potential gaps and/or themes identified during the Regulatory Scoping Exercise (ToR 4)

17 During the general work of the Group, and the work of the groups of volunteering Member States and international organizations developing selected sections of Part 3 of the Code, the common potential gaps and/or themes (MSC.1/Circ.1638, section 5) were taken into consideration as necessary.

Input from MSC MASS WG to the Joint MSC/LEG/FAL Working Group (ToR 5)

18 As instructed, the Group developed MSC MASS WG positions on the points listed in the ToR that may require consideration by the Joint MSC/LEG/FAL Working Group (the MASS-JWG).

Potential amendment of the definition for MASS

19 The Group discussed the meaning of the term MASS, the intent of its application, and its appropriateness going forward given the growing work on MASS in industry and regulatory bodies. The Group recognized that the MASS acronym was already well known and widely used elsewhere and that any proposal for its change should ensure that IMO does not become out of step with the world. The Group also discussed how and when a ship would be considered to be a "MASS" and whether a ship to which all, or only part, of the MASS Code is applied should be defined as a "MASS".

20 The Group noted that, as used in the RSE, the IMO definition of MASS was understood as:

> "Maritime Autonomous Surface Ship (MASS)" – meaning "a ship which, to a varying degree, can operate independent of human interaction";

but that alternative definitions had been proposed including:

> "Maritime Autonomous Surface Ship (MASS)" – "A self-propelled vessel which can be partly or fully operated in automatic or remote mode without the involvement of onboard crew members"; and

> "Maritime Autonomous Ships and Systems (MASS)" – "Ships and systems which, to a varying degree, can operate independent of human interaction."

21 While there was some support for the second alternative definition above, no conclusive agreement on the matter was reached. In addition, there was objection from one delegation regarding the introduction of the term "systems" (given that the Group had previously agreed to base its work on "functions" rather than "systems") and from others regarding the deletion of the word "surface".

22 Accordingly, the Group agreed that the definition of MASS should be further considered but that lack of immediate resolution did not inhibit the ongoing work of developing the Code.

Potential amendment of the definition for Degrees of Autonomy (DoA)

23 DoA one to four were defined for the Regulatory Scoping Exercise (RSE), and the general view of the Group was that they should not be used in the further development of the Code. However, as work progressed it became apparent that, when considering the extent to which functions were automatically, remotely, or autonomously controlled, it was useful to consider specific examples or levels, and that the DoA tended to provide such readymade examples or levels.

24 The Group agreed that, while it may become apparent in the progress of its work that the DoA (at least as defined now) have no place in the function-based and goal-based MASS Code, consideration of the matter at a later date would have no adverse effect on the development of the Code.

25 Subsequently it was noted that the majority of discussions within the Group tended to focus on different modes of operation (i.e. automatically, remotely or autonomously controlled).

26 Accordingly, the Group agreed that the DoA as developed for the RSE would not be used during the work of development of the Code and that consideration should be given to whether it is more appropriate to consider "Modes of Operation" in its further work.

Meaning of the terms master, crew, or responsible person

27 The Group noted that, when considering in particular a ship which is remotely operated (with or without crew on board), the traditional roles, responsibilities and activities which would normally be held or carried out by persons on board the ship may be held or carried out by persons remote from the ship. In addition, such persons as may be on board a remotely operated ship may have markedly different roles, responsibilities and expectations regarding their activities on the ship.

28 Accordingly, the Group proposed consideration of the implications raised by such modes of operation of a MASS and, in particular, the following:

.1 "key" positions and responsibilities being held by persons not located on the ship;

.2 new MASS roles, e.g. Designated Master Ashore, Remote Navigator, etc;

.3 altered roles and responsibilities of existing positions such as deck officer, engineering officer, etc;

.4 roles and responsibilities of persons located on board a remote-controlled MASS; and

.5 further, or alternative, needs for qualification and certification of personnel.

Remote-control station/centre

29 Regarding the term and associated acronym for the location from which a ship is being remotely controlled, the Group recognized that it is important that it fits with what is commonly and currently in use in industry and regulatory spheres.

30 Noting concern regarding the use of the acronym RCC (for "Remote Control Centre") and its potential confusion with the commonly used term Rescue Coordination Centre (RCC), it was suggested that a possible alternative term could be Remote Control Station (RCS); however, there was also concern that a "station" may mean a workstation within a centre. Another suggestion was the term Remote Operation Centre (ROC), as this allowed for the term to be used when a MASS may only be monitored (not for fleet management purposes but, for example, for oversight of fully autonomous vessels) as well as when MASS are being directly controlled.

31 Particular issues raised regarding the remote-control station/centre included:

.1 should functional requirements be different from, for example, a traditional navigational bridge (e.g. available technology, continuous attendance and navigational watches);

.2 potential limits on the control of multiple ships from a single control centre (or by a single operator);

.3 regulation, survey, inspection and certification of personnel, equipment, systems and operations;

.4 application of VTS and the ISM Code;

.5 training and qualification of operators;

.6 roles and responsibilities depending on type of operational phase (on passage, entering or leaving port, etc);

.7 technical requirements (e.g. cybersecurity, communications, system resilience, contingency plans, mitigation measures, fall-back provisions);

.8 should the remote operations centre be located in the country whose flag the MASS flies; and

.9 the application of local regulatory requirements to the centre.

32 Accordingly, while the Group tended towards the term "Remote Operation Centre (ROC)", it was agreed that further consideration was required regarding the correct term to describe a location from which a MASS is remotely operated. In addition, further consideration is required of the issues raised in paragraph 31 above.

Determination of the remote operator as a seafarer

33 Roughly equal numbers within the Group considered that the remote operator of a MASS should be designated as a seafarer (along with the application of STCW requirements applied to seafarers), versus those who were of the opposite opinion, however several were of the opinion that, irrespective of the final decision, a remote operator should be designated as a seafarer "at this stage". There was, however, unanimous support for requiring that the remote operator be trained and qualified in accordance with appropriate STCW requirements.

34 The Group therefore agreed that further consideration was required, perhaps in the appropriate sub-committee, of whether a remote operator should be designed as a seafarer and that the following points should be taken into account:

.1 the opinion of the Group that a remote operator (and other MASS involved positions) should be trained and qualified in accordance with appropriate STCW requirements;

.2 an alternate suggested approach of remote operators meeting relevant STCW requirements but not being designated as seafarers;

.3 whether a remote operator should have appropriate experience as an onboard officer of a seagoing vessel;

.4 that it should not be assumed that training in accordance with the STCW Code is sufficient to enable an individual to remotely operate a ship safely in water space shared with conventional ships; and

.5 an expressed concern that the status as a remote operator could lead to dilution of the skills required by the current STCW Convention.

List of volunteering Member States and international organizations with consultative status for the development of selected sections of the draft non-mandatory goal-based MASS Code (ToR 7)

35 As requested by MSC 106, and as noted in paragraph 15 above, the Group has kept a list of volunteering Member States and international organizations for the development of selected sections of part 3 of the Code and has continuously updated it, as appropriate (annex 2).

Proposal of next steps in the development of a goal-based instrument for maritime autonomous surface ships (mass)

36 Regarding the ongoing work on development of the Code, and with the expectation that a working group will be established at MSC 107 and that the correspondence group will be re-established by MSC 107, the Group proposed that consideration is given to establishing an intersessional working group (ISWG) in the latter part of 2023 to further the work on MASS, bearing in mind that there was no autumn session of the Committee in 2023 and the tight time schedule for the completion of the work on the MASS Code.

37 If the ISWG is established, the Group further proposed that the correspondence group that was expected to be re-established at MSC 107, provides the ISWG with the then current status of its work and in return, any output generated by the ISWG should form the basis for the further work of the correspondence group.

Proposal of terms of reference for MASS WG at MSC 107

38 The Group agreed to recommend to the Committee the re-establishment of the MASS Working Group at MSC 107, taking into account any decisions made in plenary, to:

.1 further develop the draft non-mandatory MASS Code, using document MSC 107/5 (Report of the Correspondence Group) and its annexes as the basis, and taking into account documents MSC 107/5/[…] [submissions made to MSC 107, as appropriate];

.2 consider the outcome of the second session of the Joint MSC-LEG-FAL Working Group on MASS and if there are additional common issues that should be submitted to the JWG;

.3 consider the involvement of sub-committees in the further development of the MASS Code;

.4 update the road map for developing a goal-based code for Maritime Autonomous Surface Ships, based on annex 10 to document MSC 106/19/Add.1;

.5 develop draft terms of reference for:

 .1 the intersessional Correspondence Group on Development of a Goal-Based Instrument for Maritime Autonomous Surface Ships (MASS); and

 .2 the intersessional Working Group on Development of a Goal-Based Instrument for Maritime Autonomous Surface Ships (MASS); and

.6 submit a written report to plenary by Thursday, 8 June 2023.

Action requested of the Committee

39 The Committee is invited to approve this report in general and, in particular to:

.1 agree, in principle, to the approach taken for, and structure of, the draft non-mandatory International Code of Safety for Maritime Autonomous Surface Ships (MASS Code) (paragraphs 5 to 35 and annex 1);

.2 note the proposed positions on matters that may be considered by the Joint MSC/LEG/FAL Working Group and forward, as appropriate, to the MASS-JWG for its consideration (paragraphs 22, 26, 28, 32, and 34);

.3 consider the proposal for the establishment of an intersessional MASS Working Group to meet the tight time schedule for the completion of the work on the MASS Code (paragraph 36 and 37); and

.4 agree with the Group's recommendation to re-establish the MASS Working Group to further the work of development of the draft non-mandatory MASS Code, with the proposed terms of reference (paragraph 38).

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ANNEX 1

DRAFT INTERNATIONAL CODE OF SAFETY FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS CODE)

PREAMBLE

1 Existing IMO instruments have historically been developed on the basis that the ship will have at least a 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 remote control and autonomous operation of key functions, will require a different approach, and therefore some adjustment of the accepted norms regarding onboard manual intervention and control as contained within SOLAS and other IMO instruments.

3 In facing these challenges, it is recognized that some aspects associated with MASS may not be adequately or fully addressed in SOLAS or other IMO instruments and that additional guidance may be required on the design and operation of MASS to achieve a level of safety that is at least equivalent to that expected of a conventional ship.

4 This Code addresses the functions needed to obtain safe and reliable operations of MASS insofar as they are not adequately or fully addressed in other applied IMO instruments, such as SOLAS, while ensuring that required safety levels are maintained or enhanced through the implementation of remote control, or autonomous operation, of key functions.

5 This Code is intended as a supplement to other IMO instruments, such as SOLAS, and provides a regulatory framework for the performance of remote control and autonomous operation of key functions, as applicable.

6 The safety principles and objectives of this Code reflect changes in the operational risks (increases or reductions) which may result from the introduction of remote control and autonomous operation of key functions and address their management and reduction through mitigation measures and controls.

7 This Code has been developed based on the *Generic guidelines for developing IMO Goal-based Standards* (MSC.1/Circ.1394/Rev.2) and the *Principles to be considered when drafting IMO instruments* (resolution A.1103(29)).

8 The provisions of this Code should be implemented for individual remotely controlled or autonomous functions even where persons are on board to handle other functions.

9 This Code takes into account that certain operational functions may be controlled from a location, or locations, remote from the MASS and addresses necessary aspects of such remote operations centres.

PART 1 GENERAL

1 Introduction

1.1 Purpose

The purpose of this Code is to provide a coherent international regulatory framework to enable [and ensure] safe, secure, and [environmentally sound] MASS operations. The Code further aims to support the safe adoption and integration of new technology for ship operations and provide for consistency of approach to the design, build and operation of MASS.

