MEGURI 2040 Seminar

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IMO MASS Code and its workplan

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Recent regulatory trend at IMO

1. From reactive to proactive and policy oriented

Traditionally, accidents responsive, e.g. tanker/bulker/passenger safety

- **MASS** for future shipping with advancing technology, e.g. automation, digitalization, communication and satellite technology
- GHG reduction from shipping, e.g. MEPC decides policy and reduction target and MSC deals with safety of alternative fuels and technologies

2. From prescriptive with detailed regulations to goal-based

(e.g. Goals, functional requirements, rules and regulations)

- Flexible to cater for technological development, with technology neutral

Regulatory scoping exercise (RSE) for MASS

1. MSC 99 (2018) started consideration on ***Regulatory scoping exercise (RSE)*** for Maritime Autonomous Surface Ships (MASS), MSC 103 (2021) finalized the RSE
2. RSE assessed existing IMO instruments to see how they might apply to ships that utilize varying degrees of automation, e.g. finding gaps
3. Based on its RSE, MSC agreed that SOLAS, COLREG, STCW, LL, SAR and Tonnage as high-priority instruments

Development of MASS Code

1. MSC (2022) started development **of a draft MASS Code, *non-mandatory and goal-based***, aiming at finalizing by 2024
2. MSC (2024) revised the Road Map, and
3. **MSC 111 (May 2026) adopted the non-mandatory MASS Code**
4. MSC 112 (December 2026) will develop a framework for an ***Experience-building phase (EBP)*** to commence from 2027
5. From 2028, MSC plans to start development of the mandatory MASS Code, based on the result from EBP; and, in spring 2030, to adopt a mandatory Code, for entry into force in 2032

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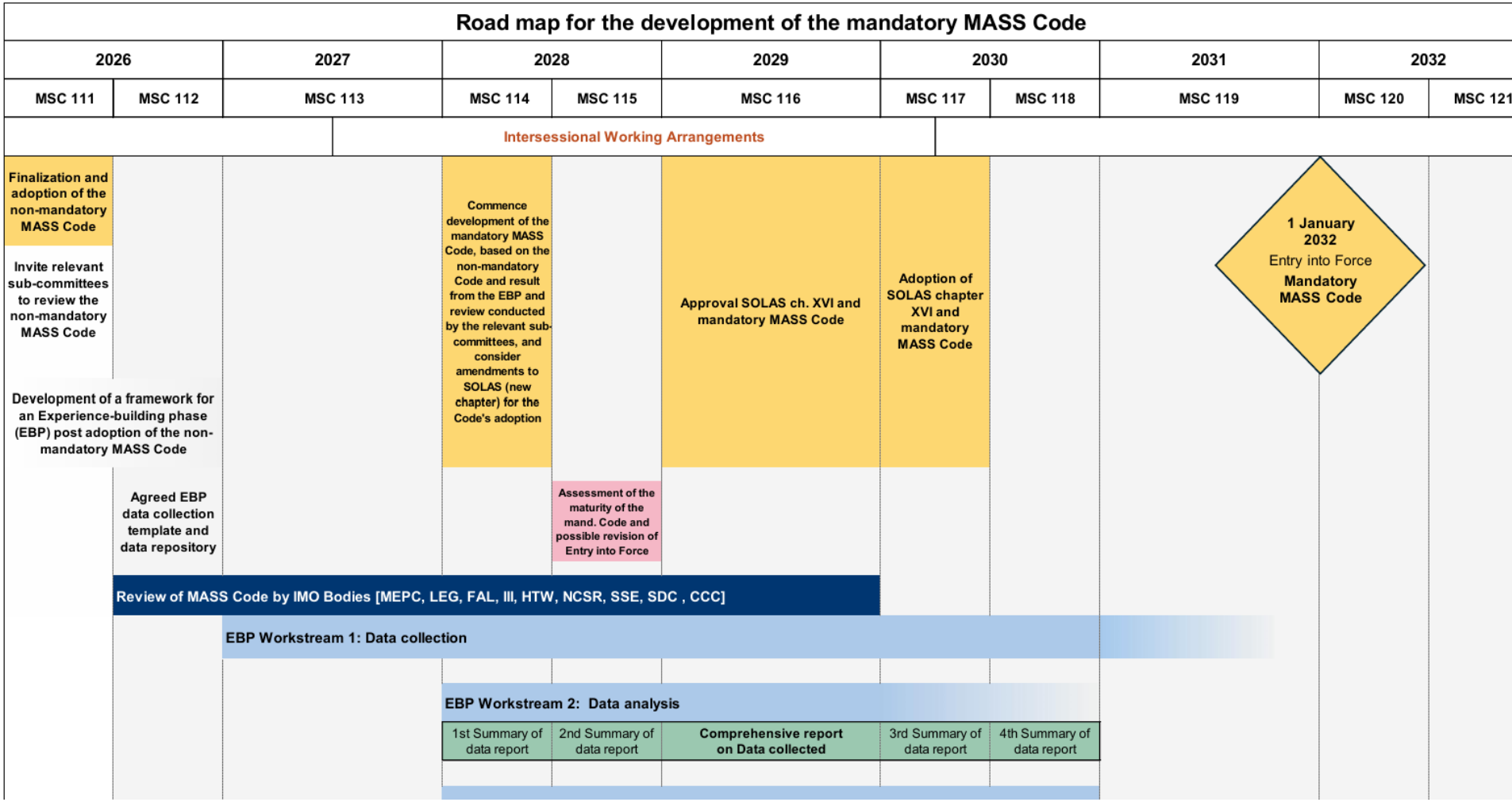
Revised road map, endorsed by MSC 111

