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| DISCUSSION PAPER |

**IMPLICATIONS**

**of**

**MARITIME AUTONOMOUS SURFACE SHIPS**

**FROM A**

**VTS PERSPECTIVE**

Working Paper Edition 0.1

OCTOBER 2021

Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

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# DOCUMENT PURPOSE

The purpose of the discussion paper is to assist the Committee achieve a common understanding of MASS and its implications on the provision of VTS by clearly and concisely identifying:

* Trends and opportunities presented by MASS.
* Issues / challenges for the management of ship traffic in a VTS area.
* Options, policies, and strategies for VTS to embrace / influence MASS.
* Implications for the regulatory and legal framework for VTS.
* Implications for IALA Standards relating to VTS.

The document supports IALA’s *Strategic Vision* and *Current Drivers and Trends* by providing a means to assist the Committee:

* Monitor the advent of MASS and its associated implications for VTS.
* Strategically plan for MASS and determine new work programme tasks associated with the preparation of new/amended IALA guidance.
* Develop guidance to assist authorities ensure the safety and efficiency of vessel movements in the VTS area, recognising:
  + The advent of MASS and their interaction with conventional manned vessels within VTS areas.
  + The interaction process of autonomous vessels with conventional traffic.
  + The information flow between MASS and shore authorities; and
  + The related information exchange with conventional traffic.

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| --- |
| **Note**  The advent of MASS will be ongoing for many years it is intended that this document will be reviewed and updated, as appropriate:   * Following VTS Committee meetings. * To reflect amendments to IALA’s *Strategic Vision and Current Drivers and Trends*. * To reflect outcomes from the MASS Task Force.   It is not the intention for this document to address the issues/implications identified. This will be achieved new/amended work programme tasks adopted by the Committee. |

# EXECUTIVE SUMMARY

The advent of MASS will have significant implications for how VTS contributes to the safety of life at sea, safety and efficiency of navigation and the protection of the environment within the VTS area by mitigating the development of unsafe situations.

This includes how VTS will interact with conventional ships, autonomous ships and control centres (remote and/or local) to mitigate the development of unsafe situations through:

* Providing timely and relevant information on factors that may influence the ship's movements and assist onboard decision-making.
* Monitoring and managing ship traffic.
* Responding to developing unsafe situations.

A key consideration in moving forward will be balancing the benefits derived from new and advancing technologies with safety, efficiency, protection of the environment and security concerns will be a primary consideration for VTS as MASS transitions from ‘local’ trial environments to operational scenarios.

1. **Opportunities**

The following opportunities have been identified:

1. **Responding to the outcomes from the IMO Regulatory Scoping Exercise** - The international response to the RSE provides the opportunity to engage and contribute to the associated change processes by providing a VTS perspective (Refer to Section 3.4)..
2. **Case studies** – The increasing number of trials and ‘test beds’ are being conducted globally and a number of potential “case studies” have been identified that may assist gaining a greater understanding of MASS and its implications by monitoring their development/outcomes and identifying opportunities for involvement/engagement.
3. **The role out of MASS 1 and MASS 2 -** xxxxx.
4. **Digital communications /information exchange** - xxxx.
5. **Issues / challenges for the management of ship traffic in a VTS area**

The implications for VTS have been identified with regards to the advent of MASS, noting the assumptions described in Section 3.3, include.

| **Degree of autonomy[[1]](#footnote-1)** | **Implications for VTS** |
| --- | --- |
| **Degree one**  Ship with automated processes and decision support | **Minimal** - There is a need to monitor advances in the automated process and decision support onboard |
| **Degree two**  Remotely controlled ship with seafarers on board | * Managing ship traffic comprising both MASS and conventional ships * Digital interaction with ships, RCCs and other stakeholders to:   + Exchange information   + Provision of advice, warning, and instruction * Managing Interaction with multiple RCCs * Operational and procedural changes associated with the above * Provision of advice, warning, and instructions to the RCC with responsibility for the vessel. * Communications and interaction with participating ships (Voice / data exchange). This may include communications between ships (MASS and Traditional). |
| **Degree three**  Remotely controlled ship without seafarers on board | * As above, plus: * Emerging situation where ship needs to be contained / controlled to mitigate incident (national gov’t, VTS, other agencies) |
| **Degree four**  Fully autonomous ship | As above, plus:   1. Operational and procedural changes associated managing Degree four MASS 2. VTS should be able to request that the RCC retakes control of the MASS 4, changing its operational status to MASS 3 |

