



**EU OPERATIONAL GUIDELINES
FOR SAFE, SECURE AND SUSTAINABLE
TRIALS OF
MARITIME AUTONOMOUS SURFACE SHIPS
(MASS)**

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PREFACE

These Operational Guidelines¹ have been developed in a spirit of enhanced co-operation and coordination among all parties involved in MASS trials, on the basis of the work of the EU/EEA Member States, EMSA and the European Commission in the *ad hoc* Expert Sub-group on Maritime Autonomous Surface Ships (MASS²) of the High Level Steering Group for Governance of the Digital Maritime Systems and Services³, taking into consideration and complementing, as far as possible, the *Interim* Guidelines for MASS trials developed at the IMO.

This Guideline is a living document that may be reviewed, updated and adjusted as more experience is gained with MASS trials following these guidelines and also as the results of MASS tests become available and more insights on the used technology and the procedures are gained.

BACKGROUND

The application of new information technologies, digitalization, automation and artificial intelligence may rapidly change the way traditional maritime transport works and operates. Development towards fully or partly autonomous ships will pose both opportunities and challenges for the sector in terms of safety, security, existing legal frameworks, and operations.

A fast changing and rapid uptake of technologies is enabling autonomous surface ships to undergo testing. This new development is putting new demands on the role the VTM⁴/VTS/MRS services can play.

To facilitate technical developments and tests/trials in a safe predictable area/environment as well as to ensure safe navigation also in mixed situations where both manned and unmanned ships will be sailing on the same routes/ports, it is important to test both vessel centric scenarios as well as scenarios related to vessel traffic monitoring, communications (bidirectional) and connectivity (such as links), management and control. Developments towards MASS and adapted Vessel Traffic Control/Services are parallel and can support each other.

There are a number of regulatory challenges directly related to MASS (looked at in the regulatory scoping exercise taking place at IMO) however it is necessary to establish the conditions for Administrations as well as industry involved in performing the various trials and tests with MASS, to ensure that systems and vessels navigate safely. This, depending on the type of MASS trials and level of autonomy, requires dedicated areas or 'zones' designated for carrying out tests/trials for various degrees of MASS, also considering that different levels of automation/autonomy can be done during one and the same trial/test.

¹ Drafted against the background of document 'Unmanned Vessels and Autonomous Vessels and VTMS' for AI 4.3 of the 3rd HLSG

² The Maritime Autonomous Surface Ships (MASS) term is used for the purpose of aligning with the one provisionally used at the IMO.

³ Established under the 'VTMS' Directive 2002/59/EC

⁴ The already applicable EU legislation – the VTMS Directive - includes provisions which need to be looked at under the perspective of automated/autonomous vessels; how they would impact maritime monitoring and surveillance/VTS and what could be done to meet future challenges, including point-to-point intra EU-trade. Another aspect directly related to the VTMS directive is the use of communication and monitoring tools (integrated maritime services).

CONTEXT

Extensive testing has been identified as a prerequisite and crucial step for safe and successful MASS traffic. Establishing safe and secure testing environments for maritime autonomy will enable proof of concept both for monitoring, management, communication and control (the VTS angle) and for the commercial applications in this field.

These Operational Guidelines, non-mandatory in nature, are intended to support the more uniform application by way of streamlining the operational processes for allowing trials in designated testing environments (test areas and/or ship safety zone/s), in the interest of the protection of human life, maritime safety, security and the environment, but should not be understood to imply any new or replace any existing legal obligations.

1. AIM

The aim of these Operational Guidelines⁵ is to provide assistance/guidance for relevant Administrations and the Applicant(s) that want to perform tests/trials on MASS systems (at full or reduced geometrical scale of the ship) in a safe, secure and environmentally friendly manner, also when conducted within specified monitoring areas such as VTS areas and SRS operational areas.

2. SCOPE AND APPLICATION

The guidelines take a goal-based approach, as far as possible, for the purpose of conducting trials in a manner that provides at least the same degree of safety, security, and protection of the environment as provided by the relevant IMO instruments and for taking the necessary steps in the overall process of establishing MASS trial/test areas; granting authorizations for trials of MASS systems in test areas; and, for performing such tests/trials.

These guidelines only concern surface trials.

3. OBJECTIVES

The main objective is to develop procedures to be used for designating test area(s) or a ship safety zone, when conducting trials of MASS-related systems and infrastructure.