(excerpt from MSC 111/WP.9, annex 2: report of MASS WG)



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Non-mandatory MASS Code

MASS CODE AT A GLANCE

International Code of Safety for Maritime Autonomous Surface Ships

PREAMBLE

Purpose and Principles

1. INTRODUCTION

- Purpose, Principles & Objectives
- Application Scope
- Code Structure
- Definitions

2. PRINCIPLES FOR MASS FUNCTIONS

- Surveys & Certificates
- Approval Process
- Risk Assessment
- Operational Context
- System Design & Software
- Safety & Security Management
- Manning & Training
- Maintenance

3. SPECIFIC OPERATIONAL REQUIREMENTS

- Safety of Navigation
- Connectivity
- Remote Operations
- Structural & Fire Safety
- Search & Rescue
- Cargo & Mooring
- Machinery & Electrical

CERTIFICATES

- MASS Safety Certificate
- MASS ROC Certificate

APPROVAL & SURVEYS

- Risk Evaluation

ANNEXES

- Approval Process
- Concept of Operations

MSC resolution adopted the MASS Code

1. INVITES all Governments concerned to take appropriate steps to give effect to the MASS Code on or after **1 July 2026**
2. ALSO INVITES all Governments concerned to apply the MASS Code, as far as practicable, to MASS of less than 500 gross tonnage

Note: SOLAS regulations generally do not apply to cargo ships of less than 500 gross tonnage

PREAMBLE

1. This Code is intended to be **supplementary to other IMO instruments**, **such as SOLAS**
2. This Code, and the use of MASS, are required to conform to the relevant rules of international law, including the United Nations Convention on the Law of the Sea (UNCLOS)
3. This Code takes into account that certain operational functions may be controlled from a location remote from the MASS and addresses necessary aspects of such Remote Operations Centres (ROCs)

CHAPTER 1 – PURPOSE, PRINCIPLES AND OBJECTIVES

1. The purpose of this Code is to provide an international regulatory framework to address autonomous or remote operation of key functions and systems, and ensure safe, secure, and environmentally sound operation of Maritime Autonomous Surface Ships (MASS). The Code further aims to support the adoption and integration of new technology for ship operations, and provide for consistent approach to the design, build and operation of MASS

2. This Code is developed on the principles that it be: supplementary to any other applied instruments, and only addressing MASS operations and functions as far as they are not adequately or fully addressed in the other applied instruments; goal-based and addressing matters at the functional level; and technology neutral, acknowledging industry practices and experience in the deployment of new technologies

CHAPTER 2 – APPLICATION

1. **This Code applies to cargo ships to which SOLAS chapter I applies**, *including any associated Remote Operations Centre(s) (ROC(s))*,… *when the Administration deems that compliance with other applicable instruments is impracticable or insufficient*

2. This Code does not apply to cargo high-speed craft to which SOLAS chapter X applies

3. ***The provisions of this Code should be implemented for individual autonomous or remote functions*** even where persons are on board to handle other functions

CHAPTER 3 – CODE STRUCTURE

Part I: Introduction covering overarching matters to be considered in the application of the Code.

Part II: Principles applicable in **all cases when applying the Code**. These principles and the resulting provisions should be met as part of any MASS approval and certification process.

Part III: Goals, functional requirements, and expected performances ***applicable to specific MASS operations and functions***. Depending on the modes of operation and functionality being certified, not all chapters of part III may be applicable.