1.2 Principles

This Code is developed on the principles that it be:

a. supplementary to any applied base IMO instruments, such as SOLAS, and only address MASS issues insofar as they are not adequately or fully addressed in the applied base instruments;

b. holistic to ensure the objectives, aims and principles of the IMO base instruments are maintained while also ensuring that the challenges of MASS functions and operations are addressed across all instruments;

c. goal-based and addressing matters at the functional level;

d. non-mandatory but developed in such a way as to facilitate future transition to mandatory status; and

e. technology neutral and taking note of industry practices and experience in the deployment of new technologies.

1.3 [Goals] [Objectives]

In achieving its Purpose, this Code is intended to:

a. ensure achievement of a level of safety at least equivalent to that expected of a conventional ship;

b. enable all ships to safely coexist without impeding or negatively impacting each other, regardless of whether certain functions are remotely controlled or autonomously operated;

c. ensure that there is no relaxation of the level of accepted standards for design, construction, or operation;

d. allow for the application of solutions that are demonstrably safe, secure, and environmentally sound in performing the designated function in all defined conditions; and

e. be cognizant of the potential for the unintended placement of regulatory barriers to new or novel application of remote control or autonomous technology on ships.

[1.4 Verification and validation (GBS Tier III)]

2 Application

The application of the Code is important to understand as it is developed, and so it is suggested that this be discussed during MSC 107 and worked on during the post-MSC 107 session of the CG.

3 Code Structure and relationship to other IMO Instruments

It is suggested that this be worked on during the post-MSC 107 session of the CG and taking account of the output of MSC 107.

4 Terminology and Definitions

It is suggested that this be worked on during the post-MSC 107 session of the CG and taking account of the output of MSC 107.

5 Certificate and Survey

Given that there still appears to be some uncertainty regarding the intent and content of this section, it is proposed that this be addressed at MSC 107.

PART 2 MAIN PRINCIPLES FOR MASS AND MASS FUNCTIONS

The following text for section 2.1 is as proposed by the Russian Federation and China and requires further consideration.

[2.1 Operational context

2.1.1 Goal

The goal of this section is to provide a clear context for safe MASS operation, taking into account specific features of MASS operation including the presence of two additional control modes in addition to the manual ship control by the crew on board (remote control and automatic control), including a combination of any of the three modes.

2.1.2 High-level functional requirements

FR1.1: During an assessment of the safety of the MASS operation, the Administration and the authorized organization should consider ship mission, geographical conditions, environmental conditions, traffic conditions, conditions of systems and assignment of roles.

FR1.3: Responsibilities for the MASS operation should be clearly defined, taking into account the availability of remote and automatic control.

FR1.4: Features of the MASS operation require specific conditions of supervision over the MASS operation, taking into account the availability of remote and automatic control, and the use of remote crew and responsible persons.

FR1.5: All goals stipulated by SOLAS shall be carried out at the autonomous ship irrespective of the control method in a complete equivalency providing safe shipping. The shipmaster shall define the most proper way to control the ship depending on the specific situation to ensure the required safety level is kept.

FR1.6: Information required for the safe operation to be available onboard following the recommendations of the Administration, including electronic format and kept in the Internet information network.

FR1.7: Safe fallback response should be implemented, including transfer of ship control to the crew onboard/remote operator and minimal risk action[1] by autonomous systems.

2.1.3 Specific functional requirements for the MASS operation safety assessment

FR2.1: Specific requirements for the MASS operation in different domains (for example, automatic control at sea, remote control when approaching/leaving a port, automatic mooring, manual control during port operations) should be reflected in a MASS class (category).

FR.2.2:[Different functional requirements may be imposed on the MASS by the Administration [in the Concept of Operation] depending on the ship mission (transportation of passengers, dangerous goods, providing technical services, etc.), geographical conditions (restrictions, international/domestic voyage, etc.), environmental conditions (sea and weather conditions, day/night, etc.), traffic conditions (traffic density, VTS, routeing system, dedicated lanes for MASS, pilotage, etc.), conditions of systems (e.g. automated navigation system, engine and propulsion systems, cargo handling systems, etc.), and assignment of roles][2].

2.1.4 Specific functional requirements for the MASS operational responsibility[3]

FR3.1: The MASS owner shall ensure the safe operation of the ship under the applicable international instruments and national regulations of the flag State of the ship, including those relating to life, health and properties of the third parties. The MASS owner bears the responsibility established by the applicable instruments and national regulations of the flag State of the ship for possible harm to third persons, the environment, as well as to protected public interests incurred due to or concerning the operation of such ship including liability limitations established by the applicable instruments.

FR3.2: Depending on the MASS autonomy degree, enforcement of the requirements concerning safe shipping and environment protection is provided by the shipowner with the help of the crew and/or by the remote crew, if any. The shipowner may entrust the third organization that is proficient in MASS operation to supervise the ship and operate the ship by the organization's remote crew staying outside the ship; meanwhile, the shipowner is responsible for meeting the requirements of safe shipping and environment protection in any case.

FR3.3: Carriage of the cargoes by MASS is performed in accordance with the applicable international practice and rules, and regulations of the State flag of the ship. Unless otherwise directed by the contract of sea carriage or by the effective international and national regulations, the shipowner of the autonomous ship is responsible for the ship's seaworthiness and safe carriage of the cargo as indicated in the contract of sea carriage. The shipowner and the cargo owner represent the interests of the shipowner and cargo owner by themselves or by the persons they authorize.

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[1] The meaning of minimal risk action could be further defined.

[2] These requirements could be Tier III provisions supporting the FRs in Section 3, which could be developed by Administrations or ROs.

[3] This part may be adjusted based on the outcome of the discussion in JWG.

2.1.5 Specific functional requirements for the MASS supervision

FR4.1: The MASS owner provides continuous supervision and, if required, control over the MASS by a crew onboard and/or remote crew outside the ship. A crewless (fully autonomous) MASS, excluding fully autonomous passenger ship, equipped with autonomous systems allowing her to navigate from the point of departure to the point of destination, and providing safe navigation and sea environment protection without continuous supervision is exempted from continuous supervision and control by a remote crew.

FR4.2: A MASS crew, excluding a fully autonomous ship, includes a shipmaster, other officers and operational staff if proper diplomas and qualification certificates stipulated by the STCW Convention are available. MASS crew members can combine various functions stipulated by the STCW Convention, subject to keeping the established work and rest hours and having the qualifications required for every function they perform.

FR4.3: A fully autonomous ship does not have a crew except the remote one.

FR4.4: The remote crew shall provide remote control of the MASS or render assistance in MASS control to the crew onboard. The remote crew may include a MASS remote master, MASS remote operators and responsible persons. Members of the remote crew follow the instructions of the shipowner relating to ship control, including ship navigation and work schedule. The instructions of the charterer concerning the commercial operation of the ship are mandatory for members of the remote crew.

FR4.5: A MASS master (including a remote master, if he/she is located outside the ship) is responsible for MASS control, including navigation, taking measures to ensure the safety of the ship's navigation, marine environment protection, keeping the order on board, preventing harm to the ship, as well as to the people and cargo on board. A MASS master, including a remote master, must have a valid shipmaster diploma and other certificates following the requirements of applied international instruments and national regulations established by the Administration.

FR4.6: When operating a fully autonomous ship that does not have a ship remote crew, the shipowner must identify the person responsible for managing the fully autonomous ship, who performs all the functions and duties assigned to the ship's master by applicable international instruments and the regulations of the flag State of the autonomous ship.

FR4.7: A remote crew member directly controlling the MASS via a remote control station located outside the ship is the remote operator. The remote operator is a seafarer, as established by the STCW Convention, who should meet the defined qualification requirements relating to chief mates or shipmasters in accordance with the provisions of regulation I/11 of the STCW Convention and regulations of the flag State of the autonomous ship. The Administration shall establish the requirements for professional training programmes on autonomous ship operations. Remote operators and responsible persons of the remote crew run [follow] the commands of the MASS master.

FR4.8: MASS remote control can be carried out by the remote crew staffed not only by the shipowner but also by a third-party organization competent in autonomous navigation and having at its disposal technical means to manage MASS as well as experts in MASS control meeting the requirements established for remote operators. The Administration shall establish the requirements for such organizations providing services for MASS operation.

2.1.6 Specific functional requirements for information required for safe MASS operation

FR5.1: The shipowner is liable for every MASS is provided with the documentation required following the recommendations of the Administration, it should also be updated on time both in paper and electronic format, respectively. The MASS master or remote shipmaster is responsible for all required ship's documentation to be onboard MASS and in the Internet information network, its proper maintenance and safety kept both in paper and electronic format, respectively.

FR5.2: Every MASS shall have valid ship's documents verifying that provisions of current international conventions, technical and fire safety requirements, due technical conditions of the ship, safety of life at sea, prevention of pollution from ships, safe cargo carriage, sanitary conditions of the ship and labour safety, logbook and engine log are met.

FR5.3: Onboard ship's documents shall be kept in electronic format to present them in paper or digital/electronic format upon the request of the authorized persons. A bridge, engine, radio, and medical logs of a fully autonomous ship are carried out by the shipowner in electronic format within the procedures established by the Administration. The logs mentioned and other ships' documents may be kept outside of an autonomous vessel and are presented by the shipowner in electronic format in case of port state control actions and other cases stipulated by international instruments and the port State.

FR5.4: Ship Minimum Safe Manning Certificate should include the autonomy degree of the autonomous ship and match with the operation modes of MASS. Ship Minimum Safe Manning Certificate for a fully autonomous ship shall not be issued.

2.1.7 Specific functional requirements for safe fallback response

FR6.1: A safe fallback response is a response of autonomous systems for MASS or a sequence of responses to an exit from operational conditions for the system to function, a system failure, or a failure or incapacity of the crew onboard/remote operator to fulfil its functions [responsibilities].

FR6.2: The safe fallback response of the autonomous systems for MASS may transfer ship control to the crew onboard/remote operator when the crew onboard/remote operator is capable of assuming control over the ship's behaviour.

FR6.3: During a safe fallback response transferring control to the crew onboard/remote operator, the autonomous systems for MASS should maintain ship control until the system has [confirmed][determined] that the crew onboard/remote operator has assumed full control over the ship's behaviour.

FR6.4: In cases where the system determines a failure of the crew onboard/remote operator to fulfil its functions, the autonomous systems of MASS should prompt a return of the crew onboard/remote operator to the required state.

FR6.5: In cases where the system determines the incapacity of the crew onboard/remote operator to fulfil a safety-critical role, the autonomous systems of MASS should execute a minimal risk action placing the MASS in a minimal risk condition in a manner consistent with marine safety requirements.]

2.2 Safe states for the ship

Consider if this section is adequately covered in the new 2.1 proposed above.

2.3 Functions Required for MASS

Further discussions required on the intent of, and need for, this section.

2.3.1 It is required for MASS that all or part of functions below which are performed by seafarers onboard should be automated or remotely controlled:

.1 Navigation;

.2 Cargo handling and stowage;

.3 Controlling the operation of the ship and care for persons on board;

.4 Marine engineering;

.5 Electrical, electronic and control engineering;

.6 Maintenance and repair; and

.7 Radiocommunications

2.3.2 In case of automating or remotely controlling the above functions, Operational Design Domain (ODD) of autonomous systems should be defined and Concept of Operation (ConOps) of MASS should be clarified for verification and certification of autonomous systems. Functions related to safety of navigation should be maintained at all times and in such a way as to conform to predefined ODD.

2.4 Risk Assessment

The Group was of the opinion that discussions now on risk assessment (as it pertains to this proposed section in the Code) would be premature however China volunteered to take leadership of development of the necessary input to the Code on this subject after MSC 107.

