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REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

Proposals for the development of a work plan

Submitted by ICS

SUMMARY

Executive summary:	This document provides analysis and comments relating to the adoption of autonomous systems, and proposals relating to the development of a work plan for the Regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS)
Strategic direction, if applicable:	2
Output:	2.7
Action to be taken:	Paragraph 18
Related documents:	MSC 98/20/2, MSC 98/20/13, MSC 98/22/7; resolutions A.947(23) and A.1047(27)

Introduction

1 This document is submitted in response to the invitation of the Maritime Safety Committee, at its ninety-eighth session, for interested Member States and international organizations to submit substantive proposals and comments to MSC 99 for consideration under the agenda item on "Regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS)" (the regulatory scoping exercise) (MSC 98/23, paragraph 20.2.12).

Discussion

2 Some Member States and international organizations have expressed strong support and an ambitious vision for autonomy[1] in international shipping. Equally, a number of others have expressed degrees of scepticism or appear averse to the concept.

[1] Autonomy in the context of this submission refers to a progression of equipment and systems (but not whole ships) through levels of autonomy marked by increasing authority for decision-making by systems and equipment, and complementary changes in the purpose and frequency of human interventions. Examples include those submitted in MSC 98/INF.2 (Denmark) and those described in Lloyds Register ShipRight Procedure – Autonomous Ships (July 2016).

3 ICS has yet to be convinced by a number of current assessments of the predicted rate of adoption of MASS in international shipping, particularly the popular image of "autonomous ships"; and therefore whether or not such assessments reflect a realistic time frame and objective.

4 Increasing automation and the availability of autonomous systems to perform particular functions will define a progression towards autonomy level 6[2] in systems on board ships. The potential for such a change in the way at least some ships operate should not be ignored. This, and the need to avoid regional regulation, justifies a careful review of the IMO regulatory framework as agreed at MSC 98 (MSC 98/23, paragraph 20.2.11). ICS considers that it is essential that there is the widest possible participation from Member States and international organizations in this discussion.

5 ICS further considers that the IMO regulatory framework should not seek to accelerate the adoption of new technology for its own sake. Nor should it slow down the adoption of beneficial new technology in international shipping. MSC 98 agreed that a work plan should properly consider the comments referred to in paragraph 11 of document MSC 98/20/13 (ITF) (MSC 98/23, paragraph 20.2.4). Therefore, it is anticipated that the regulatory scoping exercise will be undertaken without prejudice to any discussions on whether continued adoption of autonomous systems is a good idea or not.

6 Furthermore, the purpose of the regulatory scoping exercise should be as described in paragraph 24 of document MSC 98/20/2 (Denmark et al.): to allow the Committee to make informed decisions about the work required to accommodate MASS (however, MASS may be defined) within the IMO's regulatory framework.

Development of a work plan

7 The essential aspects of the work plan to be developed should be based on the identification tasks presented in paragraph 20 of document MSC 98/20/2 (Denmark et al.). However, there are two alternatives for the overall approach that could be considered:

.1 a response which defines specific forms of autonomy with a view to removing particular regulatory barriers. This approach assumes that it is only the regulations themselves which may require development, amendment or interpretation or that equivalence can be easily demonstrated. It may tend to review regulations in isolation. Moreover, it makes the questionable assumption that the approach to regulation itself will not be affected by the increasing use of autonomous systems; or

.2 a holistic response to autonomy and the associated opportunities and risks for safety, security or environmental protection. This approach assumes that autonomous systems may have implications for every aspect of the regulatory framework and seeks to inform a process of change. In addition to the reviewing the regulations themselves, this approach acknowledges that some elements of the IMO approach to regulation may also need to be reviewed. For example, it acknowledges that reliance on performance standards, whilst demonstrably effective for existing ship systems and equipment (including those which incorporate automation), may not be as effective when regulating new autonomous systems.

[2] This is based on the autonomy levels defined in Lloyds Register ShipRight Procedure – Autonomous Ships (July 2016).