1. **Options, policies, and strategies for VTS to embrace / influence MASS.**

*<High level summary of conclusions to follow>*

1. **Implications for the regulatory and legal framework for VTS**

Current expectations are that the ‘new’ resolution for VTS, expected to be adopted by the IMO Assembly in December 2021, will facilitate embracing new developments such as the advent of MASS, noting the Resolution:

* Recognises applicable IMO instruments and other international guidance

*“In complying with these Guidelines, Contracting Governments should take account of applicable IMO instruments and refer to the relevant international guidance prepared and published by appropriate international organizations”. (Section 1.4)*

* Recognises IALA Standards
  + *“NOTING that the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) has contributed significantly to the development of internationally harmonized guidance for vessel traffic services”*.
  + *“IALA is recognized as an important contributor to IMO's role and responsibilities relating to vessel traffic services”.* (Section 1.3)
  + *“Contracting Governments are encouraged to take into account IALA standards and associated recommendations, guidelines and model courses”*. (Section 9.2)

1. **Implications for IALA Standards relating to VTS**

The implications for IALA Standards relating to VTS with the advent of MASS are significant, noting the role of IALA in contributing significantly to the development of internationally harmonized guidance for vessel traffic services (Refer Section 3.5).

*xxxxxx*

# DISCUSSION

IALA has prepared IALA’s *Current Drivers and Trends* document to serve as guidance as to how IALA can reach its strategic goals with a long-term horizon and perspective. Nine trends and developments have been identified to “*be monitored closely and when required, appropriate action should be taken such as an adjustment of the priorities and/or structure of the organization”*.

The “*Development of autonomous, automated and unmanned vessels*” is one of these nine trends and developments*.* Key aspects and implications identified with regards to MASS include:

* *“The further development of autonomous vessels could lead to increased safety and efficiency*
* *Today some vessels are to some extend semi-automated or semi-autonomous*
* *The development is expected to continue with unmanned vessels as the ultimate stage*
* *The trend will have an implication on the infrastructure and lead to fewer human errors*
* *It will also require reliable and resilient Position, Navigation and Timing (PNT) and connectivity in terms of integrated and corresponding systems and machine-readable signals in cases where no crew are present”*

Recognising VTS will have a key role in the advent of MASS this document has been prepared to collate opinions and ideas as a basis for informed discussion on the advent of MASS and achieve a common understanding of MASS and its implications for VTS.

## Overview

### IMO Regulatory Scoping Exercise

In 2017, following a proposal by a number of Member States, IMO's Maritime Safety Committee (MSC) agreed to include the issue of marine autonomous surface ships on its agenda. This was 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 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.

IMO completed the regulatory scoping at the 103rd Session of the MSC in May 2021.

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.

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 Committee noted that the best way forward to address MASS in the IMO 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.