These guidelines also address the risks and vulnerabilities inside and outside the determined area/zone by ensuring the safety of navigation and considering environmental interests and third party interests, as well as any monitoring and communication issues from the land side, including how (a future) VTS may have to interact with MASS in all conceivable situations.

As far as practicable, a risk-based approach and risk-assessment methodologies shall be used throughout the process to achieve the objectives.

4. TERMS AND DEFINITIONS

For the purpose of these Guidelines, the following terms and definitions should apply:

- *Relevant Administration* – the organisation(s) (such as Competent Authority / National authority with responsibilities as flag, port and/or coastal State) responsible for designation of test area(s)/ship safety zone(s) and authorisations or approvals of trials within such areas or zones.
- *Applicant* – is the relevant stakeholder(s) formally applying for the trial and assuming responsibility and liability for the trials and submitting all the necessary information to the relevant Administration.

- *Contact point* – the person identified by the applicant who the relevant Administration (including VTS) can contact during all phases of the tests/trials, including during the course of the trials for emergency reasons.
- *Designated Test Area* – area of sea or port identified for the purpose of safe tests/trials with MASS.
- *IMS* – Integrated Maritime Services.
- *MASS* – Maritime Autonomous Surface Ship.
- *MRS* – Mandatory ship reporting system.
- *Relevant stakeholders* – e.g. shipowners/authorized representatives, operators, manufacturers, classification societies and other involved parties in the conduct of MASS tests/trials.
- *Risk assessment* – the systematic application of risk issues concerning policies, procedures, and practices, as well as the tasks of analysing, evaluating, controlling, and communicating.
- *Ship Safety Zone* – A zone around a vessel within which all other vessels should remain clear unless authorised. The size of the Ship Safety Zone may vary depending upon such factors as: the dimensions of the waterway; ship size; ship characteristics; cargo; and the degree of risk. The dimensions selected should be determined taking into account these details and a relevant risk assessment.
- *SRS* – Ship Reporting Systems
- *Test plan* – the plan/program submitted by the applicant containing details for the tests/trials that will be conducted.
- *TDM* – Traffic Density Mapping.
- *Traffic density* – the density of maritime traffic in the designated test area.
- *Trial* – means an experiment or a test or a series of experiments or tests, conducted over a limited period, in order to evaluate alternative methods of performing specific functions or satisfying regulatory requirements.
- *UMIES/SSN* – The Union Maritime Information and Exchange System (SafeSeaNet)
- *VTS* – Vessel Traffic Service means a service designed to improve the safety and efficiency of vessel traffic and to protect the environment, which has the capability to interact with the traffic and to respond to traffic situations developing in the VTS area
- *VTS authority* – the authority with the responsibility including for the appropriate staffing, management, operation and co-ordination of the VTS, interaction with participating vessels and the safe and effective provision of the service.

5. ACTIONS TO BE CONSIDERED BY THE ADMINISTRATION(S)

5.1 Designated Test Area / Ship Safety Zone for MASS Trials

5.1.1 Objective

The objective is for the involved Administrations to designate a test area/ship safety zone suitable for effective tests/trials of MASS systems and sub-systems at full or reduced geometrical scale of the vessel in a safe, secure and environmentally friendly manner.

If the test area involves Administrations from more than one EU Member State, the States involved should cooperate and follow the same steps as set out below.

5.1.2 Characteristics and Requirements

Designated test area(s)/ship safety zone should be established on the basis of the needs of the applicant and other relevant stakeholders and following the positive completion of the risk assessment and the respective administrative procedures. The geographic area depends on the individual trials or test activities and should be selected and defined in order to reduce the unplanned encounter with other vessels.

Test areas may be established for unlimited duration or be set-up, *ad hoc* and within a specified timeframe, only for the purpose of specific tests/trials.

In establishing a designated test area for MASS trials and as part of the risk analysis, several issues need to be considered, such as, but not limited to:

- possible geographical location of the test area,
- type and density of ‘conventional’ maritime traffic in the proposed area,
- purpose and type of tests/trials including the characteristics of the MASS/ship(s) to be used,
- duration of tests/trials,
- communications and shore-side infrastructure,
- compliance with the intent of mandatory instruments for the ship, such as manning, equipment, Steering and Sailing Rules (e.g. COLREG) and reporting requirements (e.g. VTS, MRS).

Requirements and/or conditions for the transit of the MASS to the designated area should be taken into account.

Once established, designated MASS test area(s) may be used by other applicants, if so agreed by the Administration.

Information on established MASS test areas should be made available by the Administration.