2.4.2 Principle
2.4.3 Definition
2.4.4 Procedure
2.4.4.1 Team of evaluation
2.4.4.2 Safety standards
2.4.4.3 Hazard identification
2.4.4.4 Control measures
2.4.4.5 Record
2.4.5 Risk management
2.4.6 Risk assessment methods
2.4.6.1 Functional Hazard Assessment (FHA)
2.4.6.2 Failure Modes and Effects Analysis (FMEA)
2.4.6.3 Systems-Theoretic Accident Model and Processes (STAMP)]

2.5 System design principles
The objective of, and need for, this section should be discussed along with its possible combination with 2.6?
2.6 Software standards
The objective of, and need for, this section should be discussed along with its possible combination with 2.5?

2.7 Communications [Connectivity]
To be considered in conjunction with Part 3, section 3 (Communications).

Aspects to be considered include traceability, accountability, trust, transparency, reliability, resilience, data, software safety assessment, cybersecurity/safety, privacy, verification and validation, through life, human oversight, and connectivity.

2.8 Human element

2.8.1 Roles and responsibilities

2.8.2 Manning

2.8.3 Training

2.8.4 Human-Machine Interface (including transfer of responsibility)

PART 3 GOALS, FUNCTIONAL REQUIREMENTS AND PROVISIONS

1 NAVIGATION

1.1 Goal
The goal of this section is to provide for safe [and secure] navigation of MASS for any mission phase [including collision avoidance in each environment condition], taking into account the mode of operation of the ship [and the number of persons on board].

1.2 Functional requirements
In order to achieve the goal, set out in paragraph 1.1 above, the following functional requirements are embodied in the provisions of this chapter.

<u>FR1.1 General</u>

A MASS should achieve the following functional requirements for navigation in general.

FR1.1.1: A MASS should comply with all relevant SOLAS Navigation Requirements [and MARPOL Requirements except where modified by the second Tier Functional Requirements below].

FR1.1.2: [A MASS should have the capability to meet all relevant STCW and COLREG requirements]/[A MASS should meet all relevant STCW and COLREG requirements by the collaboration with seafarer, remote operator, and/or Autonomous Navigation System(ANS)].]

FR1.1.3: The use of Autonomous Navigation Systems (ANS) should not endanger the safety of persons onboard, the vessel or [the traffic environment including] other vessels.]

FR1.1.4: The navigation equipment and systems which are installed on MASS should be designed, constructed, and installed to retain their functionality under the [intended/expected] environmental conditions in the [Operational Envelope of MASS]/[Operational Design Domain (ODD) of ANS].

.1 The use of autonomous systems which are delegated control of function(s) or task(s) other than navigation functions should not prevent the appropriate work of navigation system during autonomous navigation.

.2 [ANS should not affect the [existing] [other installed] navigation systems. Even in the event of failure, [existing]/[other installed] navigation system should continue to be operable.]/[Even in the event of failure on ANS, the ship should be controlled safely by operating the [existing]/[other installed] navigation system without any effects of ANS.]

FR1.1.5: In case of automating or remotely controlling the navigation functions, [Operational Envelope (OE) of MASS and Operational Design Domain (ODD) of ANS] should be defined.

FR1.1.6: Functions related to [ensuring the safety of]/[safe] navigation should be maintained at all times and in such a way as to conform to the predefined ODD.

FR1.1.7: ANS should always monitor the operation status of hardware and software related to the control of the navigational functions.

FR1.1.8: Responsibility for the safety of navigation should be clearly defined at all times.

FR1.1.9: [Resources/Manning] should be allocated and assigned as needed in correct priority to perform necessary tasks. [Especially, manoeuvring of the ship should be appropriate to the urgency of the situation and nature of the emergency].

FR1.1.10: ANS for MASS should be [approved]/[certified] by the Administration and/or recognized organization to evaluate performance in executing common operating tasks and to assess performance under [all operating conditions defined by ODD]/[defined conditions representative].

FR1.1.11: [While] all reasonable steps should be taken to maintain ANS and related equipment in efficient working order [and must be seaworthy], malfunction of that equipment should not be considered as making the ship unseaworthy or as a reason for delaying the ship in ports where repair facilities are not readily available, [provided suitable arrangements are made by the master to take the inoperative equipment or unavailable information into account in planning and executing a safe voyage to a port where repairs can take place]/[provided suitable alternative arrangements as appropriate to the level of malfunction are made by the master that allows for the planning and execution of a safe voyage to a port where repairs can take place, subject to the approval of the Administration. This can be in the form of conventional manned navigation, additional measures to compensate for the functions compromised by the malfunction or any other reasonable measures].

FR1.1.12: Task stations for the ANS should be …

<option1> located where crew/operator usually [exist (i.e., not necessarily in the bridge)]/[works place]. [Depending on the degree of autonomy, the control centre/station does not need to be located in the bridge.]

<option2> designed and located to enable crew/operators to keep a watch [at sea [or in port]] in a manner conforming to the principles of watchkeeping described in Parts 3, 4 and 5 of Section A-VIII/2 of the STCW Code, and the safe control of the ship by personnel which may from time to time be involved in the navigation of the ship.

FR1.1.13: Manuals for the use of ANS should be readily accessible at the ANS itself and in all the task stations.

[FR1.1.14: The crew/operator should be able to take command at any time.]

FR1.1.15: The ODD should be designed to take into account the following:

.1 [The ODD should provide the operator with sufficient information regarding the ship's operational capabilities and limitations in order to support their decision-making process to use ANS.]

.2 The ODD should include information on the ship-specific capabilities and limitations in relation to the assessment required for activation of the ANS.

.3 ANS should not operate out of its ODD.

.4 The ODD should include or refer to specific procedures to be followed in normal operations and in order to avoid encountering conditions that exceed the ODD.

.5 The ODD should be specified in the manual, and the operator should be aware of it.

Note: In case of multiple Remote-Control Station, all stations and the vessel/ship must keep a log of which station is in charge. This would be important to identify responsibilities in case of an event.

FR1.2 Preparation for departure [including voyage plan]
A MASS should achieve the following functional requirements in order to navigate according to an appropriate voyage plan that identifies safe routes.

FR1.2.1:

<option1> Voyage plan from [departure to arrival]/[berth/port to berth/port] should be [planned]/[approved by the responsible person] to ensure safe navigation of MASS.

<option2> A detailed voyage or passage plan should be prepared which should cover the entire voyage or passage from berth to berth.]

FR1.2.2: Voyage plan should be developed taking into account the following issues:

.1 [The voyage plan should ensure that the operators are provided with sufficient information to enable operations to be conducted with due consideration to the safety of the ship and persons [on board].]

.2 [All potential navigational hazards [and hydro-meteorological] are [accurately] identified;]

.3 [Charts and publications are corrected [updated] in accordance with the latest information available;]

.4 Comprehensive information including ODD for autonomous navigation should be provided;

.5 [Consideration of how MASS is operated (e.g., onboard crew control, remote control, unmanned etc.);]

.6 [The voyage plan describing the full voyage from departure to arrival should be definable and updatable at any time; and]

.7 [A voyage plan is an indication of preferred actions based on information available at the time the plan is prepared; therefore, departure from the plan may be necessary based actual circumstances at the time the plan is executed.]

FR1.2.3: Crew, operator and/or supervisor should verify that the voyage plan input into ANS is [correct]/[appropriate].

FR1.2.4:

<option1> Performance checks and tests to ANS comply with ANS provider's documentations, e.g. safety manuals and recommendations. Hardware interface for autonomous control are appropriately connected.

<option2> Within XX hours before departure, core systems (e.g. ANS, etc.) which are installed on MASS should be checked and tested by the [Crew/ Responsible person].

.1 The test procedure shall include, where applicable, the operation of the following:
- ANS
- Alert management system
- Data recording system
- Systems for services for navigation
- Communication system to remote operation centre
- [XXXX (if any)]

.2 The checks and tests should include:

- Appropriate work of ANS according to ANS provider's documentations, e.g., safety manuals and recommendations.
- [H/W]/[Hardware] interfaces for autonomous control are appropriately connected.
- [Communication test between the MASS and Remote Operation Centre]

Note: "Voyage plan" is to plan and conduct a route, determine position, and then input them in ANS before departure.

FR1.3: Situational awareness

Situational awareness is the perception of the navigational and technical information provided and the comprehension of their meaning, as required for timely reaction to the situation.

FR1.3.1 Lookout function which is a measure to realize the perception is to continuously monitor the ship's surroundings, when the ship is under way or at anchor, to detect, recognize and identify any objects and lights on the surface of the sea in the ship's vicinity relevant to the safety of persons and the ship as well as other ships and vessels.

.1 The detection function should provide discovery of an object and provide this information for the recognition function.

.2 The recognition function should categorize the detected object and provide this information to the identification function.

.3 The identification function should specify a unique identity of a recognized object needed to decide whether and how to react to the identified object.

.4 The lookout function should be redundant to single point faults and shall inform of degradation of performance.

FR1.3.2: When MASS is under way or at anchor, MASS should be able to continuously monitor the following items:

.1 static and dynamic objects of its surroundings on the surface of the sea in the vicinity relevant to the safety of navigation such as sea marks, other vessels and wreckage;

.2 its own status such as heading, velocity, position and condition of each subsystem; and

.3 geographic information related to safety of navigation such as nautical chart information and environment condition.

FR1.3.3: The distress or emergency signal should be immediately detected, and the type and scale of the emergency is promptly identified.

FR1.3.4: MASS[ANS] should integrate all information obtained from 1.2.3 to interpret and analyse MASS's condition with taking into account the limitations of the equipment and prevailing circumstances and conditions.

FR1.3.5: Accurate understanding of current and predicted vessel state, navigation path, and external environment should be shared with [crew/remote operator].

<u>FR1.4: [Risk analysis,] route planning and determination for collision and grounding avoidance</u>

A MASS should achieve the following functional requirements in order to ensure that decisions for collision and grounding avoidance are made appropriately.

FR1.4.1: ANS should plan an appropriate route to avoid collisions and groundings [according to changing/in all] conditions and notify other system and/or [the necessary personnel [such as the Master, crew, operator and/or supervisor]] based on the results of the situational awareness. [The route should be updated as required based on the latest inputs and conditions.]

.1 Action taken to avoid a close quarter situation or collision with other vessels is in accordance with the International Regulations for Preventing Collisions at Sea, 1972, as amended;

.2 Decisions and planning to amend course and/or speed are both timely and in accordance with safe operating limits of ship propulsion, steering and power systems ;

[.3 <option1> If ANS could not comply with the International Regulations for Preventing Collisions at Sea, 1972, as amended, due to the circumstances and conditions at the time, the ANS should notify operators.

<option2> If ANS is unable to take certain actions required by the International Regulations for Preventing Collisions at Sea, 1972, as amended, due to the circumstances and conditions at the time, a proper mechanism should be designed and applied to avoid collision.]

FR1.4.2: If unable to plan an appropriate collision avoidance route, ANS should notify other system and/or supervisors[operators] [with sufficient time] so that system and/or supervisors[operators] can appropriately override.

FR1.5: Heading, speed and track control

A MASS should achieve the following functional requirements in order to ensure appropriate control and actuation based on situational awareness and decision.

FR1.5.1: ANS should track with pre-defined accuracy based on its manoeuverability over the planned route including collision avoidance, berthing, un-berthing [and anchoring].

FR1.5.2: ANS should contain capability of controlling the motion of the MASS in response to conditions in the operating environment.

FR1.5.3: Safe operating limits of ship propulsion, steering and power systems controlled by ANS are not exceeded in normal manoeuvres.

FR1/5/4: ANS should be capable of adjustments made to the ship's course and speed to maintain safety of navigation.

FR1.5.5: If unable to track with pre-defined accuracy over the planned route, ANS should notify other system and/or supervisors/operators [with sufficient time] [so that system and/or supervisors/operators can appropriately override].

