MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

Credits: IBM / Promare

The Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) agreed to "integrate new and advancing technologies in the regulatory framework" for the implementation and facilitation of further autonomy in shipping. The aim is to introduce in IMO instruments safe, secure and environmentally sound MASS: ships that can operate independently of human interaction

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Increased automation on board ships, which could reach ultimately full autonomy or become remotely controlled unmanned vessels, are not a new maritime safety issue. As a matter of fact, the IMO's Maritime Safety Committee discussed automated ships as early as 1964. However, the recent technological breakthroughs in the fields of information technologies, digitalization and machine learning, notably supported by EU funded research, have opened the possibility of a practical implementation of some of these solutions to MASS (Maritime Autonomous Surface Ships).

MASS has a "disruptive" potential with implications in terms of technical, economic, environmental, legislative and social impacts in the years to come. This development may also provide opportunities and new concepts which could improve logistics and, therefore, also improve the overall environmental impact of transport. As a natural consequence, MASS will also need to be tackled from a regulatory point of view, since regulations have traditionally offered a safety threshold but are also, sometimes, discouraging innovation, as they were often drafted in different times.

From the regulatory point of view, the IMO's Maritime Safety Committee (MSC) agreed to include on its agenda a new item on MASS and MSC 99 agreed to undertake a regulatory scoping exercise (RSE) to assess the impact of MASS upon the existing international maritime safety regulatory framework. It is expected that significant work will have to take place in a regulatory context after the completion of the RSE for the implementation and facilitation of further autonomy in shipping.


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The Mayflower Autonomous Ship, which was completed and launched in September 2020, is an artificial intelligence, solar-powered marine research vessel that will sail across oceans to collect environmental data. Its name commemorates the crossing of the original Mayflower 400 years ago

Why has IMO decided to look at the regulation of autonomous ships?

IMO's Strategic Plan has a key Strategic Direction to "Integrate new and advancing technologies in the regulatory framework". This involves balancing the benefits derived from new and advancing technologies against safety and security concerns, the impact on the environment and on international trade facilitation, the potential costs to the industry, and finally their impact on personnel, both on board and ashore. In 2017, following a proposal by a number of Member States, the International Maritime Organization's MSC agreed to include the issue of marine autonomous surface ships on its agenda.

This would be in the form of a scoping exercise to determine how the safe, secure and environmentally sound operation of Maritime Autonomous Surface Ships (MASS) may be introduced in IMO instruments. The MSC recognized that IMO should take a proactive and leading role, given the rapid technological developments relating to the introduction of commercially operated ships in autonomous mode (operating without crew). The scoping exercise was seen as a starting point and was expected to touch on an extensive range of issues, including the human element, safety, security, liability and compensation for damage, interactions with ports, pilotage, responses to incidents and protection of the marine environment. The aim was to complete the scoping exercise by 2020. For the purpose of the regulatory scoping exercise, "Maritime Autonomous Surface Ship (MASS)" was defined as a ship which, to a varying degree, can operate independently of human interaction.

The regulatory scoping exercise

To facilitate the progress of the regulatory scoping exercise, the degrees of autonomy are organized (non-hierarchically) as follows (it was noted that MASS could be operating at one or more degrees of autonomy for the duration of a single voyage):

• **Degree One: Crewed ship with automated processes and decision support**. Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.

The Maritime Safety Committee (MSC) endorsed a framework for a regulatory scoping exercise, as work in progress, including preliminary definitions of Maritime Autonomous Surface Ships (MASS) and degrees of autonomy, as well as a methodology for conducting the exercise and a plan of work