5.1.3 Identification of the designated test area for MASS trials

The Administration intending to establish/designate a test area for MASS trial or a ship safety zone should consider the density/volume of traffic and the degree of risk within and in the vicinity of the possible test area or test zone. Areas with a low or medium traffic density should

be preferred at initial stages of trials. The geo-physical characteristics and other constraints should also be taken into account. Depending on the national organisation, local and/or regional authorities may need to be involved in the process. If the MASS trial is fully or partly within a VTS area, the relevant VTS authorities should participate in the process.

The criteria for a designated test area or ship safety zone for MASS trials are part of the risk assessment procedure and should take into consideration the tools available to support the identification of a suitable area (c.f. section 5.2).

The following elements should be considered for the purpose of the risk assessment, *inter alia*:

- geographical identification of the area; the geographical identification may need to be verified against national maritime spatial plans;
- indication whether the area is open or closed to other maritime traffic;
- determine the ‘maritime picture’ including the overall traffic flow (and its type) / areas of high-density traffic in and around the designated test area (c.f. section 5.2);
- availability of essential dynamic and static data;
- hydro-meteo, met-ocean conditions, charts and bathymetric data, fishing zones, environmentally sensitive areas;
- marking an area if inside/outside a VTS Area; there should be means to mark such an area, e.g. notice/s to mariners, marking with buoys and transmission of NAVTEX messages (as a minimum);
- availability of (electronic) communication infrastructure on shore (command centres and land-based systems) and on-board, including communication links, dedicated frequency channels and redundancy (satellite communication links, dedicated VHF radio channel, etc);
- identification of vulnerabilities in the ship-to-shore (and vice-versa) satellite communication interface i.e. with the control/command centre ;
- availability of monitoring/supervision infrastructure including radar, lidar, cameras etc.

Where available and if specified by the relevant stakeholder, video, radar, AIS or other recordings of the designated trial area may be made available to the applicant by the Administration for the purpose of the MASS trials (algorithms) during the preparatory phase. Availability of various services, necessary data and back-up solutions in the area should be identified, such as:

- Vessel traffic services (VTS);
- Search and rescue (SAR) services;
- Communications: VHF, Satellite communication (SAT COM), AIS, other communication means (i.e. MF/HF), terrestrial networks (3G/4G/5G);
- Navigational systems: position fixing, other shore-based tracking infrastructure (e.g. coastal radar), intelligent fairway, virtual aids to navigation (AtoN).

5.2 Digital maritime services and support tools hosted by EMSA

EMSA hosts and operates systems and services, with unlimited geographical coverage, that can support in the process of (a) identifying suitable areas for MASS tests/trials; and, (b) during the performance of tests/trials. This support, whether of a more permanent nature or ad hoc,

includes in particular the integrated maritime services (IMS⁶) for (a) and (b); traffic density maps (TDM⁷) for (a); and, automated behaviour monitoring (ABM⁸) services for (b).

Integrated Maritime Services (IMS)

The integrated maritime services of the Union Maritime Information and Exchange System allows Member States that so wish to make full use of the SafeSeaNet Ecosystem Graphical User Interface (SEG⁹) with information from terrestrial and satellite AIS, LRIT, VMS and access to meteorological and oceanographic data, as well as national vessel position data such as coastal radar and Administration's patrol assets.

IMS combines information from the various traffic and monitoring systems capable of supporting the related activities, inter alia, the identification and positioning of vessels (especially if outside T-AIS coverage), the collection of the information specific to the vessel (integrated ship profile), surveillance of traffic in close vicinity, including the detection and information of vessels close by or liable to assist, provision of earth observation satellite imagery, as well as access to relevant met-ocean information.

The SEG also includes the Traffic Density Mapping Service (TDM).

Traffic Density Maps (TDM)

The use of Traffic Density Maps (TDM) is a simple and effective way of displaying vessel movement patterns, which contributes to a better understanding of maritime traffic. The existing SafeSeaNet Ecosystem Graphical User Interface (SEG) includes the TDM service accessible to entitled users.

The TDM service may provide support for establishing maritime traffic density for a relevant area to allow for the identification of possibly suitable trial areas with:

- (a) Less dense traffic;
- (b) More dense traffic at certain time periods; and/or,
- (c) Irregular density of traffic (e.g. due to adverse weather, like ice).

These EMSA hosted services, together with local knowledge and information (e.g. VTS centres, SAR stations) as well as possible infrastructure requirements, are key elements in a first identification of a suitable designated sea area for MASS trials.