Note1: Parameters specific to the berthing/unberthing function (e.g., angle of approach, change in manoeuvrability in response to vessel speed) should be considered.

Note2: COLREG rule 6 “safe speed” may be used as a reference.

FR1.6: Alert management

An ANS should achieve the following functional requirements in order to enhance the handling, distribution and presentation of alerts within the ANS and to ensure that onboard crew and/or the remote operator can override any autonomous functions and/or take over the control of the ship when necessary.

FR1.6.1: The alert management should support the proper application of SOLAS regulation V/15. The alert management of ANS should handle the [reasonably foreseeable] abnormal situations including those specific to MASS operations, such as the following situations that:

.1 the ANS cannot make an appropriate collision avoidance plan;

.2 the ANS cannot control the ship appropriately (e.g., deviation from the intended course and/or set speed range);

.3 the ANS itself and/or any other systems connected to the ANS (including sensors, actuators, and communication systems) have any abnormalities [and/or degradation];

.4 any conditions are about to deviate, or have already deviated from the predefined operating conditions of the ANS; and

.5 the ANS detects undefined event (e.g., signal to which response is not defined).

[FR1.6.2: In case that personnel are in multiple places (regardless of whether on board or off board), the clearance of one alarm should be report to all stations, including the ones not engaged at the moment of the alarm.]

FR1.6.3: In case of remotely controlled MASS with crew on board, all the alerts and the alert management status (e.g., acknowledgement of alarms and warnings) should be presented in the task stations both on board the ship and in the remote-control station, with consistency among those task stations. Any abnormalities of the equipment in the remote-control station should also be presented in the task stations both on board the ship and in the remote-control station.

FR1.6.4: In case of MASS without crew on board, all the alerts and the alert management status (e.g., acknowledgement of alarms and warnings) should be presented in the task stations in the remote-control station. If alert management is conducted by onboard automatic back-up system, all the alert information including the abnormalities of the equipment in the remote-control station should also be transferred to the back-up system.

[FR1.6.5: In case of fully autonomous MASS without crew on board, in the event that the ANS loses control over the route, the [responsible person] must be alerted to take control of the vessel.]

Note: Because any emergency situations (e.g., fire, collision, flooding or distress of the own ship and other ships) would affect the navigational behaviour, the alert information of such situations may have to be transmitted to the ANS depending on the ConOps. [Any "external" inputs that may affect the ANS should be transmitted (not transferred) to the ANS. For example, if for some reason due to engine failure the ship can only sail at reduced speed, this should be known to the agent (human or machine).]

<u>FR1.7: Data record</u>

A MASS should achieve the following functional requirements in order to adequately store data that contributes to safety navigation and casualty investigations.

FR1.7.1: Proper records of the movements, activities and time relating to ANS should be maintained at the same level as voyage data recorders.

FR1.7.2: In case of remotely controlled MASS, the audio of conversations and communication logs at the remote-control station should be stored.

FR1.7.3: In case of MASS without crew on board, records of navigational activities and daily reports should be stored automatically or remotely.

Note1: Which items of ANS data should be recorded and maintained at the level of VDR needs to be considered.

Note2: It is necessary to state within this code that not only the operational status of ANS but also the maintenance status of ANS itself (including system renewals, etc.) should be recorded. When ANS is shut down unexpectedly, critical data in use, including voyage plans etc., should not be lost.

Note3: It should be considered whether data records need to be shared remotely ashore in case records cannot be recovered from the sea.

<u>FR1.8: Services for navigation</u>

A MASS should achieve the following functional requirements in order to safely navigate by utilizing the services described in SOLAS chapter V.

FR1.8.1: MASS should use a mandatory [and recommended] ship's routeing system. If MASS decides not to follow the route for compelling reasons, any such reason should be recorded.

FR1.8.2: Safe embarkation of necessary and expected external personnel [(e.g., pilots)] should be ensured regardless of the [concept of operations] [nature] of the MASS [taking into account security issues]

FR1.8.3: In case of remotely controlled MASS, a remote operator should have access to information on navigation warnings, meteorological services, ice patrol service, vessel traffic services, aids to navigation [, port operation services,] and danger messages.

FR1.8.4: In case of fully autonomous MASS without crew on board, information on navigation warnings, meteorological services, ice patrol service, vessel traffic services, aids to navigation [, port operation services] and danger messages should be automatically [entered/input] into the ANS.

FR1.8.5: In case of MASS without crew on board, observed meteorological data, information relating to ship reporting systems, reports to VTS and danger messages should be reported automatically or remotely, as required.

[FR1.8.6: In case of MASS without crew on board, MASS without rescue facilities, which is in a position to rescue a ship in distress, should automatically or remotely inform the search and rescue service that it is impossible to proceed to the assistance of the ship in distress.]

Note: Depending on the MASS operation method, different type of service for navigation should be considered. And this concern should be reflected to FR from 1.2.1 to 1.2.11.

<u>FR1.9: Redundancy</u>

A MASS should achieve the following functional requirements in order to ensure the redundancy necessary for the reliable operation of navigation systems.

FR1.9.1: Redundancy design of ANS should be considered as necessary based on a result of risk assessment taking into account its level of autonomy and the use of remotely controlled navigation systems. [Based on the results of the risk assessment considering the ConOps of the MASS, redundant design of the ANS should be implemented as required.]

[FR1.9.2: In case of MASS with crew on board, qualifications of the crew and their ability to perform planned and emergency maintenance should be taken into account.]

<u>FR1.10: Human Machine Interface (HMI)</u>

An ANS should have HMI that achieves the following functional requirements so that crew/operator can operate it appropriately and receive information quickly and accurately.

FR1.10.1: HMI should be designed appropriately for all the possible interactions between the crew/operator and MASS.

FR1.10.2: HMI should be designed taking into account the following issues:

[.1 Continuously displayed information should be reduced to the minimum necessary for safe operation. Supplementary information should be readily accessible.]

[.2 Operational information should be presented in a readily understandable format without the need to transpose, compute or translate.]

[.3 Displays and indicators should present the simplest information consistent with their function.]

[.4 All information required by the user to perform an operation should be available on the current display.]

[.5 The human machine interface should use marine terminology.]

[.6 Taking command action should be a simple and intuitive action.]

FR1.10.3: In case of remotely controlled MASS with crew on board, all the displayed information should be consistent both on board the ship and in the remote-control station. Interactions between onboard crew and remote operator should be considered for HMI design.

FR1.10.4: In case of MASS without crew on board, in case that any [qualified][authorized][certified] person could embark the ship (e.g., to address the emergency situations), HMI of the ANS should be designed so that such a person can easily understand how to operate the ship.

Note: The details of the requirements for HMI of the equipment in the remote-control station/centre may be specified in the "Remote operations" section.

FR1.11: Override and safe fallback response

An ANS should be capable of override and safe fallback response set out in the following functional requirements.

FR1.11.1: In case of ANS failure[malfunction/error], appropriate fallback response to the urgency and nature of the situation should be designed. [One critical failure of a component of system should not affect entire operation of ANS.]

FR1.11.2: When ANS [exits/deviates] its ODD without its own failure, appropriate fallback response to the urgency and nature of the situation should be designed.

FR1.11.3: When supervisor takes over a task in fallback response, appropriate measures ensuring to switch the entity performing the task should be designed. [Adequate means of redundancy will be provided for required cyber / network connections for safe navigation of the vessel.]

[FR1.11.4: "Take Command" procedure should always be performed by the operator and taking into account following issues:

.1 the autonomous system should not take the control on its own; and

.2 all existing equipment in the vessel should share the control entity at that time, so they can perform appropriate operations.]

[FR1.11.5: In the event of ANS failure, crew/operator/supervisor should easily take ship control.]

[FR1.11.6: In case of remotely controlled MASS with crew on board, overriding authority must be clearly defined and tasks split among shipborne crews and remote operators.]

FR1.11.7: In case of MASS without crew on board, when MASS is not under command, ANS should notify other vessels.

Note: Fallback response means an appropriate response when it is not possible for a ANS to stay within ODD, and Operational Design Domain (ODD) means the range of operation that ANS can work properly, in this document.

2 REMOTE OPERATIONS

2.1 Goal

The goal of this section is to enable the safe remote operation of a MASS, or automated functions thereof, from a position which is not onboard the ship.

2.2 Functional Requirements:

In order to achieve the goal, set out in paragraph xx above, the following functional requirements are embodied in the provisions of this chapter.

FR2.1: [A ROC/RCC/RCS should comply with all relevant IMO instruments as modified by the Functional Requirements below].

FR2.2: A MASS, or the automated functions thereof, should be able to be operated from a ROC/RCC/RCS at a secure location to ensure the safe, secure, and effective control of MASS at any time when they are in service.

The location should provide the ROC/RCC/RCS with:

.1 facilities that are secure from unauthorized access.

.2 means to enable reliable connectivity and communication between the ROC/RCC/RCS and the MASS, third parties and any shipboard personnel.

.3 facilities to authorize access to, and sharing of, certificates and other mandatory documents required to demonstrate MASS are compliant with international, national and regional requirements.

.4 mechanism(s) by which failure and recovery of the ROC/RCC/RCS would not result in an unsafe state or intolerable risk on any MASS in service, including the use of redundancy or back up measures.

The ROC/RCC/RCS should be equipped with:

.1 validated and verified systems to support the execution of effective remote operation of MASS.

.2 sufficient and relevant qualified personnel [in accordance with Management of Safe Operations requirements] to enable effective remote operation, taking into consideration the total number of MASS that are operated from the same ROC/RCC/RCS.

.3 mechanism(s) by which failure and recovery of a control station would not result in an unsafe state or intolerable risk on MASS in service, including the use of redundancy or back up measures.

FR2.3: To ensure the safe, secure, and effective control of a MASS, or the automated functions thereof, a control station located within a ROC/RCC/RCS should:

.1 have appropriate validated and verified systems to enable effective remote operation.

.2 provide sufficient and accurate data and information to enable the remote operator to carry out their role(s) effectively.

.3 be fully compatible throughout its operational life with MASS or the automated functions under its control.

.4 be tested to ensure that when installing and updating remote operation system(s) on MASS, it should be confirmed that the related onboard equipment and devices have appropriate compatibility and interoperability with those in the ROC/RCC/RCS.

.5 ensure failure and recovery of the control station(s) would not result in an unsafe state or intolerable risk, on or around the MASS, including the use of redundancy and back up measures.

.6 be designed and operated in such a way that their location in different jurisdictions does not result in loss of control or negatively affect their performance.

FR2.4: The control station(s) and MASS, or the automated functions thereof, to be operated remotely should have validated and verified systems and interfaces that enable the remote operator:

.1 to keep a watch at sea or in port in a manner conforming to the principles of watchkeeping, [such as those described in Parts 3, 4 and 5 of Section A-VIII/2 of the STCW Code].

.2 [to have simultaneous information displayed in the not less amount and in equivalence with that provided at the bridge]

.3 to be able to send and receive sufficient and accurate information/commands effectively and securely between the ROC/RCC/RCS, MASS, third parties, and any shipboard personnel.

.4 and shipboard personnel to make all decisions necessary to ensure the safe operation of MASS.

.5 and the shipboard personnel to know at all times the status of the connectivity between the control station(s) and MASS and any third parties.

.6 and the shipboard personnel to know at all times which systems can be controlled and to have the location which is in control clearly visible and know whether this is in accordance with the operational envelope.

.7 and shipboard personnel to be aware of when conditions on the MASS in service or at the ROC/RCS/RCC deviate from the operational envelope.

.8 and shipboard personnel to monitor the condition and operation mode of MASS equipment and systems and, take measures to prevent and/or rectify deficiencies when emergency warnings actuate.