CHAPTER 4 – DEFINITIONS

1. For terms used, but not defined in this Code, **the definitions as given in SOLAS, should apply**

2. **Concept of Operations (ConOps)** means a document describing the characteristics of a MASS.

3. **Modes of operation** means the condition(s) under which the functions of a MASS are operated, i.e. autonomous or remotely-operated, with or without persons on board (used to “four degree of autonomy”)

Note: Figure 1 in annex 2 (Framework for concept of operations) illustrates the relationship between the ***Operational Envelope (OE)***, ***Operational Design Domain (ODD)***, ***fallback state*** and ***contingency plans*** (according to CHAPTER 8 – OPERATIONAL CONTEXT, see next Figure 1)

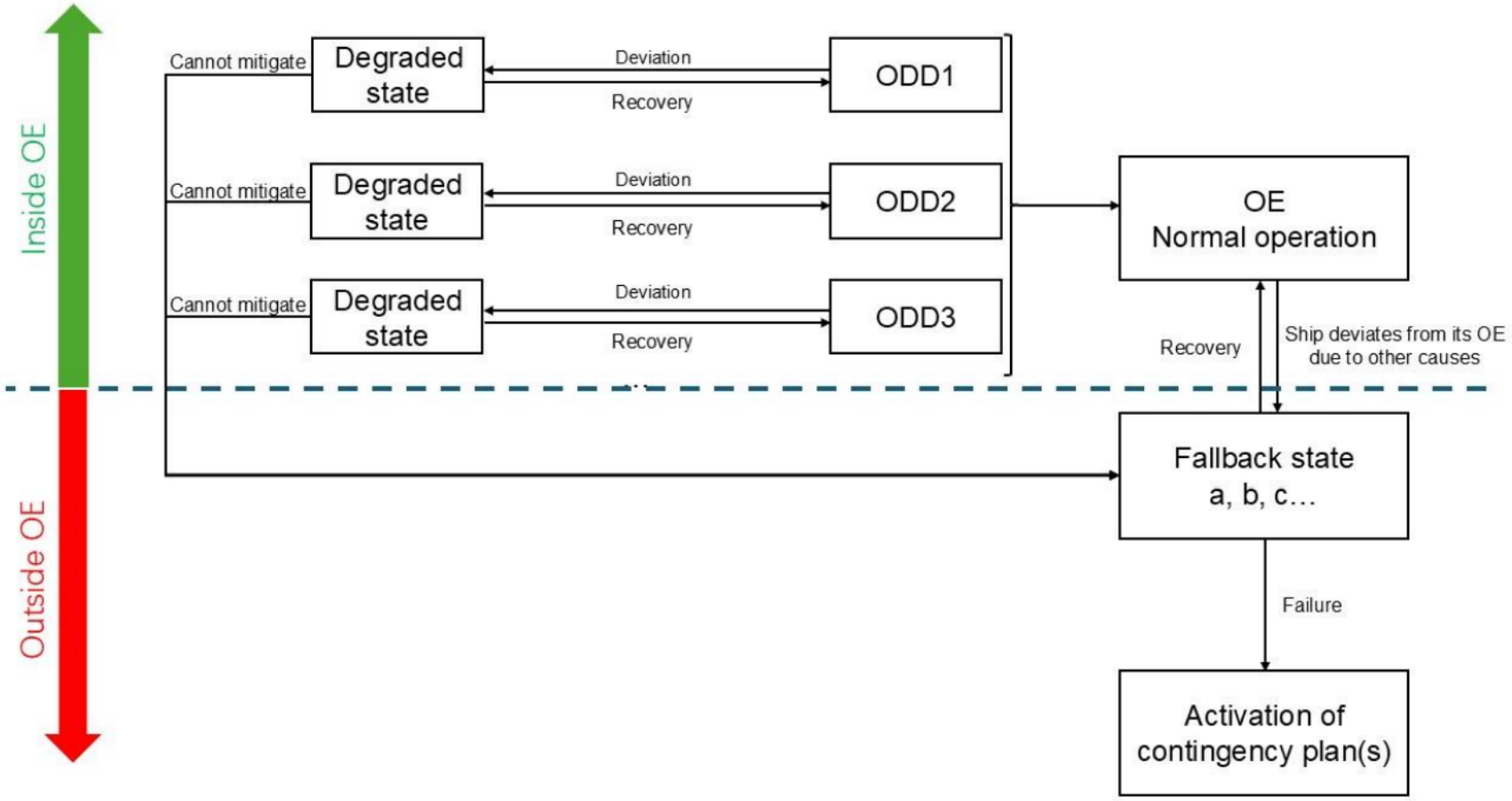
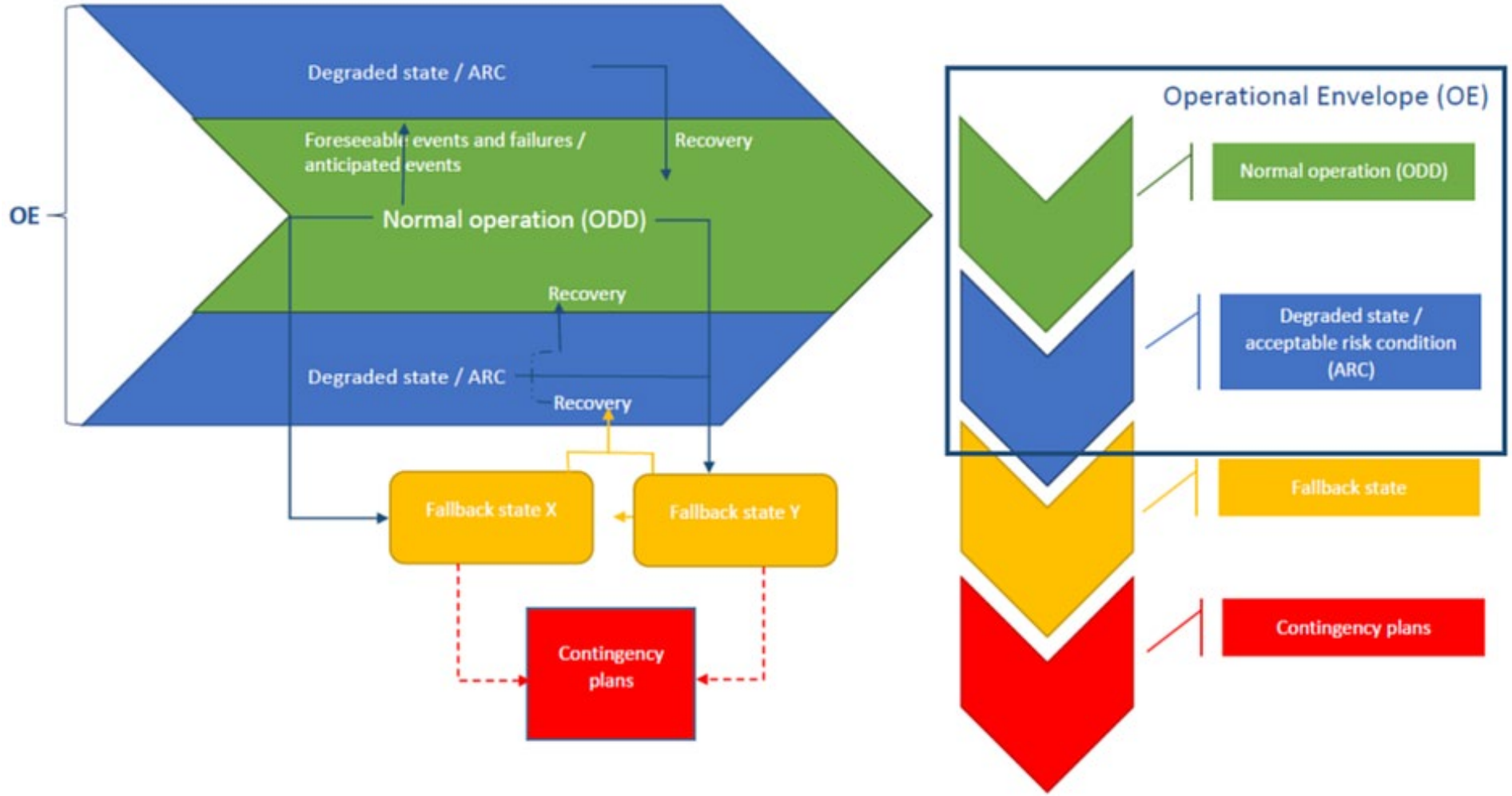


Figure 1: Illustration of the relationship between Operational Envelope, Operational Design Domain, Fallback State and Contingency Plans to support the application of chapter 8 (Operational Context)

(previous version of Figure 1)



CHAPTER 5 – SURVEYS AND CERTIFICATES

1. The **MASS Safety Certificate** and the **MASS Record** should be issued in addition to other relevant certificates required in SOLAS regulation I/12
2. Where compliance with any of the requirements of SOLAS is achieved through application of this Code, ***resulting exemptions or equivalent arrangements should be reflected on the appropriate SOLAS certificates***
3. The MASS Safety Certificate validity, survey dates and endorsements should be harmonized with the relevant SOLAS certificates (HSSC)
4. **Every ROC should, for each MASS it operates, have a valid MASS ROC Certificate** issued after an initial or renewal survey, accompanied by a MASS ROC Record

CHAPTER 5 – SURVEYS AND CERTIFICATES (cont.)