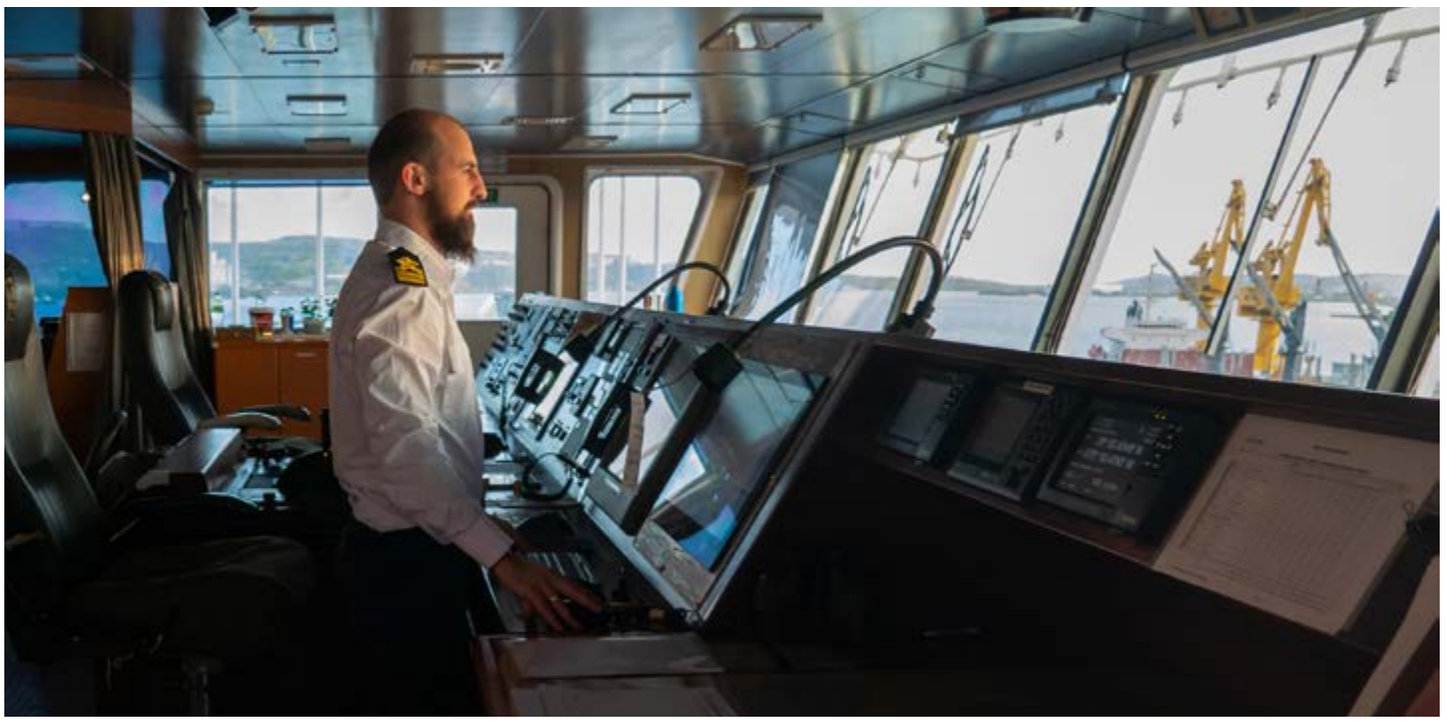
• **Degree Two: Remotely controlled ship with seafarers on board**. The ship is controlled and operated from another location, but seafarers are on board.

• **Degree Three: Remotely controlled ship without seafarers on board**. The ship is controlled and operated from another location. There are no seafarers on board.

• **Degree Four: Fully autonomous ship**. The operating system of the ship is able to make decisions and determine actions by itself.

As a first step, the scoping exercise identified current provisions in an agreed list of IMO instruments and assess how they may or may not be applicable to ships with varying degrees of autonomy and/or whether they may preclude MASS operations.

As a second step, an analysis was conducted to determine the most appropriate way of addressing MASS operations, taking into account, inter alia, the human element, technology and operational factors. The Maritime Safety Committee, during its 99th session (16-25 May 2017), established a correspondence group on MASS to test the framework of the regulatory scoping



Clarifying the meaning of the term "master", "crew" or "responsible person" has been identified as a high priority

exercise and, in particular, the methodology. Four years later, in May 2021, IMO at its 103rd session of the Maritime Safety Committee finalized its analysis of ship safety treaties, to decide next steps for regulating MASS. The completion of the scoping exercise represents an all important first step, paving the way to focused discussions to ensure that regulation will keep pace with technological developments.

Identifying high-priority issues

The exercise involved assessing a substantial number of IMO treaty instruments under the remit of the MSC and identifying provisions which:

- applied to MASS and prevented MASS operations;
- or applied to MASS and do not prevent MASS operations and require no actions;
- or applied to MASS and do not prevent MASS operations but may need to be amended or clarified, and/or may contain gaps;
- or have no application to MASS operations.

The safety treaties assessed include the SOLAS Convention and various codes made mandatory under SOLAS (Casualty Investigation, Enhanced Survey Programme (ESP), Fire Safety Systems (FSS), Fire Test Procedures (FTP), Bulk Chemical (IBC), Gas Carrier (IGC), Solid Bulk Cargoes (IMSBC), Dangerous Goods (IMDG), Carriage of Irradiated Nuclear Fuel (INF), Intact Stability, International Safety Management (ISM), Ship and Port Facility Security (ISPS), Grain, Polar, Recognized Organizations (RO)); collision regulations (COLREG); Load Lines Convention and 1988 Protocol; Convention on Safe Containers (CSC); STCW Convention and Code, as well as STCW-F Convention; search and rescue (1979 SAR Convention); tonnage measurement (Tonnage 1969) and the Code of Safe Practice for Cargo Stowage and Securing (CSS Code) and IMO Instruments Implementation Code (III Code).

For each provision, the exercise identified whether MASS could potentially be regulated by:

- equivalences as provided for by the instruments or developing interpretations;
- and/or amending existing instruments; and/or developing a new instrument;
- or none of the above as a result of the analysis.

The outcome highlights a number of high-priority issues, cutting across several instruments, that would need to be addressed at a policy level to determine future work.

These involve the development of MASS terminology and definitions, including an internationally agreed definition of MASS and clarifying the meaning of the term “master”, “crew” or “responsible person”, particularly in Degrees Three (remotely controlled ship) and Four (fully autonomous ship).