FR2.5: Provisions should be made to enable the safe and secure transfer of control of MASS, or the automated functions thereof, ensuring:

.1 transfer of all necessary information is possible between control station(s), ROC/RCC/RCS and the MASS, or automated function thereof.

.2 control can be transferred safely and securely during failure and/or recovery or an emergency situation at the ROC/RCC/RCS or control station(s).

.3 the control is not provided by multiple positions at the same time and the present control position is clearly indicated both in ROC/RCC/RCS and on board the MASS.

.4 when the control is transferred to a ROC/RCC/RCS there is no loss of control of the MASS and it does not negatively affect performance of the MASS or the ROC/RCC/RCS, including when transferring to different jurisdiction(s).

FR2.6: Software for remote operation used in the control station(s), ROC/RCC/RCS, and/or on board the ship should:

.1 be designed, integrated, managed, maintained, and supported throughout its operational life to ensure safe and secure operation of MASS;

.2 be able to receive, recognize and assist with the prioritization of emergency and non-emergency situations, such as out-of-the-loop loss of situational awareness, occurring on board the MASS to enable the remote operator to carry out their role(s) effectively;

.3 have a defined operational envelope, including the communication quality; and

.4 [be designed to ensure that the remote operator is able to read and understand the information transmitted to the ROC/RCC/RCS, in order to support safe decisions by the remote operator.]

FR2.7: Data and information used, produced, sent, or received by a ROC/RCC/RCS should be retained in reliable and tamper proof storage and at a suitable standard of data quality, considering the information necessary for remote operation, the number of the vessels to be controlled remotely, and referring to the SOLAS requirements for Voyage Data Recorders.

3 COMMUNICATIONS

3.1 Goal

The goal of this section is to provide for effective communication for operation of MASS during normal operation, including reasonably foreseeable abnormal events, and in emergency situations.

3.2 Functional Requirements:

In order to achieve the goal above, the following functional requirements are embodied in the regulations of this section.

3.2.1 General

FR3.1.1: A MASS should comply with the functional requirements of regulation 4, chapter IV of SOLAS Convention, as amended, and GMDSS basic functions, as modified by the following requirements.

FR3.1.2: During normal operation, including reasonably foreseeable abnormal events, two-way data and/or voice communications ship-to-shore and ship-to-ship should be permanently available at all points along the intended operating routes. If the ship-to-ship and/or ship-to-shore communications become unavailable, a fallback mechanism should be activated.

FR3.1.3: The communication services used for data communication between MASS and ROCs should:

.1 be capable of accommodating current technologies as well as emerging technologies that will be developed in the future.

.2 be capable of ensuring cybersecurity and ensure that the ship does not enter an intolerable risk condition after suffering from technical failures and cyberattacks. There must be a monitoring system that can be continuously verified and visually displayed, and a backup device in case a cyberattack occurs.

.3 be capable of performing high-quality communication, such as sufficient bandwidth, minimal time delay, high redundancy, automatic switching between main equipment and standby equipment, and so on.

.4 be capable of giving an alarm if the communication quality is found to be reduced to a level where ROC operators cannot perform their intended operations. There must be a monitoring system that can be continuously verified and visually displayed.

.5 be capable of storing and transmitting unsent data once the communication is re-established in case of communication is lost for a period of time.

FR3.1.4: If a ship can be controlled by one of multiple ROCs, e.g. to provide redundancy in case of an accident in one ROCs, configurations of communications between ROCs and between MASS and ROCs should have the following properties:

.1 sufficiently short switch-over times between the ROCs to not endanger safe operation of the ship.

.2 mechanisms to ensure that only one ROC is in control at any one time.

3.2.2 Specific functional requirements for MASS

FR3.2.1: For a MASS without appropriate certificated qualified Radio personnel onboard, the ship should automatically forward the following information to ROCs:

.1 the received shore-to-ship distress alerts;

.2 the received ship-to-ship distress alert relays;

.3 the received search and rescue coordinating communications;

.4 the received on-scene communications;

.5 the received MSI;

.6 the received signals for locating;

.7 the received urgency and safety communications;

.8 the received bridge-to-bridge communications;

.9 the received general communications; and

.10 communication system failure on board.

FR3.2.2: For a MASS without crews onboard, the following requirements should be followed:

.1 two-way data and/or voice communications must have an automatic function. In addition, it is necessary to have three-way simultaneous communication in consideration of simultaneous control from shore and other ships.

.2 ship to shore distress alerts must be automatically generated onboard. The alerting process must ensure that alerts are transmitted when required and that false alerts are avoided (see resolution MSC.514(105)).

.3 all requirements related to at-sea electronic maintenance capability may not be observed. However, maintenance capabilities should be scheduled and monitored.

.4 critical functions onboard must be implemented to provide the intended function through the full voyage without physical maintenance or repair. This may be achieved through redundancy where applicable and by ensuring that no single point of failure causes loss of the critical functionality.

.5 two-way VHF radiotelephone apparatus for survival craft may not be installed.

FR3.2.3: For a MASS of remote operation, the following requirements should be followed:

.1 the position from which the ship is normally navigated should be ROCs.

.2 information required for remote operation of the ship, such as situation awareness information, states of equipment, should be transferred to ROCs.

.3 in order to achieve efficient and reliable information transmission, the system that handles communication between MASS and ROCs should be able to:

a) manage and operate the information to be sent and the state of the communication network in an integrated manner;

b) reduce congestion on the network between MASS and ROC by adjusting and pausing the speed of transmission; and

c) select priorities and adjust and provide bandwidth according to the importance of information to be sent.

3.2.3: Specific functional requirements for ROCs

FR3.3.1: For a MASS without appropriate certificated qualified Radio personnel onboard, the following functions should be operated by ROCs:

.1 transmitting ship-to-shore distress alert relays;

.2 transmitting ship-to-ship distress alert relays;

.3 transmitting search and rescue coordinating communications;

.4 transmitting on-scene communications;

.5 transmitting signals for locating;

.6 transmitting urgency and safety communications;

.7 transmitting bridge-to-bridge communications;

.8 transmitting general communications; and

.9 transmitting any of system failure.

FR3.3.2: For a MASS of remote or fully autonomous operation, all incidents connected with the radiocommunication services should be recorded and kept in ROCs, to the satisfaction of the Administration and as required by the Radio Regulations. Automatically and periodically back up of communications logs of equipment to a save media should be considered.

FR3.3.3: ROCs should automatically receive relevant information forwarded by MASS in FR2.1 and process them.

4 SUBDIVISION, STABILITY AND WATERTIGHT INTEGRITY

4.1 Goal

The ship shall, owing to the varying conditions of service, e.g., the loading condition(s), sailing conditions and the weather conditions, not be vulnerable to stability failures, regardless of whether in intact or damaged conditions.

4.2 Functional Requirements

4.2.1 Onboard systems

FR4.1.1: A stability control system shall be in place, capable of continuously determine by calculations and/or measurements the ship intact stability during its operation as well as to assess the survivability of the ship in case of damage, to maintain that the ship, at all times is operating within the stability envelope as prescribed in the stability booklet.

FR4.1.2: The stability control system shall be resilient to single failure.

FR4.1.3: The stability control system shall be supervised by an independent control system. The action of the supervising independent control system shall be triggered by failures/events (*) of the stability control system.

FR4.1.4: Any automated/autonomous system performing and supervising intact stability of the ship shall be capable of restoring ship's compliance with relevant applicable intact stability requirements (*) if the system has detected that these requirements are not met.

FR4.1.5: The control system supervising the stability control system shall rely on an independent measuring system and sensors.

4.2.2 Remote Control Centre

FR4.2.1: The Remote-Control Centre (RCC) shall be supplied with real-time information as is necessary to control the ship draughts and stability at all times, including ship movements in 6 degrees of freedom.

FR4.2.2: The stability control system and/or the supervising control system shall be able to detect existing or predictable intact stability failures, as well as damaged stability failures if in damaged condition, and alarm the ship and the RCC if, for example, the rolling accelerations or amplitudes exceed prescribed limits.

FR4.2.3: The stability control system, the supervising control system and the RCC shall be able to bring the ship to the Minimum Risk Condition (MRC) upon an alarm.

FR4.2.4: The stability control system, the supervising control system and the RCC shall be able to monitor, control and operate any systems (*) onboard that may affect the stability of the ship.

5 FIRE SAFETY

5.1 GOAL

The goal of this section is to fulfil the fire safety objectives of SOLAS, taking into account the number of persons on board and [the level of autonomy] [mode of operation].

5.1 Functional Requirements

5.1.1 High Level

FR5.1.1: A MASS should comply with all relevant SOLAS fire safety requirements as modified by the specific Functional Requirements below.

.1 To provide easy access for “emergency response and rescue” personnel.

.2 To provide information and instructions for proper ship and cargo handling operations in relation to fire safety to be performed by external personnel.

FR5.1.2: The use of [automated and/or remotely controlled] fire-fighting systems should not endanger the safety of any persons on board or of the ship.

FR5.1.3: Onboard [and remote] management of automated[autonomous] fire-fighting systems should be provided to enable control and isolation of the systems.

FR5.1.4: Means shall be provided to enable the assessment of fire-fighting effectiveness and fire extinction [during and after fire.].

FR5.1.5: A MASS shall remain under control during and following a fire event.

FR5.1.6: The use of automated [autonomous] systems shall not prevent the effective prevention, detection, containment, and extinction of fires on board nor the maintenance of effective control during and following a fire event.

5.1.2 Specific

FR5.2.1 All required alarms related to the fire safety systems shall be routed to the ["continuously manned] [central] control station"].

[Proposed definition:

"continuously manned central control station" is that;

- *this station has function same as fire control panel specifying the location of fire site and initiating the fire-fighting system*

- *this station located in place where person always stay regardless of whether this person monitor fire alarm or not.]*

FR5.2.2: Isolation of compartment boundaries shall occur automatically [autonomously] to enable effective firefighting [without preventing the possibility for escape].

Proposed combination Isolation of compartment boundaries required to be isolated in the event of a fire shall be capable of being automatically and/or remotely closing from a manned control station to enable effective firefighting.

FR5.2.3: Shutdown and isolation of systems shall occur [automatically] [autonomously] to enable effective firefighting, however this should not damage them or endanger the vessel further.

Alternatively:

FR5.2.3: Shutdown and isolation of systems shall occur [automatically][autonomously] to enable effective firefighting, however this should not damage or endanger the vessel or any persons on board.

FR5.2.4: Critical systems for maintaining appropriate control of the vessel shall be protected from foreseeable fire events.

FR5.2.5: All spaces where a fire can occur shall be fitted with a suitable fixed fire detection system.

FR5.2.6: Effective fire-fighting measures are to be provided in all compartments/open deck areas where there is a fire [hazard/risk] which are able to extinguish a sustained fire of the type likely to be expected in that space/area. These may be active or passive.]

Alternatively:

FR5.2.6: Effective fire-fighting measures are to be provided in all compartments/open deck areas where a fire can occur and should be able to extinguish a sustained fire of the type(s) likely to be expected in that space/area. These may be active or passive and be capable of remote and automatic activation.

FR5.2.7: Provision should be made to enable fire-fighting control and response to be undertaken on board by an external responder. This should include provisions for establishing communications with the remote operating centre and a response to a fire on board. Information concerning onboard firefighting and extinguishing systems shall be readily available to the responders.

FR5.2.8: The fire-fighting media and by-products of any [[automated]/[autonomous or remotely controlled]] fire-fighting system should be managed so that they do not present a [an increased] risk to the safety of persons on board or of the ship.

FR5.2.9: Automated [autonomous] fire-fighting systems shall be able to be safely isolated for compartment access or maintenance and shall provide onboard indication and warning of activation.