Such a suitable area may also, depending on the types of trials, as well as on the risk assessment outcome, be in a more dense traffic area.

Automated Behaviour Monitoring (ABM)

⁶ <http://www.emsa.europa.eu/operations/maritime-monitoring.html>

⁷ <http://www.emsa.europa.eu/related-projects/tdms.html>

⁸ <http://www.emsa.europa.eu/combined-maritime-data-menu/abm.html>

⁹ <http://www.emsa.europa.eu/ecosystem.html>

ABMs are Integrated Maritime Services (IMS) tools analysing position reports for the detection and alerting on specific ships' behaviours.

They are in use in various operational contexts, such as safety of marine traffic, coastal protection, environmental protection, fisheries control, border control, and security.

Patterns, such as a vessel entering an area of interest like a MASS trial area, encounters at sea, approach to shore, deviation from the usual (planned or reported) route, are detected and operators will be automatically alerted in real time via email or through the graphical user interface. There is also possibility to integrate these alerts in the national or local system by connecting via system to system interface.

In the context of MASS trials in trial areas, the purpose would be that such a trial area is 'marked' and an alert goes off should any other vessel enter/sail into the area or, should the MASS leave/sail out from the trial area the same would happen. This would support a higher level of monitoring and better ensure maritime safety even if the trial area is outside a VTS control.

Ship safety zone - ABM

Depending on the type of trial/s the ship safety zone ABM service may also be used (or a combination with an ABM for a test/trial area) for supporting/facilitating the authorities responsible for monitoring. This could become necessary for trials where the risk assessment outcome is a low risk e.g. an otherwise fully compliant vessel is doing some equipment/sensor trials.

It would work in a way that a movable safety zone (or 'bubble') could be virtually created around a vessel e.g. a MASS that would indicate a 'keep out area' around it (same as ABM for a restricted test/trial area but now for the vessel). This may also be a possible way of providing monitoring for more advance stage MASS trials in more dense traffic conditions.

5.3 Limitations

The Administration may prescribe specific limitations/recommendations in relation to the designated sea area, type of MASS/ships, duration of trials and type of trials planned as appropriate. Limitations can concern factors/features such as:

- the ship itself, its behaviour and manning,
- attendance of a guard vessel,
- degree of autonomy,
- number of trial/s in parallel,
- test/trials during the night, during poor visibility whether by day or night,
- seasonal specificities (e.g. adverse conditions),
- type of communication, appropriate level of connectivity, capacity, latency, reliability and redundancy (for the safe conduct of the trial based on degree of autonomy),
- operational environment (coastal, port or open sea area) of the trial are to be provided, and,
- any other specific feature.

In all cases, the Administrations should consider the risk assessment outcome, which may identify other limitations in relation to the specific MASS tests/trials program. Depending on level of autonomy and trials being carried out – initially, especially for navigation tests, including collision avoidance tests e.g. COLREGs tests, an area solely dedicated to the trials (if an area is established within a VTS Area, an area with low traffic density should preferably be selected) to mitigate risks should be considered. As technology evolves and the legal framework is established, areas with increased (conventional maritime) traffic may be considered.

Any such limitations should be clearly specified in the authorization granted by the Administration.

5.4 Administrative procedure/s for authorising tests/trials

The Administration should have in place, based on this guidance, a procedure containing all the necessary steps to file an application, for carrying out tests/trials on MASS systems at sea.

The Administration should, as far as practicable, apply a “single point of entry” for the applicant to file its application.

The Administration should:

- verify that the applicant has filed all the necessary information, including the risk assessment;
- evaluate the risk assessment presented by the applicant;
- if necessary perform a physical inspection prior to the trial;
- on that basis and if positive, grant the authorisation for tests/trials, including in a designated sea area. Any limitations should be clearly specified in the authorisation granted by the Administration.

5.5 Management, monitoring, communication and control - operations

5.5.1 Objectives

The objective is to perform trials in a safe, secure and environmentally friendly manner by using the tools available to the Administration and to the applicant in an efficient and effective way.

5.5.2 Performance Requirements

One person responsible for the entire duration of the trial should be identified (on board - if the ship is manned it may be the Master). The responsible person should evaluate when, if and how the trial may take place within the limitations established by the Administration and the conditions of the risk assessments.

The Administration should under no circumstance take over the command of the ship (MASS) under test/trial. A clear and accessible chain of command and control of the vessel before, during and after the trials, including one contact point, should be established. A plan including measures for emergency situations should be defined for each specific test or test plan.