1. ***Provisional MASS Safety and MASS ROC Certificates*** may be issued
2. The Company should ensure that ***the SMS is implemented and maintained on the MASS and at any ROC(s)*** involved in its operation
3. Where the alternative management described in II/11.3 is used for the operation of a ROC(s), certification should follow a similar approach as the ISM Code with a ***ROC Safety Management System (ROCSMS)***; ***a Document of Compliance for the Remote Operation Management Company (ROM DoC)***; and ***a ROC Management Certificate (RMC)*** for each ROC
4. A MASS and any ROC operating a MASS should be subject to the International Ship and Port Facility Security (ISPS) Code

CHAPTER 5 – SURVEYS AND CERTIFICATES (cont.)

1. A MASS should be issued with a **minimum safe manning document (MSMD)** according to resolution A.1047(27), as amended, and to the satisfaction of the Administration

2. ***A ROC operating a MASS should be issued with a MSMD*** for operation of that MASS

3. A ROC operating several MASS should be issued with one MSMD per MASS. For such ROCs, a MASS ROC Master Plan (MRMP) for watchkeeping and other tasks should be developed and approved by each Administration who has issued MSMDs

CHAPTER 6 – APPROVAL PROCESS

1. The ***steps and documentation required*** in this chapter (and annex 1, see next slide) provide the general basis of the approval process, without prejudice to other information or documentation that may be requested by the Administration
2. The **evaluation criteria and an assessment plan** thereof should be agreed with the Administration
3. For each approval step, ***information and supporting documentation*** required by the Administration should be produced and submitted
4. Any ***operational conditions*** should be determined during the approval process, and they should be clearly documented and communicated to relevant parties

Table 1 – Relevant documentation for approval steps

	Preliminary design development	Preliminary design approval	Testing, simulation and other verification methods	Final approval	Operation
Preliminary design documents	X*	X			
Drawings and information documents		X		X	X**
Risk Assessment	X*	X		X	X**
Task allocation summary		X		X	X**
Approval basis and Actions register	X*	X	X	X	X**
Regulatory gap analysis		X			
Verification and validation plan		X			
Testing and verification reports			X		

* Preliminary and high level only

** In case of changes in the approved concept, assumptions and conditions

CHAPTER 7 – RISK ASSESSMENT

1. A **risk assessment should be conducted** to ensure that risks arising from the use of MASS functions, including relevant functions in Remote Operations Centres (ROCs); The risk assessment can be conducted on MASS as a whole, and/or on the MASS functions.

2. The risk assessment should analyse and address ***hazards associated with the intended OE of the MASS*** including any associated ROCs, as described in the ConOps

3. The ***adopted mitigation measures*** should take into consideration single failure events, but also foreseeable events within the OE of the MASS that may influence the performance of more than one system at the same time

CHAPTER 8 – OPERATIONAL CONTEXT

1. The **operational context for a MASS** should, within the applicable regulatory framework, … consider all aspects of the MASS operation and describe the autonomous or remotely-operated function(s) and the external environment that influences its operation
2. The operational context encompasses ConOps, OE, the system-specific ODD, fallback states, the modes of operation and the human control and supervision
3. The ConOps should be drafted to ensure the safe, secure and environmentally sound operation of the MASS
4. The OE of the MASS should encompass the operational capabilities and limitations of the autonomous or remote operation, and ship-specific capabilities and limitations

CHAPTER 8 – OPERATIONAL CONTEXT (cont.)

1. An autonomous or remotely-operated system and related equipment should operate within its ODD and should be able to detect whether its current state of operation meets the ODD

2. ***In case of deviating from its OE, a MASS should enter a predefined fallback state, offering an additional mitigation layer***; A deviation from an OE beyond a predefined fallback state, should lead to the activation of contingency plan(s)

3. The mode of operation of a MASS may be changed for different phases of a voyage, and procedures to change from one mode of operation to another, along with the criteria for any such change, should be described in the ConOps

CHAPTER 8 – OPERATIONAL CONTEXT (cont.)