FR5.2.10: Management of a fire event shall be possible from the remote operation centre and the operator shall be provided with sufficient information to understand the scale and impact of a fire event and the response and success of the fire-fighting measures.

FR5.2.11: An appropriate level of communication between the MASS and the remote operating centre shall be maintained during and following a fire event.

FR5.2.12: Upon identification of a fire event the MASS shall enter an appropriate fall-back state and be capable of maintaining that state during and following the fire event to the degree necessary to prevent it becoming a hazard. [[Post fire capability shall be determined by the Owner] [The ship's owner should determine the ship's required capability following extinguishing of a fire]].

6 LIFE SAVING APPLIANCES AND EQUIPMENT

6.1 Goal

The goal of this section is to save and maintain human life during and after an emergency situation taking into account the mode of operation of the ship and the number of persons onboard.

6.2 Functional requirements

In order to achieve the goal, set out above, the following functional requirements are embodied in the provisions of this chapter.

FR6.1: All life-saving appliances should be in a state of readiness for immediate use.

FR6.2: In the event of an emergency, human safety should be the priority.

FR6.3: All ships should provide means for a safe abandonment for all persons.

FR6.4: All personnel involved in the operation of MASS shall be trained to take appropriate measures in case abandonment of personnel is required.

FR6.5: All ships should provide means for the safety and survivability of all persons after abandonment for the time until expected rescue.

FR6.6: All ships should have an effective emergency management system.

FR6.7: The use of [automated and/or remotely controlled] lifesaving appliances should not endanger the safety of any persons on board or of the ship.

FR6.8: Proper instructions and information to be provided in relation to all lifesaving appliances and their use.

FR6.9: All Survival craft and lifesaving appliances shall occur automatically [autonomously] to enable the safe abandonment of personnel from the MASS.

FR6.10: Sequence of abandonment of survival craft and lifesaving appliances with the necessary equipment's must be pre-established.

FR6.11: Provision should be made to enable the deployment of lifesaving appliances and response to be undertaken on board by an external responder. This should include provisions for establishing communications with the remote operating centre and a response to an abandonment of personnel.

FR6.12: The lifesaving appliances media and by-products of any [automated] [autonomous or remotely controlled] lifesaving appliances should be managed so that they do not present a [an increased] risk to the safety of persons on board or of the ship.

FR6.13: Management of an abandonment of personnel using lifesaving appliances shall be possible from the remote operating centre and the operator shall be provided with sufficient information to understand the scale, impact, response, and success of the survival of personnel.

FR6.14: An appropriate level of communication between the MASS and the remote operating centre shall be maintained during and following an abandonment of personnel.

7 MANAGEMENT OF SAFE OPERATIONS

7.1 Goal

The goal of this section is to provide for management of safe operation of MASS in order to:

a) ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular, to the marine environment, and to property; and

b) provide for necessary adaptation for Companies operating MASS in order to reach the objectives and meet the requirements of SOLAS chapter IX and the ISM Code, taking into account the Mode of Operation* of the MASS.

7.2 Functional Requirements

In order to achieve the goal, set out in paragraph 7.1 above, the following functional requirements are embodied in the provisions of this chapter.

FR7.1: If the operation of a MASS involves any functions, including supervision, monitoring or control of the MASS, to be performed physically at a place different from the ship itself, then the ship and this physical location should be considered and managed as one overall system.

FR7.2: Any hazard particular to the safe operation of a MASS resulting from the Mode of Operation and resulting complexity of systems of the ship should be properly addressed in the safety management system (SMS) developed and maintained by the company. Special attention should be given to assessing all identified risks and implementing appropriate safeguards with regard to safety functions conducted by software systems or data services for extended periods of time.

FR7.3: Sufficient and properly qualified personnel, with relevant system and safety competencies, should be provided in the company, at the Remote Operation Centre** and on board, as appropriate, taking into account the Mode of Operation applied, in order to encompass all aspects of maintaining safe operations on board, including latency to, and activation of safety functions.

FR7.4: If the operation of a MASS involves remote supervision, monitoring or control to be performed physically at a place different from the ship, any equipment and systems necessary to maintain contact to the ship, the sudden operational failure of which may result in hazardous situations, should be properly identified as well as required measures to ensure reliability of these components.

FR7.5: Any lines of communication of MASS resulting from the Mode of Operation of the ship should be properly identified, taking into account the concept of supervising, operating and controlling the ship, giving due regard to cybersecurity needs and relevant safeguards to mitigate associated cyber risks.

FR7.6: The function of overriding authority [by the master or a person with similar authority], should be maintained regardless of the Mode of Operation of the ship, and taking into account the concept of operating, supervising, and controlling the ship and the concept of making emergency decisions.

FR7.7: Any additional resources, other than personnel, required in the company and at the Remote Operation Centre, if applicable, resulting from the Mode of Operation of the ship should be properly identified and allocated.

[FR7.8: Accident and near miss reporting associated with the operation of the MASS should be considered as an essential source to support safe introduction of technological innovation, with special emphasis on artificial intelligence, and machine and deep learning, if applicable. Equipment, software, and systems, including management systems, should be designed and implemented to enable reporting and the investigation of accidents and near misses, and accident and near miss reporting should be properly implemented.]

FR7.9: Any emergencies, or other potentially unsafe conditions that require third-party assistance, resulting from the Mode of Operation of the ship should be properly identified, and required responses resulting thereof should be properly implemented.

FR7.10: Possible challenges for emergency handling, or handling of other potentially unsafe conditions, resulting from the Mode of Operation of the ship should be properly identified, and procedures should be established and implemented to respond to them.

* Mode of Operation: note that the term Mode of Operation used here is used to describe the overall operational environment for the management of safe operation of the MASS-system, possibly including a Concept of Operation (ConOps) which might involve some, or all, functions required to provide for safe operation of the ship, like supervision, monitoring or control, performed physically at a place different from the ship itself, and regardless of the level of the number of persons on board, the level of remote control and the level of automation, being aware that this term may change in the future

**Remote Operation Centre: note that the term ROC used here is used to describe the location from which a vessel may be operated, controlled, or monitored, or where safety features are activated, being aware that other terms are also used and that this term may change in the future

8 CONTROLLING THE OPERATION OF A SHIP

Aspects intended to be addressed in this section are covered elsewhere and the section will be deleted and subsequent sections remumbered.

9 SECURITY

9.1 Goal

The goal of this section is to fulfil the security objectives of SOLAS and the ISPS Code, taking into account the number of persons, [and the property] on board and [the level of autonomy] [mode of operation].

9.2 High Level Functional Requirements

FR9.1.1: A MASS should comply with all relevant SOLAS security requirements for all security levels as modified by the specific Functional Requirements below.

.1 To detect security threats and take preventive measures against security incidents affecting ships.

.2 To ensure confidence that adequate and proportionate maritime security measures are in place.

FR9.1.2: The use of [automated and/or remotely controlled] security systems should not endanger the security of any persons or property on board or of the ship.

FR9.1.3: Onboard [and remote] management of automated[autonomous] systems should be provided to enable control of the systems.

FR9.1.4: Means shall be provided to enable the assessment of security effectiveness.

FR9.1.5: A MASS shall remain under control during and following a security event.

FR9.1.6: The use of automated [autonomous] security systems shall not prevent the effective physical security; structural integrity; personnel protection systems; procedural policies; radio and telecommunication systems including computer systems and networks; and other areas that may, if damaged or used for illicit observation, pose a risk to persons, property, or operations on board the ship.

FR9.1.7: There should be a mechanism for safely shutting MASS communications down when the security of the control station centre has been compromised.

Specific Functional Requirements

FR9.2.1 Means of providing for the effective coordination on security level between port and MASS.

FR9.2.2: Critical systems for maintaining appropriate control of the vessel shall be protected from foreseeable security events.

FR9.2.3: Boundaries where a security event can occur shall be fitted with a suitable control system.

FR9.2.3: Effective security measures are to be provided in all compartments/open deck areas where there is a security [hazard/risk]. [These may be active or passive to prevent unauthorized access to ships and their restricted areas and to prevent the introduction of unauthorized weapons, incendiary devices, or explosives to ships or port facilities].

FR9.2.4: Provision should be made to enable security control and response to be undertaken on board by an external responder. This should include provisions for establishing communications with the remote operating centre and a response to a security event on board. Information concerning onboard control systems shall be readily available to the responders.

FR9.2.5: The security system should be managed so that they do not present a [an increased] risk to the safety of persons on board or of the ship.

FR9.2.6: Communication systems for ships shall be maintained.

FR9.2.7: Management of a security event shall be possible from the remote operation centre and the operator shall be provided with sufficient information to understand the scale and impact of an event and the response and success of the security measures on board the ship.

FR9.2.8: An appropriate level of communication between the MASS and the remote operating centre shall be maintained during and following a security event.

FR2.9: Upon identification of a security event the MASS shall enter an appropriate fall-back state and be capable of maintaining that state during and following the event to the degree necessary to prevent it becoming a hazard.

FR9.2.10: Means of providing for the effective coordination on security level between port and MASS.

FR9.2.11: Means of controlling access to the ship, as well as the embarkation of persons and their effects automatically. (Conventionally by seafarers.)

FR9.2.12: Means of monitoring and recording restricted areas, deck areas, areas surrounding the ship;

10 SEARCH AND RESCUE

10.1 GENERAL

10.1.1 Goal

The goal of this section is to ensure that MASS fulfil the duties and tasks of any vessel under the international law regarding distress situations, taking into account the mode of operation of the ship [and the number of persons on board].

These duties and tasks can be summed up as a duty to:

1. render assistance and to proceed to rescue persons in distress at all possible speed;

2. coordinate with the SAR services of the coastal State; and

3. render assistance as requested by the coastal State.

10.1.2 Functional requirements:

In order to achieve the goal, set out above, the following functional requirements are embodied in the provisions of this chapter:

FR10.1.1: Every MASS in position to be able to provide assistance and receiving information from any source of persons in distress at sea, is bound to render assistance insofar as such action may reasonably be expected of him and he can do so without serious danger to the ship, the crew, or the passengers.

FR10.1.2: Having account of the previous FR, every MASS should proceed with all possible speed to the rescue of persons in distress.

FR10.1.3: With the limitations imposed by its ODD, every MASS will be at the disposal of the search and rescue service responsible for the SAR operation the MASS is involved in, except if its participation is deemed not necessary.

FR10.1.4. After a collision, every MASS should render assistance to the other ship, its crew and its passengers, and provide the other vessel with the name of the vessel, its port of registry and the next port of call.

10.2 DISTRESS SIGNALS & COMMUNICATIONS

10.2.1 Goal

The goal of this section is to ensure that the MASS fulfil the duties and tasks regarding the use of distress signals and communications related to a distress situation.

10.2.2 Functional requirements:

In order to achieve the goal, set out above, the following functional requirements are embodied in the provisions of this chapter. In particular, the vessels to whom SOLAS chapter III applies should be able of the following:

FR10.2.1: MASS should be able to emit, receive, identify, locate, and relay distress signals.

FR10.2.2: Personnel in charge of the MASS should be able to emit and identify distress signals.

FR10.2.3: MASS should be able to transmit, receive, identify, and relay distress communications.

FR10.2.4: MASS should be able to keep an operation watch at the distress frequencies.

FR10.2.5: Personnel in charge of the MASS should be able to transmit receive, identify and relay distress messages.

FR10.2.6: Personnel in charge of the MASS should have training on distress incidents communications.

FR10.2.7: Personnel in charge of the MASS should be able to coordinate SAR communications.

FR10.2.8: MASS sensors should be able to collect environmental data.

10.3 SAR ACTIONS

10.3.1 Goal

The goal of this section is to fulfil the duties and tasks of every MASS receiving a distress alert, apart to those related with distress signals and communications.