Other key issues include addressing the functional and operational requirements of the remote-control station/centre and the possible designation of a remote operator as seafarer.

Another high priority issue is the need to address the functional and operational requirements of the remote control station/centre MASS may be operated by, and the possible designation of a remote operator as seafarer

Further common potential gaps and themes identified across several safety treaties related to:

- provisions containing manual operations and alarms on the bridge;
- provisions related to actions by personnel (such as firefighting, cargoes stowage and securing and maintenance);
- watchkeeping;
- implications for search and rescue; and information required to be on board for safe operation.

The best way forward

IMO considered that the best way forward to address MASS in the regulatory framework could preferably be in a holistic manner, through the development of a goal-based MASS instrument.

Such an instrument could take the form of a "MASS Code", with goal(s), functional requirements and corresponding regulations, suitable for all four degrees of autonomy, and addressing the various gaps and themes identified by the RSE. In this light, all Member States were invited to submit proposals on how to achieve the best way forward. More in detail the results of the up-to-now work of IMO is fully described in the IMO Circular MSC.1/Circ.1638 dated 3 June 2021 (Outcome of the Regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS).

The high-priority issues identified in the IMO Circular as potential gaps of how to introduce MASS operation safely and effectively in the regulatory framework, could be summarized as follows:

- **meaning of the terms "master", "crew" or "responsible person"**. It was recognized that in a substantial number of instruments there was a need to clarify the meaning of such terms. The role, responsibility and definition of "master", especially for Degrees of autonomy Three and Four, where personnel on the shore side might control the ship, were considered to be a common theme identified in several instruments as a potential gap;
- **remote control station/centre MASS may be operated by**. It was noted that the functional and operational requirements of the remote control station/centre, as well as for monitoring, needed to be addressed. It was further noted that this was a new concept to be implemented in IMO instruments and a common theme identified in several instruments as a potential gap;
- **remote operator as seafarer**. IMO revealed that the possible designation of a remote operator as seafarer was considered to be a common theme identified in several instruments as a potential gap. Qualifications, responsibility and the role of remote operator as seafarer was one of the most complex issues to be addressed.

More recently EMSA, the European Marine Safety Agency, provided support to the European Commission on this subject by participating at IMO work. A horizontal "task force" was set up in January 2020 within the Agency in order to become the technical facilitator in relation to autonomous ships and, more in particular, to become the platform for technical structured discussions with administrations, industry and academia. Moreover, in 2019 EMSA commissioned to DNV the SAFEMASS study with the objective to identify new risks and regulatory gaps, which will be created by implementing certain levels of autonomy. The overall objective of SAFEMASS was to identify emerging risks and regulatory gaps that are posed by the implementation of different degrees of au-

tonomy. The intention was to provide meaningful input to the EU Member States and the European Commission, and possibly IMO.

Could autonomous superyachts be the future thanks to artificial intelligence?

In commercial shipping, the idea of autonomous ships is huge, driven by the objective of reduced costs. Consider the savings by eliminating crew costs, plus the accommodation space freed up for paying cargo. But all current technologies seem well designed for a single, small boat project, but how does artificial intelligence factor into the world of superyachts? Is an autonomous yacht on the horizon?

At ground the most familiar autonomous developments are the self-driving cars currently being tested. Elements of this technology, such as automatic breaking, self-parking, front crash avoidance and lane drift warnings are already in use, and Mercedes-Benz, Tesla and Cadillac have more complex driver assist systems for limited applications. However, fully autonomous cars, originally promised for 2017, remain a dream. Fatalities during testing mean only controlled simulations at this time. Let's try to imagine the training necessary to autonomously operate something as complex as a 100-metre superyacht. There are, however, a growing number of superyacht-related operations in which artificial intelligence can be really useful. Yacht design is an interesting area of development for artificial intelligence: an example is engine exhaust temperatures. High temperatures could mean in-engine wear, exhaust filter clogging, bad weather, excessive hull/prop fouling or something else entirely. In order to determine and address the cause, you need data from various sources and diagnostics incorporating, all in real time. As another example, in addition to navigation a captain has many tasks, such as keeping the logbooks and processing weather forecasts in the daily planning. This combination of responsibilities does not make digital support an unnecessary luxury.

IMO developed a goal-based MASS instrument with goals, functional requirements and regulations, suitable for all 4 Degrees of autonomy

A degree of autonomy will reduce the number of errors on board. In addition, autonomous sailing provides savings in fuel consumption and is therefore also more sustainable. With autonomous technology we can have the navigation tasks carried out by a digital co-pilot. The captain becomes a supervisor and can fully focus on the safety and deployment of people and ship. Autonomous does not necessarily equate to unmanned. But while it's easy to see how this example could improve boat design and operation in the near future, it's hard to imagine it replacing experienced superyacht crew when it comes to service, despite several recent studies revealing that millennials actually prefer interacting with robots. Stay tuned.