1. All onboard crew and remote operators responsible for managing MASS operations should be able to exercise human oversight and control for operation of the MASS

2. **There should be a human master responsible for a MASS, regardless of the mode of operation** and the master should have the means to intervene when necessary

3. The onboard crew or remote operator should be provided ample time and sufficient information to be able to establish situational awareness, assume responsibility and exercise direct or supervisory control of all functions according to the ConOps

CHAPTER 9 – SYSTEM DESIGN

In addition to complying with relevant rules, regulations, and standards, ***systems related to MASS functions should comply with the following high-level principles***

..

Human-centred design

..

Security and cybersecurity

Data management and quality

Proper record keeping (data logging)

..

CHAPTER 10 – SOFTWARE PRINCIPLES

The principles in this chapter should be implemented to ensure that software on MASS or supporting MASS functions is reliable, trustworthy, safe and secure

CHAPTER 11 – MANAGEMENT OF SAFE OPERATIONS

1. The MASS, the Company and the Remote Operations Centre (ROC) should follow the provisions of this chapter, which are **supplementary** to the requirements for the management for the safe operation of ships in SOLAS and the ISM Code

2. With regard to ***a Remote Operation Management (ROM) company operating one or multiple ROC(s),*** this company could, to the satisfaction of the Administration, establish a SMS for the operation of those ROCs (ROC Safety Management System (ROCSMS)) under their responsibility. This ROCSMS should supplement the MASS's SMS developed by the Company, and the MASS ROC Certificate clearly establishing the relationship between the SMS and ROCSMS, to ensure that the safety level of the MASS established through the MASS's SMS is maintained.

CHAPTER 12 – SPECIAL MEASURES TO ENHANCE MARITIME SECURITY

in addition to the requirements in SOLAS chapter XI-2 and the ISPS Code, the following provisions should be applied:

1. The ship security assessment (SSA) and ship security plan (SSP) should identify and address additional security risks related to MASS operations
2. Ship security assessment and plans should account for the ROC(s), where appropriate, aligning as closely as possible with the concept, terminology and appropriate provisions of the ISPS Code
3. Communication with the MASS should be maintained during and following a security event on board, or impacting upon, a MASS

…

CHAPTER 13 – ALERT MANAGEMENT

The alert management provides:

1. the means to draw the attention of the onboard crew and remote operators to the existence of alert situations;
2. the means to enable the human operator to identify and evaluate the situation and handle alert announcements;
3. the means for onboard crew and remote operators and relevant third parties to assess the urgency of different alerts in cases where more than one alert should be handled;
4. the means to manage alerts in a distributed system structure in a consistent manner; and
5. support for effective supervision of autonomous and remotely-operated functions.

When an emergency alarm is activated, dedicated human operators, including the master, should be able to take control of the MASS until the emergency is over.

CHAPTER 14 – MANNING, TRAINING AND WATCHKEEPING (purposes)

1. For the purpose of this chapter, the training and watchkeeping standards as addressed by the 1978 STCW Convention and STCW Code, may be considered by the Administration for the assigned roles in the Remote Operations Centre (ROC).

2. A ROC may be considered by the Administration as a directly associated location to the navigational bridge or part of the machinery space, as applicable, to ensure that the watchkeeping provisions of 1978 STCW Convention and STCW Code may also apply to remote operators

CHAPTER 14 – MANNING, TRAINING AND WATCHKEEPING (safe manning)

1. The minimum level of safe manning should ensure sufficient onboard crew and/or remote operators to operate the MASS in an effective and efficient manner
2. Clear lines of authority and responsibility between onboard crew and/or remote operators should be established to ensure the safety and security of personnel and operations
3. The minimum level of safe manning should provide for sufficient hours of rest,..
4. **If there are crew or persons on board, the master should be physically present on board**
5. Only one master should be responsible for a MASS at any given time

CHAPTER 14 – MANNING, TRAINING AND WATCHKEEPING (safe manning for ROCs)

1. remote operators should be qualified and competent to a level not less than what is required under the 1978 STCW Convention and STCW Code

2. ***where remote operators perform watchkeeping duties***, there should be:

    1. a sufficient number of remote operators that meet the appropriate training and certification requirements to cover all watches, that are intended to be performed at a ROC; and
    2. sufficient time, resources, and procedures should be provided to ensure that they can establish situational awareness and are fully familiar with the MASS and any ROC before assuming responsibility for a watch

CHAPTER 14 – MANNING, TRAINING AND WATCHKEEPING (Watchkeeping)