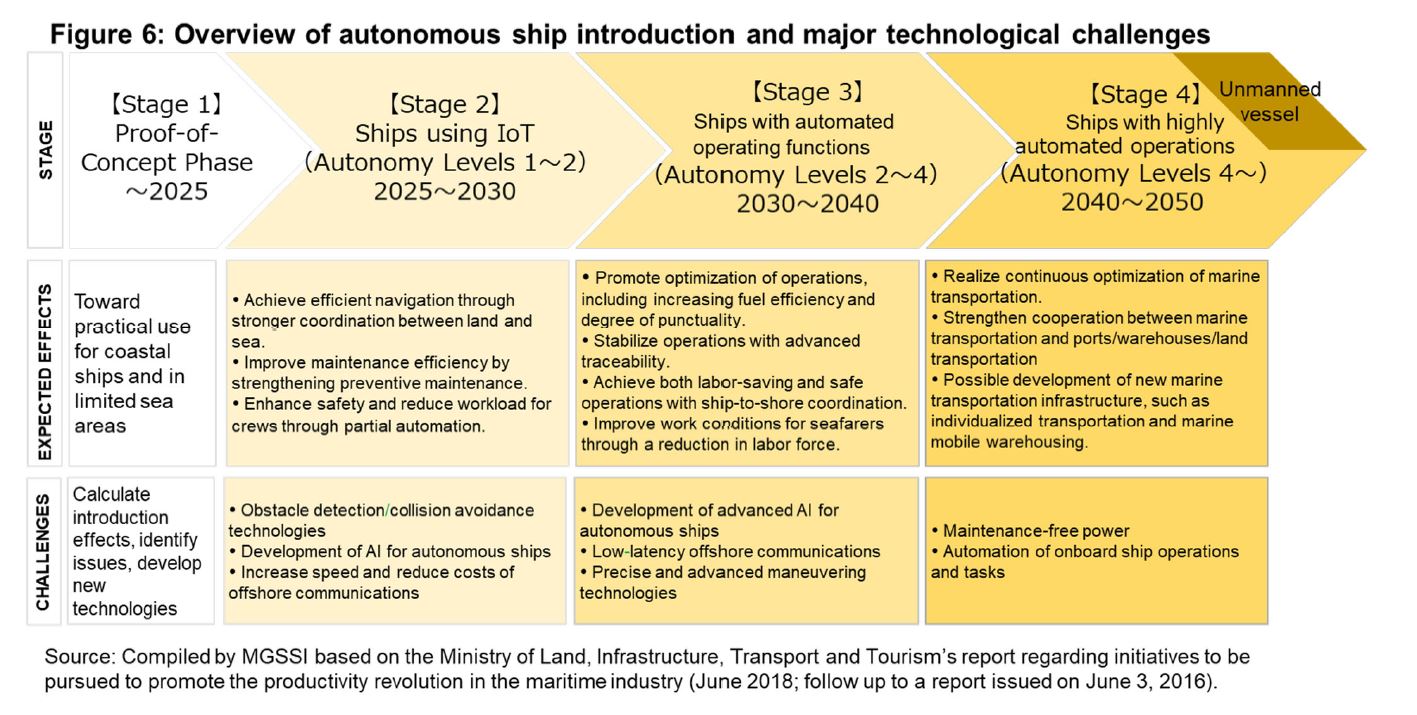
The Committee has invited Member States to submit proposals on how to achieve the best way forward to a future session of the MSC.

<NOTE - Section 3.1.1 to be updated following MSC104>

### Expected Time frame

Pending updated information:

Source - Mitsui & Co. Global Strategic Studies Institute Monthly Report September 2019



## Opportunities

Developments currently underway that provide an opportunity to strategically plan for MASS and determine work programme tasks associated with the preparation of new/amended IALA guidance specifically related to VTS include:

1. Responding to the outcomes from the IMO Regulatory Scoping Exercise.
2. MASS Trials and ‘Test Beds’ - The use of case studies.
3. The role out of MASS 1 and MASS 2.
4. Digital communications /information exchange.
5. **Responding to the outcomes from the IMO Regulatory Scoping Exercise** – The RSE completed in May 2021 identified far ranging implications to international conventions which need to be worked through. For example:
   * *“ …. 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”.*
  + *“….. the best way forward to address MASS in the IMO regulatory framework could, preferably, be in a holistic manner through the development of a goal-based MASS instrument.”*

The international response to the RSE provides the opportunity to engage and contribute to the associated change processes by providing a VTS perspective (*Refer to Section 3.4*).

1. **MASS Trials and ‘Test Beds’ - The use of case studies** – The increasing number of trials and ‘test beds’ are being conducted globally and a number of potential “case studies” have been identified that may assist gaining a greater understanding of MASS and its implications by monitoring their development/outcomes and identifying opportunities for involvement/engagement.