In situations where there is imminent risk to the safety of navigation, to the marine environment and to human life or property, the Administration must take the necessary steps to demand the immediate termination or suspension of the trial to the (applicant) Contact Point.

A plan may cover trials for various technologies and for different scopes such as navigation tests, obstacle/collision avoidance, mooring trials, manoeuvrability in open waters or close to a coastline, communications trials, sensor trials etc.

5.5.3 Operational requirements for VTS in MASS trials

For the VTS function:

While the applicant has the uninterrupted responsibility for the trial, the VTS should be actively involved in all stages of the trial process, depending on the case from application stage to the debriefing meeting. VTS should be provided with relevant data relating to MASS and the typology of trials that are planned to be carried out. VTS, depending on the risk assessment and type of trials, should have the ability to:

- Communicate directly with other ‘conventional’ traffic that may be affected by the trials;
- Supervise the trials;
- Promulgate any information related to the trial/s within the VTS area to ‘conventional’ vessels that may be affected by the trial (information, warnings, instructions, etc.);
- Order the responsible to stop the MASS from carrying out the trial/s if need arises.

VTS should further have the ability to:

- Verify that MASS is able to interact with VTS;
- Maintain direct-link communication with MASS, shore-based control operator, contact point responsible and all other parties within the VTS area directly/indirectly affected by running of the trial;
- If the test area is established in a VTS area or the MASS using a ship safety zone is operating in a VTS area, the VTS personnel should have the required level of qualification and receive appropriate specialized instruction¹⁰.

For the systems:

- AIS messages;
- VHF – as specified by Appendix 18 of the ITU Radio Regulations;
- Satellite communications - i.e. as determined by the MASS command centre;
- Mobile phone number is provided;
- Depending on the GMDSS Sea Area in relation to the designated sea area as well as type of test/trial, different equipment may be required on-board (e.g. DSC, Satellite communication equipment, MF, EPIRB, etc.) as appropriate¹¹.

Referring to the five existing associated IALA model courses (V103/1 to V103/5 included in the IMO MSC.1/Circ.1065/Rev.1 “IALA Standards for training and certification of Vessel Traffic Service (VTS) personnel” and any other relevant training for the VTS personnel that could ensure that MASS trials are being conducted in a safe and secure way within a VTS area.

¹¹ Preferably by using digital communication facilities standardized interfaces.

5.6 Responsibilities before and during test/trials

The Administration should inform the applicant about the designated test area or safety zone around the ship for MASS trials, the application process and make available any characteristics for ensuring safe, secure, and environmentally friendly test/trials to all relevant stakeholders.

The Administration retains the authority to intervene in emergency situations (responsibility of Coastal State) in particular to demand stopping the trials, or to make changes to the test program, by using the (one) Contact point as provided by the Applicant. This is particularly important when the trials are being conducted within a VTS area or a MRS operational area.

The Administration should verify that all the preparatory work prior to the trials has been conducted as required.

The Administration may:

- take the opportunity, using the occasion of MASS trials at sea, to explore future operational and technical capabilities of its own systems and communication channels involved in the assessment of the technology used for safety purposes by the relevant stakeholder during MASS trials;
- allow representatives of the Administration to be present during the trials and to gather data on the behaviour of MASS in order to develop policies for future MASS operations and to harmonize such policies internationally, while ensuring that the impact is kept minimal on other vessels in or nearby the designated test area; and
- allow test area(s) to be used by any flag under the same procedures, unless the Administration has specified such limitations.

6. ACTIONS TO BE CONSIDERED BY THE APPLICANT

The Applicant should establish a clear and accessible chain of command and control, in particular for intervention in emergency situations of the MASS before, during and after the trials.

The Applicant shall cooperate fully with the Administration(s).

It is critically important for Administrations to have all and accurate information in a timely manner, as this will assist in making the assessment leading to correct decisions.

It is therefore imperative that commercial interests do not prevent the Administration from having access to all relevant and accurate data or from taking the required decisions to safeguard safety of navigation, the environment, life and property.

When filing a request for MASS trials at sea the Applicant¹² shall submit a risk assessment (see Annex II) including, but not limited to, type of trials to be conducted, associated risk, risk level including mitigating actions, test plan, scope, duration, repetitions, MASS and other assets involved. Where third party verification of the risk assessment is needed, the process and third party verifier should be mutually agreed between the applicant and the Administration.

¹² If the Applicant is part of a consortium (e.g. industry or academy), the request should be submitted by the consortium leader.