10.3.2 Functional requirements:

In order to achieve the goal, set out above, the following functional requirements are embodied in the provisions of this chapter.

FR10.3.1: If applicable, every MASS should be fitted with, at least, one remote rescue boat.

FR10.3.2: If applicable, rescue boat manual should be available to the personnel in charge of the MASS.

FR10.3.3: Vol. III of IAMASAR Manual should be available to the personnel in charge of the MASS.

FR10.3.4: The MASS should have specific plans and procedures for the rescue of persons in Distress.

FR10.3.5: A MASS should detect all objects of at least one arcminute size on a 360-degree horizontal field of view with visibility to the horizon.

FR10.3.6: A MASS should be able to establish relative bearing to detected objects.

FR10.3.7: A MASS should be able to launch, recover and stow the rescue boat.

FR10.3.8: A MASS and the rescue boat should have means to ease the boarding of persons in distress.

FR10.3.9: A MASS should have a sheltered space on board to accommodate persons in distress.

FR10.3.10: A MASS should be able to use a line-throwing appliance.

FR10.3.11: A MASS should have a training and drills plan related to the rescue of persons in distress.

FR10.3.12: A MASS should have a rescue boat maintenance plan.

11 CARGO HANDLING

11.1 Goal

The goal of this chapter is to provide guidance for the care of cargoes during loading, unloading and voyage as well as keeping the ship, human life, and the environment safe from events caused by cargoes under voyage.

11.2 Functional requirements

11.2.1 Cargo information connectivity

FR11.1: Provide necessary connectivity for transferring relevant cargo information irrespective of the level of manning or means of control of the ship and its cargo.

Specific functional requirements to cargo information connectivity

.1 Should provide connectivity for the ships designated cargo systems to receive relevant cargo information to enable the necessary precautions for proper stowage and safe carriage of the cargo.

.2 Should provide connectivity to monitor the cargo operations for proper stowage, segregation, loading, unloading and safe carriage of the cargo.

.3 Should provide connectivity for cargo monitoring during the voyage capable of being locally or remotely controlled, as necessary.

.4 Should provide connectivity to provide for the safe stowage and securing of cargo, capable of being locally or remotely controlled, as necessary.

11.2.2 Relevant cargo information

FR11.2: All relevant cargo information should be provided irrespective of the level of manning or means of control of the ship and its cargo.

Specific functional requirements to relevant cargo information*

.1 Should ensure that necessary cargo information is obtained.

.2 Should ensure compliance with cargo information.

.3 Should ensure that loss or likely loss of cargoes dangerous to navigation is reported.

11.2.3 Carriage and stowage of cargoes

FR11.3: Handling of cargo required by IMO instruments should be provided irrespective of the level of manning or means of control of the ship and its cargo.

Specific functional requirements for the safe carriage and stowage of cargoes*

.1 Should provide for the safe carriage and stowage of cargoes.

.2 Should provide means for stowing cargo transport units carried on or under deck of the ships during voyage so as to prevent damage or hazard to the ship and the persons on board.

.3 Should provide means for segregating cargo transport units, where required, carried on or under deck of the ships during voyage so as to prevent damage or hazard to the ship and the persons on board.

.4 Should verify that cargo remains properly stowed and handled, if necessary and feasible while the vessel is under way.

11.2.4 Cargo emergency response

FR11.4: The Cargo emergency response should be provided irrespective of the level of manning or means of control of the ship and its cargo.

Specific functional requirements for cargo emergency response

.1 Should provide means for an emergency shut down systems for cargo transfers operations capable of being continuously locally or remotely controlled as necessary.

** Alternative to 11.2.2 and 11.2.3:*

11.2.2 Relevant cargo information

All relevant cargo information should be provided irrespective of the level of manning or means of control of the ship and its cargo.

Specific functional requirements to relevant cargo information

.1 Where human interaction is required by IMO instrument, a suitable automated alternative must be available, or an alternative person may be designated.

11.2.3 Carriage and stowage of cargoes

Handling of cargo required by IMO instruments should be provided irrespective of the level of manning or means of control of the ship and its cargo.

Specific functional requirements for the safe carriage and stowage of cargoes

.1 Where human interaction in required by IMO instrument a suitable automated alternative must be available, or an alternative person may be designated.

12 PERSONNEL SAFETY AND COMFORT

12.1 Goal

The goal of this section is to ensure the health, safety, and comfort of any personnel on board a MASS or at a Remote Operation Centre.

12.2 Functional Requirements

In order to achieve the goal, set out in paragraph 3.12 above, the following functional requirements are embodied in the provisions of this chapter.

FR 12.1: Where a MASS can be boarded, or operates with persons on board, it should meet all applicable existing regulations for personnel safety and comfort.

FR 12.2: Personnel should have safe means of embarkation and disembarkation to and from a MASS.

FR 12.3: Remote Operation Centres and workstations should be developed using Human Centred Design (add footnote defining Human Centred Design as per MSC.1/Circ.1512 "where systems are designed to suit the characteristics of intended users and the tasks they perform, rather than requiring users to adapt to a system"). (*may overlap with Part 3 Section 2)

FR 12.4: Remote Operation Centres and workstations should be ergonomically designed [including visual ergonomics]. (*may overlap with Part 3 Section 2)

FR 12.5: Use of Wearable technologies should adhere to health and safety requirements.

FR 12.6: Personnel working at a Remote Operation Centre should have suitable hours of work and rest. (*may overlap with Part 3 Section 2)

FR 12.7: Personnel should not be exposed to levels of noise that exceed safe working conditions.

FR 12.8: Human Machine Interfaces should be designed to meet the capabilities of all intended users. (*may overlap with Part 3 Section1.2.3)

FR 12.9: Personnel should not be exposed to levels of vibration that exceed safe working conditions.

FR 12.10: Risks to personnel from hazardous circumstances should be minimized.

FR 12.11: Personnel should be provided with appropriate medical care or aid.

FR 12.12: The facilities and working conditions of a Remote Operation Centre or MASS should [promote] [support] the health and well-being of all personnel.

FR 12.13: There should be sufficient and suitable ventilation, natural or artificial or both, supplying fresh or purified air.

FR 12.14: The best possible conditions of temperature, humidity and movement of air should be maintained, and larger fluctuations avoided.

FR 12.15: There should be sufficient and suitable lighting, natural or artificial, or both.

FR 12.16: Sufficient and suitable sanitary conveniences should be provided for in suitable places and be properly maintained.

FR 12.17: Sanitary conveniences should be adequately ventilated and so located as to prevent nuisances. They should not communicate directly with workplaces.

FR 12.18: Control room should have sufficient space to comfortably accommodate all necessary equipment and allow operator to move freely.

13 TOWING AND MOORING

13.1 Goal

The goal of this chapter is to provide for additional to SOLAS [and STCW] measures to minimize the danger to personnel, structural facilities, environment, and ships during remotely controlled or autonomous mooring and towing operations of MASS.

13.2 Functional requirements

In order to achieve the goal, set out in paragraph 13.1 above, the following functional requirements are embodied in the provisions of this chapter, in addition to the regulation II-1/3-8 of SOLAS.

FR13.1: Shipboard mooring arrangements shall enable the securing of a ship to a marine facility, terminal, berth, or another ship using methods which can be deployed, monitored, controlled, and recovered by the personnel assigned duties and responsibilities by the Company for mooring operations, regardless of how or from where control of manoeuvring of the ship is exercised.

FR13.2: Shipboard towing arrangements shall enable the connecting up or letting go of a tow [including an emergency tow] using methods which can be deployed, monitored, controlled and recovered by the personnel assigned duties and responsibilities by the Company for towing operations, regardless of how or from where control of manoeuvring of the ship is exercised.

FR13.3: Shipboard mooring and towing arrangements shall be capable of deployment in the absence of main power on the ship to be moored or towed.

FR13.4: Means of communication shall be provided to ensure sustained and secure communication between the [remote operator] [ROC/RCC/RCS] and a mooring and towing team.

FR13.5: Means shall be provided for the effective coordination and conduct of mooring and towing operations from onboard the ship, regardless of how or from where control of manoeuvring of the ship is exercised;

FR13.6: Operational and maintenance instructions should be readily available on board [and at the ROC/RCC/RCS]; .

FR13.7: Operability of the mooring or towing and communication equipment must be checked each time before the mooring or towing operation begins.

FR13.8: Means shall be provided to automatically maintain the tension of the ropes within the set limits.

FR13.9: Unless means are provided for mooring or towing, including emergency towing, without the intervention of the crew, ships without crew trained in accordance with Section A-II/5 of the STCW Code shall be provided with a means of embarkation and disembarkation of such personnel for the purposes of mooring and towing operations.

FR13.10: Means of embarkation or disembarkation of multiple personnel required for mooring operations shall be designed, installed, and maintained in a manner which allows deployment and recovery without the intervention of personnel trained in accordance with Section A-II/5 of the STCW Code and regardless of how or from where control of manoeuvring of the ship is exercised.

FR13.11: Adequate alarm shall be provided in case of equipment failure during mooring at the berth for ship operating and shore personnel.

FR13.12: The Company shall ensure that personnel responsible for the operation of MASS are provided with sufficient information about mooring and towing arrangements at marine facilities, terminals, and berths to enable mooring and towing operations to be planned and conducted with due consideration to safety of property and personnel, and as appropriate, environmental protection.

14 MARINE ENGINEERING/MACHINERY INSTALLATIONS

14.1 Goal

The goal of this section is to provide for machinery installations capable of delivering the required functionality to ensure safe navigation and the safe carriage of cargo and persons on board both during normal operation and in any emergency situation, taking into account the [mode of operation of the ship and the number of persons on board]

14.2 Functional Requirements

In order to achieve the goal, set out in paragraph 14.1 above, the following functional requirements are embodied in the provisions of this chapter.

FR14.1: A reliable and secure connection between the remote-control station(s) and the ship shall be provided in normal and emergency situations.

FR14.2: Taking into account that connectivity might be lost [or be below an acceptable threshold], ensure that machinery systems are able to support any [fallback states] [Minimum Risk Conditions].

FR14.3: Condition-based monitoring shall be provided to assess to system reliability.

FR14.4: Local means of isolation with visual indication shall be provided to ensure remote control or autonomous systems cannot start machinery if being worked on by [authorized] persons onboard.

FR14.5: Monitoring, and control capability shall be provided to ensure machinery system failures or malfunctions are [immediately] detected and operation in normal and emergency situations is maintained.

FR14.6: Redundancy shall be provided taking into account the number of [authorized] persons onboard available to respond to machinery system failures and malfunctions.

15 ELECTRICAL AND ELECTRONIC ENGINEERING

15.1 Goal

The goal of this section is to provide for:

.1 all electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions will be ensured without recourse to the emergency source of electrical power, taking into account the [mode of operation of the ship and the number of persons on board].

.2 emergency sources of power capable of delivering the required functionality of essential systems in emergency situations, taking into account the [mode of operation of the ship and the number of persons on board].

.3 Protection of all persons on board the ship from electrical hazards.

15.2 Functional Requirements

In order to achieve the goal, set out in paragraph 15.1 above, the following functional requirements are embodied in the provisions of this chapter.

FR15.1: A reliable and secure connection between the remote-control station(s) and the ship shall be provided in normal and emergency situations.

FR15.2: Taking into account that connectivity might be lost [or be below an acceptable threshold], ensure that electrical systems are able to support any [fallback states] [Minimum Risk Conditions].

FR15.3: Condition-based monitoring shall be provided to assess to system reliability.

FR15.4: Local means of isolation with visual indication shall be provided to ensure remote control or autonomous systems cannot start machinery or energize the electrical system while work is in progress by [authorized] persons onboard.