Refer to document VTS51-TG1.2.5 Proposed Case Studies)

1. **MASS 1 and MASS 2** – Embracing MASS 1 and MASS 2 as soon as possible - <text to follow>
2. **‘Fast tracking’ adoption of digital communications and automated data exchange** - <text to follow>

## Issues / challenges for the management of ship traffic in a VTS area

The advent of MASS will present issues and challenges for VTS operations and will undoubtedly contribute to major changes to how VTS interacts with participating ships and manages ship traffic to ensure the safety and efficiency of ship movements by VTS. Questions to be considered include, for example:

* **VTS Operations**:
  + How VTS receives, assimilates and processes data and information from MASS.
  + How does VTS interact with both conventional ships and MASS.
  + How does the VTS interact with the entity in control of the ship (Master/RCC/automated systems).
  + How VTS manages ship traffic, including:
    - A mix of conventional ships and MASS.
    - The means of providing warning, advice and instruction to achieve its purpose.
  + How VTS responds to the development of unsafe situations (conventional ships and MASS).
  + Knowing the degree of MASS for individual ships.
  + Managing interaction with multiple RCC’s.
  + Emerging situations where a ship needs to be contained / controlled to mitigate incident effects (national governments, VTS, other agencies).
* **Communications and interaction** 
  + Embracing digital communications.
  + Data and information exchange, including automated exchange.
  + Managing a mix of VHF voice, digital communications and automated data exchange.
  + The need for MASS to communicate their status.

The advent of MASS will invariable be associated with VTS managing ‘big data’, interacting with MASS using digital means, and possibly centralised, distributed and/or virtualised VTS ‘centres’ in the future.

Recognising the considerable work identified in the IMO Regulatory Scoping to determine how the safe, secure and environmentally sound operation of Maritime Autonomous Surface Ships (MASS) may be introduced in IMO instruments (*Refer to Section 3.5*) and the change processes associated with these, identifying the issues, challenges, and implications for VTS has been approached by adopting key assumptions.

It is recognised these assumptions will change as the advent of MASS evolves and the framework provided by international conventions is amended accordingly, however, achieving a common understanding of these provides a platform to facilitate discussion and analyses in exploring the implications of MASS for VTS.

### Overarching Assumptions

Consideration of the implications of MASS from a VTS perspective have been prepared based on the following overall assumptions:

* MASS will be required to participate in VTS. That is, subject to the same:
* Regulatory reporting requirements, and
* Obligations with regards to the issue of advice, warnings and instructions as deemed necessary.
* MASS will be subject to COLREG, as amended.
* MASS will be required to broadcast status as to who/what is in command at any time (Master/on-board DST, Remote Control Center?

### Degree of autonomy, Assumptions, and Implications for VTS

The implications of MASS from a VTS perspective have been identified in the table below, noting the overarching assumptions regarding MASS described in Section 3.3.1.

| **Degree of autonomy** | **Assumption/s** | **Implications for VTS** |
| --- | --- | --- |
| **Degree one**  Ship with automated processes and decision support.   * Seafarers are on board to operate and control shipboard systems and functions. * Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control. | MASS of degree one is considered as a conventional ship with some additional functions to support human decision making on board.  The master and crew of the ship are in control of all ship operations at all times. | **Minimal**  There is a need to monitor advances in the automated process and decision support onboard |
| **Degree two**  Remotely controlled ship with seafarers on board:   * The ship is controlled and operated from another location. * Seafarers are available on board to take control and to operate the shipboard systems and functions. | MASS of degree two is controlled and operated from the RCC.   * Seafarers considered as a back-up should remote control experience problems/fail.   The RCC may release control and operation to the master/crew.  No matter if MASS can be operated from another location, seafarers on board are assumed to be able to meet all the operation and control requirements. | * Managing ship traffic comprising both MASS and conventional ships * Digital interaction with ships, RCCs and other stakeholders to:   + Exchange information   + Provide advice, warnings and instruction * Managing Interaction with multiple RCCs * Operational and procedural changes associated with the above * Provision of advice, warnings and instructions to the RCC with responsibility for the vessel. * Communications and interaction with participating ships (Voice / data exchange). This may include communications between ships (MASS and Traditional). |
| **Degree three**  Remotely controlled ship without seafarers on board:   * The ship is controlled and operated from another location. * There are no seafarers on board. | The ship is controlled and operated from the RCC with no seafarers on board. | * As above, plus: * Emerging situation where ship needs to be contained / controlled to mitigate incident (national gov’t, VTS, other agencies) |
| **Degree four**  Fully autonomous ship:   * The operating system of the ship is able to make decisions and determine actions by itself. * There are no seafarers on board. | The operating system of the ship is able to make decisions and determine actions by itself.  A remote control centre may exist for MASS 4 but will have minimal impact on voyages except to define destinations and a route plan  The remote control centre could take control of the MASS 4 if necessary and in such circumstances would change the vessel status to MASS 3. | As above, plus:   1. Operational and procedural changes associated managing Degree four MASS 2. VTS should be able to request that the RCC retakes control of the MASS 4, changing its operational status to MASS 3 |