The Applicant should, *inter alia*:

- provide the levels of automation/autonomy of the MASS¹³; list the functions ‘normally’ done by crew to be replaced by technology under the trial.
- provide a description of the type of technologies intended to be used for communication, control and automation;
- specify if the trial is carried out in its own line of sight or beyond the line of sight from the control and command position;
- provide the line of command for the vessel/s carrying out the trials;
- specify how the communication and control is maintained with the MASS, also specifying the location of the Contact point and of the Operator, as well as of the officer on watch;
- ensure that any personnel involved in MASS trials, whether remote or on-board, should be appropriately qualified and experienced to safely conduct MASS trials;
- provide effective emergency plans describing the measures put in place to ensure redundancy and/or in providing mitigating measures, e.g. in case of communication or control link break down, in the event of adverse external environmental conditions in the trial area (deterioration of weather conditions, and/or the system being suitable in daytime only etc.), to minimize risks and reduce the impact of any foreseeable incidents or failure during the MASS trial.
- provide a cyber risk management plan (in place) where the applicant should demonstrate that the systems being tested provide for an adequate level of cyber-security with measures in place to prevent and counter cyber-attacks, ensuring continuity of the planned operation(s);
- lay-out the trial time schedule with date(s) and time(s) when the tests/trials will begin and end and if there are any specific intervals when no tests/trials will be conducted;
- arrange proof of insurance coverage, adequate or specific third-party liability insurance cover or equivalent financial guarantee (Directive 2009/20/EC on the Insurance of ship-owners for Maritime Claims);
- provide a Marine Salvage plan, specifying the process of rescuing, repairing and re-floating the MASS, and crew (if manned) and other properties from unforeseen imminent peril.

If the ship carrying out the trial is remotely controlled, the Applicant should also specify how to maintain control of the ship and how the roles and responsibilities between the ship and the on-shore control centre during the trials are established and exercised. This includes the need to make available in the area, during the trial, a support/tender vessel capable of intervening and abortion of operations, in the event of total loss of the control during the trials.

In all cases, the Applicant should make one contact point available and reachable at all times during the trials, having the authority to suspend/abort the trials.

¹³ For the time being the levels that are normally used are those of the IMO RSE. Other levels may be used, but should then be described in detail. Levels may need to be updated and aligned once definitions have been decided.

6.1 MASS – the Ship

6.1.1 Objectives

Compliance with the intent of mandatory instruments should be ensured as stipulated in MSC Circ.1604, paragraph 2.2.1 and 2.2.2 and supported by the relevant risk assessment.

The Applicant should demonstrate the ability to maintain meaningful human control at all times during the tests/trials, and have the ability to abort the tests/trials, as well as ensuring consistency with the results of the risk assessment.

6.1.2 Characteristics and Requirements

Main characteristics of the ship under test/trial should be specified by the applicant, including the applicable level of automation/ autonomy of the MASS and/or provision of remote control for the ship.

Type of equipment installed, as well as ship particulars, such as speed, propulsion system, signalling lights, on-board sensor systems (sensor monitoring and sensor networks), anti-collision software, control algorithms, object recognition, etc., should conform with best practice and applicable standards, be specified in the application form and considered in the risk-assessment.

The Applicant must, in accordance with requirements of the Administration and taking into account section 6.1.1, submit valid certificates related to the ship in operation that fall within national legislation and/or under international conventions and instruments.

Information should be made available to allow the flag administration to issue, where necessary, any equivalence and/or exemptions and/or permit to operate during the trials including the size of the ship safety zone. Authorisation should also be obtained from the coastal State and/or port State authority where the trial will be conducted. Parties should endeavour to cooperate ensuring the overall objectives of these guidelines

The ship(s) or the Administration may require the establishment of a ship safety zone around it/them (as per IALA Guideline 1070 - VTS role in managing restricted or limited access areas) when underway and/or during tests/trials. This should be taken into account in the description of the risk assessment by the Applicant especially when undertaking tests/trials among conventional traffic (mixed traffic).

Additional safeguards may need to be in place to ensure the system's integrity throughout the various levels of automation/autonomy.

The 'operators' appointed by the applicant guiding and/or supervising the specific MASS trials/tests, no matter if they are on shore or aboard, should have the certifications required by national/international regulation for the ship in question.

The Applicant for the MASS under test should be able to:

- demonstrate how an equal level of safety to its 'conventional counterparts' and in relation to the applicable instruments or Conventions can be achieved.
- bear additional marking, lights and daylight shapes as applicable;

- provide information to other maritime traffic by using the appropriate nautical publications, as well as AIS, VHF, NAVTEX, others as applicable.