FR15.5: Monitoring and control capability shall be provided to ensure electrical system failures or malfunctions are [immediately] detected and operation in normal and emergency situations is maintained.

FR15.6: Redundancy shall be provided taking into account the number of [authorized] persons onboard available to respond to electrical system failures and malfunctions.

16 MAINTENANCE AND REPAIR

16.1 Goal

The goal of this section is to provide the maintenance and repair objectives of SOLAS, taking into account the mode of operation of the ship and number of qualified persons on board to ensure that the maintenance and repair requirements are not compromised by the ship's operational requirements or mode of operation.]

16.2 Functional requirements

In order to achieve the goal set out in paragraph 16.1 above, the following functional requirements are embodied in the provisions of this chapter.

FR16.1: Computer-based integrated system maintenance should be done in accordance with the manufactures recommendation and conducted when the ship is not operating in an autonomous mode.

FR16.2: Suitable monitoring and control capability shall be provided at the remote-control centre, or by autonomous technology to ensure system and machinery faults are detected during autonomous modes of operation in normal and emergency conditions.

FR16.3: Suitable redundancy shall be provided taking into account the number of qualified persons onboard that are available to respond to system and machinery faults.

FR16.4: Maintenance requirements for the equipment and systems used on board shall not be compromised by ships mode of operation.

FR16.5: Qualified persons shall be available to remotely monitor system and equipment faults and abnormal conditions to verify their cause and confirm that the designed redundancy has been effective in maintaining the intended performance.

FR16.6: Spare parts shall be made available to qualified persons at the location of repair based on the ship's mode of operation and repair philosophy.

FR16.7: Technical operating and maintenance manuals shall be made accessible on board and remotely where qualified persons are situated.

FR16.8: Suitable arrangements shall be available to embark personnel at sea to conduct repairs taking into consideration how a failure or sea state could affect embarkation.

FR16.9: Systems and equipment redundancy arrangements shall be regularly tested to confirm correct operation taking into account the ship's mode of operation and number of qualified persons on board.

FR16.10: Suitable onboard local control lockouts shall be provided to ensure remote control or autonomous systems cannot start machinery if being worked on by persons on board.

FR16.11: Procedures shall be in place outlining how an investigation and analysis of a failure is conducted with a view to reduces recurrence taking into account the ship's mode of operation and number of qualified persons on board.

17 EMERGENCY RESPONSE

17.1 Goal

The goal of this section is to provide measures for adequate and immediate responses in emergency situations, taking into account the mode of operation, in order to ensure the safety of human lives, property, and the environment.

17.2 Functional Requirements

17.2.1 High Level Functional Requirements

FR17.1.1: Measures should be in place for ship emergency prevention, preparation, response, and recovery activities.

FR17.1.2: An effective emergency response plan and command structure should be established to sufficiently respond to a full range of emergencies that may occur on autonomous ships.

FR17.1.3: Emergency response should prioritize the protection of human lives, reducing or eliminating the impact of the incident and preventing them from escalating the emergency.

FR17.1.4: Emergency response measures should consider the mode of operation.

FR17.1.5: In the event of an emergency, a function should provide that makes the person or system timely decide on the appropriate emergency scale or response level should be provided.

FR17.1.6: Real-time situational information should be automatically(autonomously) recorded and kept up to date from the occurrence to the termination of the emergency.

FR17.1.7: An adequate communication system with external notification points, including ships in the vicinity, ROC, and ashore, should be maintained in the event of an emergency.

17.2.2. Specific Functional Requirements

FR17.2.1: Emergency response plan should cover all steps from the detection to the termination of the emergency until the vessel and personnel are in a safe state.

FR17.2.2: For an effective emergency response, an emergency response plan should cover the following;

.1 Response process

.2 System

.3 Information

.4 Resource management

.5 Training and education

.6 Interface between ship and ROC

.7 Interface between the human and machine

.8 Other measures, etc.

FR17.2.3: Ships and company should identify all potential hazards that may arise from the ship or ROC and have an emergency response plan for each type of hazard.

FR17.2.4: Sufficient information, including the nature, location, and scale of the emergency, shall be provided to the detection/analysis functions of the emergency response system to enable effective emergency response.

FR17.2.5: Determination of the need for emergency response and the method and response speed of the system should be based on the rate at which the incident may escalate and its impact.

FR17.2.6: The handover of command-and-control functions between people and machines, between vessels and ROC, as required by the emergency response situation, should occur as appropriate.

FR17.2.7: For unmanned MASS, the system should be able to perform a risk situation assessment to identify additional risks and refine response strategies during an emergency.

FR17.2.8: In unmanned operation, complementary sensors should be used to redundantly confirm that an actual emergency has occurred.

FR17.2.9: To respond to the emergency, any responsible person should be able to recognize that an emergency has occurred and issue commands to activate the vessel's emergency response system.

Note1: ‘any responsible person' in the above context, include the crew onboard and remote operators in ROC.

FR17.2.10: The vessel shall be equipped with the capability and back-up facilities to respond autonomously in case the identification or response to an emergency is not successful.

FR17.2.11: Response command locations, including ships, ROC and ashore, should be equipped for recording and storing emergency response related information with reference to SOLAS requirements for VDRs.

FR17.2.12: In the event of an emergency, the ability to immediately report relevant information should be provided, and updated situational information should be provided to external notification points after the emergency response has begun.

FR17.2.13: The internal communication line for emergency situations should be guaranteed first, and communication between the emergency vessel and ashore should take priority over communication between the normal vessel and ashore.

FR17.2.14: The judgement function should utilize sufficient information about the emergency situation to determine whether the situation has ended as a result of the emergency response.

Fr17.2.15: If it is determined that it is not possible to respond to the emergency using only the emergency response system or additional response, the responsible person, including the master, shall be notified.

FR17.2.16: The effectiveness of the emergency response plan should be reviewed periodically and updated whenever there is a change in the installation of the system or external circumstances that could significantly affect the content of the plan.

Fr17.2.17: Emergency response systems shall be operated/inspected/tested and maintained in accordance with appropriate procedures to ensure that their functional requirements are maintained.

FR17.2.18: All personnel involved in the operation of autonomous vessels shall be educated and trained to take appropriate action in the event of an emergency.

~~**PART 4 SPECIFIC PROVISIONS FOR REMOTE CONTROL OF SHIP FUNCTIONS**~~

~~**1 Remote Operations and Control Centres**~~

~~1.1 xxxxxxx~~

~~1.2 xxxxxxx~~

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ANNEX

MASS TRIALS – MSC.1/Circ.1604 – "Interim Guidelines for MASS Trials"

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ANNEX 2

VOLUNTEERING MEMBER STATES AND ORGANIZATIONS WITH OBSERVER STATUS FOR THE DEVELOPMENT OF SELECTED SECTIONS OF THE DRAFT NON-MANDATORY GOAL-BASED MASS CODE

Section of the MASS Code	Volunteering State and/or organization	Lead State or organization	Contact Details for Lead Person
Part 3, section 1: **Navigation**	Bahamas, Brazil, China, CIRM, France, India, Italy, Japan, Liberia, Norway, Pakistan, Poland, Republic of Korea, Russian Federation, Saudi Arabia, Singapore, Spain, Türkiye, United Arab Emirates, United States, GlobalMET, IALA, ICS, IHMA, IMPA, INTERTANKO, ISO, Nautical Institute, WMU, World Sailing	Japan	(Dr. /Ms.) Megumi SHIOKARI shiokari@m.mpat.go.jp
: Lookout Function	Finland, Spain, EC	Finland/EC	lauri.kuuliala@traficom.fi Jacob.terling@ec.europa.eu
Part 3, section 2: **Remote operation**	Bahamas, Brazil, China, CIRM, France, India, Italy, Japan, Liberia, Marshall Islands, Norway, Pakistan, Poland, Republic of Korea, Russian Federation, Saudi Arabia, Singapore, United Kingdom, United Arab Emirates, United States, GlobalMET, IHMA, IMCA, IMPA, INTERTANKO, ISO, ITF, Nautical Institute, WMU, World Sailing	United Kingdom	Dr. Katrina Kemp katrina.kemp@mcga.gov.uk +44 (0)7771 389112
Part 3, section 3: **Communication**	Brazil, China, France, Italy, Pakistan, Russian Federation, Spain, Sweden, Türkiye, United Arab Emirates, CIRM, IALA, ICS, IHMA, ISO, ITF, WMU	China/Türkiye	Ms. LI Zhe, China Maritime Safety Administration, 158092224@qq.com Mr. SUN Wu, China Class Society, wsun@ccs.org.cn
Part 3, section 4: **Subdivision, stability and watertight integrity**	Poland, Sweden, EC, BIMCO	BIMCO	Jeppe Skovbakke Juhl JSJ@bimco.org
: Static Stability	EC, EMSA	EMSA/EC	Jacob.terling@ec.europa.eu
Part 3, section 5: **Fire protection/safety**	Brazil, Marshall Islands, Norway, Spain, Sweden, United Kingdom, IACS	Norway	Lisbeth Toft Senior Legal Adviser Department of Operational Supervision LCT@sdir.no
Part 3, section 6: **Life saving appliances and equipment**	Canada, France, Sweden, United States	Canada/United States	Berube, Veronique veronique.berube@tc.gc.ca Lee Franklin - USCG (USA) Lee.N.Franklin@uscg.mil

Section of the MASS Code	**Volunteering State and/or organization**	**Lead State or organization**	**Contact Details for Lead Person**
Part 3, section 7: **Management of safe operations**	Denmark, France, Germany, Norway, Sweden, BIMCO, IALA, IHMA, IMCA, IMPA, WMU	Germany	Jörg Kaufmann Joerg.Kaufmann@bsh.de
Part 3, section 8: **[Controlling the operation of the ship]**	N/A	Delete as unnecessary.	N/A
Part 3, section 9: **Security**	Republic of Korea, Liberia, Spain, IHMA, IMCA	Spain	Miguel Nunez mnunez@mitma.es
Part 3, section 10: **Search and rescue**	Spain, France, CIRM, ICS, IMCA	Spain	Andrés Galván agalvan@mitma.es Hernán del Frade: hjdelfrade@mitma.es
Part 3, section 11: **Cargo handling**	Sweden, Italy, BIMCO, IPTA, WSC	Sweden	Mats Hammander mats.hammander@transportstyrelsen.se
Part 3, section 12: **Personnel safety and comfort**	France, Philippines, Poland, Sweden, United Kingdom, GlobalMET, ITF, Nautical Institute,	ITF	Tracey Mayhew tmayhew@seafarers.org +1-301-256-6989
Part 3, section 13: **Towing and mooring**	Canada, Italy, IHMA, IMPA	Canada	Berube, Veronique veronique.berube@tc.gc.ca
Part 3, section 14: **Marine engineering/Machinery installations**	Australia, Canada, Italy, Norway, Sweden, United States, ITF	United States	Lee Franklin - USCG (USA) Lee.N.Franklin@uscg.mil
Part 3, section 15: **Electric and electronic engineering/ Electric Installations**	Australia, Canada, Norway, Sweden, United States, ITF	United States	Lee Franklin - USCG (USA) Lee.N.Franklin@uscg.mil
Part 3, section 16: **Maintenance and repair**	Australia, Canada, France, IHMA	Australia/Canada	Berube, Veronique veronique.berube@tc.gc.ca
Part 3, section 17: **Emergency response**	Denmark, France, [Germany], Marshall Islands, Republic of Korea, Sweden, IALA, IHMA	Republic of Korea	Dr. Han-Seon PARK hspark@kmi.re.kr Tel: +82 (0)51 797 4627 Mobile: +82 (0)10 3319 8525
Part 2, section 1: **Operational context**	China, Russian Federation	Russian Federation	Alexander Pinskiy al@marinet.org

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