## Options, policies and strategies for VTS to embrace influence MASS.

* IALA Strategy/Vision
* Case Studies
* This document
* Greater IALA engagement with MSC and FAL

## Implications for the IMO regulatory regime for VTS

Current expectations are there are no implications for the IMO regulatory regime for VTS with the advent of MASS, noting:

* The IMO Regulatory Scoping Exercise completed in May 2021 (*Section 3.1.1*) did not identify any implications associated with SOLAS regulation V/12 (Vessel Traffic Services).
* The revision of the Guidelines for vessel traffic services (Resolution A.857(20)) by the IMO on the basis, amongst other things, that a new resolution should be ‘future proofed’ as much as possible to accommodate new trends, such as the development, adoption and implementation of Maritime Service Portfolios, e-navigation and other evolving instruments aimed at the facilitation of safe, secure, and efficient maritime traffic and trade.

The ‘new’ IMO resolution for VTS is expected to be adopted by the IMO Assembly in December 2021 and consensus is that the revision has ‘future proofed’ the document as much as possible by:

* + Recognises applicable IMO instruments and other international guidance

*“In complying with these Guidelines, Contracting Governments should take account of applicable IMO instruments and refer to the relevant international guidance prepared and published by appropriate international organizations”. (Section 1.4)*

* + Recognises IALA Standards
    - *“NOTING that the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) has contributed significantly to the development of internationally harmonized guidance for vessel traffic services”*.
    - *“IALA is recognized as an important contributor to IMO's role and responsibilities relating to vessel traffic services”.* (*Section 1.3*)
    - *“Contracting Governments are encouraged to take into account IALA standards and associated recommendations, guidelines and model courses”*. (*Section 9.2*)

## Implications for IALA Standards relating to VTS

The implications for IALA Standards relating to VTS with the advent of MASS are significant, noting the role of IALA in contributing significantly to the development of internationally harmonized guidance for vessel traffic services (Refer Section 3.5).

To facilitate this two Work programme Tasks have been identified:

* Ensuring VTS Guidance Documents evolve with the Advent of Mass
* Digital VTS Communications

### Ensuring VTS Guidance documents evolve with the advent of MASS

To ensure IALA Standards specifically related to the establishment and operation of VTS evolve with the advent of MASS and continue to provide an effective framework for achieving worldwide harmonisation of VTS a new work programme task has been proposed to:

* Identify guidance requiring updating/amendment.
* Identify additional guidance required with the advent of MASS.
* Provide a framework for planning the preparation of amended/new guidance that reflects the conclusions described in the *Discussion Paper - Implications of MASS from a VTS perspective*.

Note: Refer to *VTS51-9.2.1.3 Proposed new task - MASS - Implications for IALA Guidance*

### Digital VTS Communications

Consensus is that new/additional guidance will be required, particularly in the short term for VTS digital communications (Refer to *VTS51-X.X.X Proposed new task - Digital VTS Communications*)

# Acronyms

AIS Automatic Identification System

MASS Maritime Autonomous Surface Ships

RCC Remote Control Center

VDES VHF Data Exchange System

VTS Vessel Traffic Services

# references

<reference list to be reviewed / updated and an explanatory sentence under each as to why it is included>

1. China MSA. (2020). Scoping exercise on the implications of MASS on VTS documents (VTS48-8-2.6).
2. NL Paper on the impact of MASS on VTS (VTS49-3.1.2).
3. IALA. (2019d). VTS COMMITTEE TASK REGISTER FOR 2018 – 2022.
4. IALA Standards S1040
5. IALA Guideline 1141
6. IMO. (2021). MSC.1/Circ.1638
7. IMO. (2019). MSC.1/Circ.1604
8. IMO. (2018). MSC 100/20/add.1
9. IMO. (2017). MSC 98/20/2

1. The degrees of autonomy are as defined by the IMO for the purposes of the Regulatory Scoping Exercise completed at the 103rd Session of the MSC in May 2021 [↑](#footnote-ref-1)