8 The response described in paragraph 7.1 may oversimplify the regulatory response to a potentially fundamental change in how some ships operate at sea. Furthermore, this approach may not respond to the recognized complexity of this development (MSC 98/23, paragraph 20.2.2) and could introduce two regulatory tiers, particularly with respect to safety. This is because it may not adequately account for the implications that autonomous systems can reasonably be expected to have on the regulatory approach itself. Moreover, this approach has the disadvantages that it:

.1 may inadvertently undermine the opportunities of autonomous systems in the future. This is because rather than enabling the use of autonomous systems, making them fit existing regulatory requirements may limit the situations in which they can be used. An example would be a requirement for ships using an autonomous collision avoidance system to indicate that it is a ship not under command. This would make an autonomous collision avoidance system redundant and negate any potential benefits; and

.2 pre-supposes that particular forms or levels of autonomy are compatible with the safety, security and environmental objectives of the Organization. Moreover, there is a risk of assuming that the minimum safety level for autonomous systems is equivalent with existing requirements, but this may not be adequate. In both cases, it is questionable whether sufficient evidence is available to justify such assumptions.

9 Consequently, it is recommended that the holistic approach described in paragraph 7.2 above be adopted. This should ensure that all relevant aspects of the implications of autonomous systems are addressed when providing the Committee with the information required to make informed decisions (MSC 98/23, paragraph 24). This approach should be considered to ensure the safe, secure and environmentally sound operation of ships using autonomous systems. Moreover, it should be considered to maximize the potential benefits of adoption of autonomous systems.

10 In addition to the work proposed in paragraph 20 of document MSC 98/20/2 (Denmark et al.), the Committee should consider including in its technical deliberations the following matters. These matters have been arranged by the elements of successful implementation of technological change:

.1 people (the human element);

.2 procedures; and

.3 technology.

The human element

11 It is recalled that the Committee previously noted views expressed regarding consideration of the human element (MSC 98/23, paragraph 20.2.3). Whilst human error is often considered a justification for autonomous systems, human success in complex systems is a justification for carefully considering the optimum use of autonomous systems as complement, rather than replacement, for human decision-making. Further recalling paragraph (g) of the goals in the annex to the human element vision, principles and goals for the organization (resolution A.947(23)), the human element objective should be to assess the risk factors associated with autonomous systems in a holistic and systematic manner.

12 This should include, but may not be limited to, identification of the:

.1 work necessary to understand the characteristics of the most effective means of combining, or otherwise, human decision-making and autonomous systems, and the implications for the regulatory framework;

.2 knowledge and skills required to supervise automated systems, interact with autonomous systems, and maintain such systems[3]. This work may inform any future review of the STCW Convention;

.3 implications of remotely supervised systems for operators. In particular, the unique challenges such systems pose for appropriate human-machine interfaces, information management, fatigue and task engagement[4]; and

.4 potential for a growth in scope of the human element to include decision makers outside the scope of IMO instruments. This may include, but not be limited to, the developers of algorithms used by autonomous systems to make recommendations or decisions relating to safety of navigation and protection of the marine environment.

13 Taking into account the complexity of the issues highlighted at MSC 98 (MSC 98/23, paragraph 20.2.2), it will also be necessary to identify approaches to how ship-ship (collision avoidance), ship-shore (including mandatory ship reporting and SAR) and ship-human (including SAR, pilotage, mooring and other relevant operational activities) interactions could be effectively managed.

14 It has been observed that in general discussion of this topic "unmanned ship" is often synonymous with MASS or "autonomous ship". ICS considers that to assume any particular arrangements for safe manning based on current knowledge and experience of operations using autonomous systems is premature. Consequently, safe manning in the context of the provisions of SOLAS regulation V/14 and associated guidance (resolution A.1047(27)) should not be part of any discussions pertaining to defining MASS or "autonomous ship".