The Applicant should verify the VTS awareness¹⁴.

If a MASS intends to navigate both outside and within VTS areas, as the case may be, it must be able to communicate and operate as all other vessels according to the international radio regulations, including communication with the VTS centre (by using the VHF working channels). If the trial is conducted for an unmanned vessel, communications have to be done indirectly from the MASS control centre using the appropriate VHF channels (and possibly with a radio repeater installed on the MASS to reflect reality).

6.3 Responsibilities during tests/trials

The applicant shall carry out trials efficiently without risking the safety of maritime traffic or any possible adverse effect on the environment.

The applicant should provide a valid insurance certificate¹⁵ (P&I and H&M, as applicable) or equivalent financial guarantee.

The Applicant shall provide a procedure for the management of emergency situations specifying how the trials can be aborted at any time and to gain, at the same time, full control of the vessel (by stopping it, or controlling its course and speed).

The Applicant should also have a pollution response plan in place to address any pollution incident or loss of the vessel, including means of salvaging the vessel (such as tugs), deal with any emergency situation or recovery of a wreck. A specific procedure on this issue should be put into place before the start of trials, and be included in the emergency plan and agreed upon by the Administration.

The applicant should have the ability of performing visual and audio recordings (CCTV, Radar, AIS, VHF, Satcom, etc) to collect information that can be evaluated (*c.f.* chapter 7).

7. REPORTING REQUIREMENTS AND INFORMATION SHARING

The test plan should include meetings between the applicant, other relevant stakeholders and the Administration as deemed appropriate.

Test reports and relevant documents, without prejudice to commercial sensitive information, should be made available to the Administration for the purpose of evaluating and assessing the results in view of future use of the area, and in view of developing policy for MASS operation.

The following documents should be used as guidance for reporting on MASS trials:

- IMO MSC.1/Circ.1494 Guidelines on harmonization of testbed reporting; and
- IALA Guideline 1107 “*PLANNING AND REPORTING OF e-NAVIGATION TESTBEDS*” (Harmonisation and Reporting of Testbed Results (Chapter 5)).

¹⁴ IALA Guideline G1149 on VTS training for deck officers [A new recommendation to this guideline will be finalised at VTS49 which will be named: IALA Recommendation (Rxxxx – number to be assigned) - Marine Aids to Navigation awareness for mariners.]

¹⁵ it may be a temporary such but should then cover from starting point to end point, e.g. certificate of insurance or other financial security in respect of civil liability for oil pollution damage (SOLAS Annex 1).

A final report containing conclusions and an assessment of the trials conducted should be shared with / submitted to the Administration. The final report should contain information such as how the trials met the intended trial objective(s); and may contain statistics regarding sailed time and distance (nautical miles); description of manoeuvres including a description of the circumstances when human intervention was necessary to bring the vessels back to safety; the trial plan, general characteristics of the assets involved, and, degree of autonomy in relation to the specific tasks, etc.

Relevant parts of the reporting on the trial(s) conducted may also be shared with other interested parties, subject to the consent of the applicant that performed the trial.

All stakeholders involved in trials are encouraged to share relevant dynamic and static data for machine-to-machine communications during the trial, without compromising business secrets, to enable safe, secure and environmental-friendly trials.

8. BACKGROUND DOCUMENTS

- [1] MSC Circ.1604
- [2] MSC 99/INF.13 submitted by Finland: Establishing international test area "Jaakonmeri" for autonomous vessels;
- [3] MSC 100/5/2 submitted by Norway: Interim guidelines for MASS trials;
- [4] Maritime Autonomous Surface Ships: UK Industry Conduct Principles and Code of Practice (2018);
- [5] Discussions at INAS Test Area Workshop, Busan, 2018;
- [6] published reports from the High Level Steering Group for Governance of the Digital Maritime System and Services Ad hoc Expert Sub-group MASS,
- [7] EU PoR Operational Guidelines;
- [8] REF MSC-MEPC.2/Circ.12/Rev.2
- [9] IALA Guideline No. 1070 – VTS role in managing Restricted or Limited Access Areas
- [10] IMO MSC.1/Circ.1494 Guidelines on harmonization of testbed reporting
- [11] IALA Guideline 1107 PLANNING AND REPORTING OF e-NAVIGATION TESTBEDS
- [12] Standards for relevant maritime software
 - EN IEC 63154:2020 (Draft)
 - Industry Standard on Software Maintenance of Shipboard Equipment (Version 1.0) produced by the CIRM/BIMCO Joint Working Group
 - relevant generic ISO/EN/CEN/CENLEC standards for development and testing of OT system software
- [13] Directive 2009/20/EC on the Insurance of ship-owners for Maritime Claims
- [14] IALA Guideline G1149 - VTS training for deck officers

ANNEX I – Content of Application

This Annex provides an example for developing comprehensive and relevant documentation when applying for MASS trials. The section may set out aspects of intended operations, authorisations, liabilities and responsibilities, reporting and safety cases.