Watches should be carried out based on the following bridge, engine-room and ROC resource management principles:

1. remote operators may maintain a safe watch or watches at the ROC without being physically present on board the MASS
2. watchkeeping may be shared between onboard crew and remote operators

CHAPTER 14 – MANNING, TRAINING AND WATCHKEEPING (training)

1. In addition to being qualified as required by the 1978 STCW Convention and STCW Code, onboard crew should have completed training to attain the competencies that are appropriate to the capacity to be filled and so that their duties and responsibility can be taken up
2. Remote operators at any level of responsibility should, at a minimum, be qualified to a level not less than that required by the 1978 STCW Convention and STCW Code and have completed training to attain the competencies that are appropriate to the capacity to be filled so that their duties and responsibility can be taken up

CHAPTER 15 – MAINTENANCE

1. autonomous and remotely-operated systems can be safely maintained, tested and inspected to ensure their reliability
2. Qualified and authorized persons should be available on board or remotely to monitor the system and equipment faults and abnormal conditions to verify their cause and implement corrective actions

Part III – Goals, functional requirements and expected performance applicable to specific mass operations and functions

1. Each chapter in this part consists of the Goal of the chapter, Functional Requirements to fulfil the goal, and the Expected Performance (EP) associated with those functional requirements

2. ***Chapters should be applied in full, but*** application of chapters in this part of the Code may be waived in agreement with the Administration as part of the approval process depending on the Concept of Operations and/or MASS functions implemented

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Road map for the development of the mandatory MASS Code

2026		2027	2028		2029	2030		
MSC 111	MSC 112	MSC 113	MSC 114	MSC 115	MSC 116	MSC 117	MSC 118	

Intersessional Working Arrangements

Finalization and adoption of the non-mandatory MASS Code

Invite relevant sub-committees to review the non-mandatory MASS Code

Development of a framework for an Experience-building phase (EBP) post adoption of the non-mandatory MASS Code

Agreed EBP data collection template and data repository

Commence development of the mandatory MASS Code, based on the non-mandatory Code and result from the EBP and review conducted by the relevant sub-committees, and consider amendments to SOLAS (new chapter) for the Code's adoption

Assessment of the maturity of the mand. Code and possible revision of Entry into Force

Approval SOLAS ch. XVI and mandatory MASS Code

Adoption of SOLAS chapter XVI and mandatory MASS Code

Review of MASS Code by IMO Bodies [MEPC, LEG, FAL, III, HTW, NCSR, SSE, SDC , CCC]

EBP Workstream 1: Data collection

EBP Workstream 2: Data analysis

1st Summary of data report	2nd Summary of data report	**Comprehensive report on Data collected**	3rd Summary of data report	4th Summary of data report

EBP Workstream 3: Development of SOLAS chapter XVI amendments and mandatory MASS Co

Draft framework of EBP (report from WG at MSC 111)

1. The purpose of the MASS EBP is to provide a systematic and evidence-based process for reviewing and improving the text of the non-mandatory Code based on the experience gained through its application during the practical development and operation of MASS

2. The EBP may have three workstreams with overlapping timelines: data collection; data analysis; and Code review and development of amendments and additions to the Code

3. WG prepared a draft template to be used by Administrations during the EBP for the reporting of data on actual MASS design, approval and operational experience and related feedback on the provisions of the non-mandatory MASS Code

Summary - MASS Code and its workplan

1. Chapter 1: The MASS Code was adopted, aiming to support the adoption and integration of new technology for ship operations, and provide for consistent approach to the design, build and operation of MASS
2. Since there have been few MASS which the Code could be applied with and even though the Code may not be perfect, the MSC adopted the non-mandatory Code for further maturity via EBP
3. Relevant Committees and sub-committees are expected to consider and examine the MASS Code
4. At the same time, it would be very tight schedule for EBP; and, in particular, development of draft mandatory MASS Code

Additional information:

Following slides are excerpts from chapters 16 to 24 in Part III - Goals, functional requirements and expected performance applicable to specific mass operations and functions, for reference purposes

CHAPTER 16 – SAFETY OF NAVIGATION

1. a MASS should comply with all relevant requirements for safety of navigation in SOLAS and the Convention on the International Regulations for Preventing Collisions at Sea, 1972, as amended (COLREG), as supplemented by the functional requirements of this chapter
2. An autonomous navigation system (ANS) or system for remote navigation should ensure there is a means to take action in accordance with COLREG to prevent collisions, as well as allisions and groundings
3. An ANS or system for remote navigation should be capable of being overridden from location(s) where control of navigation can be exercised