Procedures

15 The procedures element would further address the potentially broader implications of autonomous systems for the regulatory framework. In addition to developing the process that would be used to complete the identification tasks in paragraph 20 of document MSC 98/20/2 (Denmark et al.), the focus of the procedures element would be on:

.1 identifying and addressing the Committee's needs with respect to the collection, and analysis of evidence and data regarding the performance of autonomous systems. The need for more data and evidence to be shared regarding technology in general was highlighted in document MSC 98/22/7 (Denmark et al.). However, ICS considers that the Committee should endeavour to direct the data and evidence collection so that it obtains the data and evidence it needs for informed decision-making; and

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3 The current framework for training in the STCW Convention may not be appropriate for application where systems used for functions described in the STCW Convention are of autonomy levels beyond AL 2 and the use of decision support tools.

4 Shively (2015), *Human performance considerations for Remotely Piloted Aircraft Systems (RPAS)* available at https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150011435.pdf

.2 identifying and considering appropriate regulatory approaches, taking into account the unique challenges posed by autonomous systems. Related matters are highlighted in paragraph 16 below.

Technology

16 The technology element would focus on the capabilities and limitations of autonomous systems, their expected performance[5] and approaches to verification. In this regard, it should be noted that:

.1 availability of data and evidence regarding the performance of autonomous systems, particularly at autonomy level 3 and above[6], may be inadequate for the purposes of informed decision-making. This reflects the:

.1 limited number of ships operating using autonomous systems;

.2 period over which such ships have been operating;

.3 size and operational purpose of such ships; and

.4 range of environments in which they have operated.

This limitation on data and evidence may justify the inclusion of a data and evidence collection phase as a supplement to any work plan. This may be necessary to develop risk models necessary for any formal safety assessment (FSA) and determining appropriate safety levels for autonomous systems. It should be noted that without such information it will be difficult to objectively assess whether equivalence with the requirement of existing IMO instruments is an adequate safety level objective;

.2 concerns are being raised regarding the limitations of performance standards (and associated test standards) as a basis for verifying the effectiveness of an autonomous system in uncertain, real-world situations[7]. This also has implications for type-approval and the formulation of the Tier IV requirements of goal-based standards which may be used to regulate such systems;

.3 given the issues in paragraph 16.1 and 16.2 above, probabilistic methods may need to be used to develop certain requirements for autonomous systems. Such a development is not unforeseen in the context of ship systems and equipment. However, in the context of autonomous systems used for tasks including navigation and collision avoidance, this may be considered significant and worthy of careful consideration; and

5 Expected performance may need to include new dimensions, including but not limited to, ethical factors. This is particularly relevant for autonomy levels 4 to 6.

6 This is based on the autonomy levels defined in Lloyds Register ShipRight Procedure – Autonomous Ships (July 2016).

7 Johnson (2016), *Role of Regulators in Safeguarding the Interface between Autonomous Systems and the General Public* presented at the 34th International System Safety Conference, USA and Danks and London (2017), *Regulating Autonomous Systems: Beyond Standards*, IEEE Intelligent Systems, Vol.32, Issue 1.

.4 the need to promote transparency, as a matter of priority. This will be important in testing, development, installation and operational use of autonomous systems. The objective being to:

.1 build confidence in autonomous systems. Such confidence building is important for the Organization, for the industry and for society in general;

.2 support the data and evidence needs of the Committee for informed decision-making;

.3 enable effective approval and certification of autonomous systems; and

.4 provide for the traceability of recommendations and decisions made by autonomous systems, particularly in the context of maritime safety investigations.

Proposal

17 ICS proposes that the following is included in the work plan and/or the terms of reference of a working group which may be established to consider this matter: In addition to addressing the identification tasks in paragraph 20 of MSC 98/20/2 (Denmark et al.):

.1 assess the risks for the effectiveness of the regulatory framework of embarking on work limited to removing specific barriers to MASS (however it may be defined), taking into account the analysis and comments in paragraphs 7 to 9 of this document; and

.2 consider the need for a holistic approach to the regulation of autonomous systems, and identify the necessary human element, procedural and technology matters which should be addressed in a work plan, based on the analysis and comments provided in paragraphs 11 to 16 of this document.

Action requested of the Committee

18 The Committee is invited to consider the analysis and comments provided in paragraphs 2 to 16, the proposals in paragraph 17, and take action, as appropriate.