CHAPTER 17 – CONNECTIVITY

1. Connectivity between the MASS and ROC is essential for remote monitoring or control and should be ensured as described in the Concept of Operations (ConOps)
2. The infrastructure for connectivity should .. provide a quality of service and connectivity, adequate to ensure the safe operation of MASS, taking into account factors such as bandwidth, data integrity, reliability, resilience, and network latency; Connectivity should be such as to operate the MASS safely, considering operational limitations of connectivity, such as meteorological and oceanographic conditions
3. Connectivity performance should be monitored against stated requirements and measures should be in place to address disconnection or performance degradation and to implement necessary actions including entering a fallback state when necessary

CHAPTER 18 – REMOTE OPERATIONS

1. The goal of this chapter is to ensure the safe and secure remote operation of MASS systems or functions, when duties and responsibilities for safe operation are assigned to a Remote Operations Centre (ROC)
2. A ROC should be at a suitable location to enable the safe and secure remote operation
3. The software used for remote operation should be appropriately designed, managed and maintained to ensure the safe and secure operation

CHAPTER 19 – STRUCTURE, SUBDIVISION, STABILITY AND WATERTIGHT INTEGRITY

1. a MASS should comply with all relevant SOLAS structural, stability, subdivision and watertight integrity requirements, as well as the International Convention on Load Lines, 1966 as amended by the 1988 Protocol, and the 2008 Intact Stability Code, as supplemented by the functional requirements of this chapter
2. A stability control system (SCS) should be in place, capable of continuously assessing the intact stability of the MASS during its operation as well as supporting the assessment of the survivability of the MASS in case of damage
3. Means should be provided for the SCS to reduce the risk of excessive motions of the MASS in adverse sea conditions

CHAPTER 20 – FIRE PROTECTION, FIRE DETECTION AND FIRE EXTINCTION

1. A MASS should remain under control or enter a fallback state during and following a fire event in any single compartment that is directly linked to the control of the MASS
2. A fire which is limited to a single compartment that does not have a direct link to the control of the MASS, should not cause a loss of control or lead to a fallback state
3. Means should be provided to detect, confirm, and locate a fire incident; to enable the appropriate use of fire-extinguishing systems, taking into account possible human presence; to monitor and assess fire growth and fire-fighting effectiveness during and after fire; to enable the remote and onboard control of all active fire protection measures, including containment measures; and to facilitate an intervention from external fire responders

CHAPTER 21 – SEARCH AND RESCUE

1. A MASS and its associated Remote Operations Centre(s) (ROC(s)) should be provided with a ship-specific plan and procedures which enable the master to provide assistance to persons in distress when obligated to do so
2. Rescue equipment provided on board should be able to be safely used independently of the presence of crew
3. Persons retrieved on board should be able to be safely accommodated until such time as they can be delivered to a place of safety

CHAPTER 22 – CARRIAGE OF CARGOES

1. the MASS should comply with the requirements of SOLAS chapters VI and VII and relevant regulations relating to the carriage of cargoes, as supplemented by the functional requirements of this chapter
2. Means should be provided to enable for the safe carriage of cargo involving autonomous or remotely-operated systems and functions

CHAPTER 23 – ANCHORING, TOWING AND MOORING

1. It should be noted that these functions may be treated independently from each other
2. Autonomous or remotely-operated anchoring, towing and mooring arrangements should allow the safe conduct of these operations
3. Where anchoring, towing and mooring operations involve a Remote Operations Centre (ROC), the remote operators should have sufficient information, oversight and control to enable safe and effective operations with due consideration to interactions with any third parties, infrastructure and/or involved personnel
4. Anchoring arrangements should be able to be activated autonomously or remotely during fallback states and in emergency situations

CHAPTER 24 – MACHINERY AND ELECTRICAL INSTALLATIONS

1. Electrical power production and distribution should be capable of maintaining the MASS in normal operation and fallback states, and ensuring that essential systems remain operational in emergency situations for the period(s) specified by SOLAS
2. Machinery and electrical installations should be able to support predefined fallback states, and be fault tolerant to connectivity being lost or below an acceptable threshold; Monitoring should be provided to assess system robustness, reliability and effectiveness
3. Measures should be provided to prevent machinery or electrical systems being autonomously or remotely-activated when operated or serviced by authorized persons on board, and to ensure the safe reactivation upon completion; to detect machinery or electrical system malfunctions or failures to maintain safe operation in normal and emergency situations