Application:

Applicant:

- Name, address, ship owner, operator, home port
- Contact point: email, phone

- Administration:

Applicants are advised that local, regional, national authorities as well as VTS operators may participate in the decision-making process. These competent administrations may also request the power to stop the trials.

- Envisioned level of presence of authorities
- Other authorities to be involved (including military Administrations if relevant)

- Type of test applying for:

- New sea area to be designated, or
- Existing specified designated sea area for trials
- Ship Safety Zone around the ship/ship-centric sea monitoring zone is specified for a specific geographical area or routes (the trial area is the ship itself and a ‘bubble’ around her kept under strict watch at all times)
- Other (to be described by the Applicant)

- Purpose of test and duration

- Type of vessel:

- Full size, or Reduced scale (model)
- Level of automation/autonomy (as per MSC.1/Circ.1604, MSC100-WP.8))
- Main characteristics
 - name, IMO/MMSI number, ship particulars, draught, maximum speed, propulsion system, fuel, signalling lights, sensors, communication and navigational equipment, specific design features, etc
- Type of equipment installed and used for the trials
 - vessel itself
 - behaviour
 - manning
 - communications (see below)
 - alternative solutions for the purpose of the trials requested by the Applicant (provided that the Applicant can demonstrate to maintain effective human control at all times during the trials)
 - additional type of equipment if any, additional or original use

- Software (*c.f.* Chapter 8 [12])
 - customary certificates (submitted with the application)
 - meet the intent of COLREG requirements
 - bear special marking, also with lights and daylight shapes for limited manoeuvrability
 - provide notifications for other maritime traffic by using one or more available instruments such as AIS, VHF, NAVTEX, RADAR, and COLREG signalling
 - insurance company, policy number
 - support vessel characteristics
- Geographical identification of the designated sea area
- Sufficient number of coordinates to establish a closed perimeter
 - Area already used by other applicants?
 - Area open or closed to other maritime traffic?
 - Other activities in the designated sea area (also seasonal. Name stakeholders, if possible)
 - Specific relevant information about the designated sea area (structures, restrictions, hydrographic/weather patterns/sea conditions, environment, ...), previous permissions as available
 - Marking
 - marking with buoys maybe sufficient
 - notices to mariners
 - mark the area on nautical charts
 - notification with various instruments such as AIS, VHF, NAVTEX, COLREG signalling
- Communications and supervision
- Availability of electronic communication infrastructure on shore and on board
 - Vessel Traffic Services (VTS)
 - IMO adopted Ship Reporting Systems (SRS)
 - AIS, dedicated VHF radio channel, SAT COM (details on the satellite-based communication network), MBR, Radar, Lidar Cameras, Mobile phones, characteristics of data link
 - Details on the telecommunication systems used by on-shore based crew controlling the MASS trials i.e. operational commands;
 - Cyber-risk management plan (see below)
 - Main command and control station
 - Location
 - Contact details
 - Control link type
 - Frequency
 - Declaration on operator license and certification

- Other measures taken such as Cyber Risk management plan addressing also potential technological defences to deter cyber-attacks during the MASS trials, etc., or secondary means of positioning in the event of GPS failure/jamming.
- Test plan
 - Scope (e.g. obstacle avoidance, mooring trials, manoeuvrability in open waters, close to a coast line etc.)
 - Duration
 - calendar dates, specific location
 - single test session or unlimited for the same kind of experimental set-up
 - Number of repetitions
 - Vessels involved
 - Type of technologies (activities)
 - In line of sight or beyond
 - Financial guarantee/liability
 - Chain of command and control within the applicant organization (before, during and after the trials)
 - If at a model scale, how is the control link maintained with the MASS model vessels? (Is the Operator placed on a support vessel/on shore/ ...)
 - If an actual full size MASS vessel, how is control of the vessels maintained?
 - Division of roles of the master and control centre.
 - Consequences in the event of a failure of command and control datalink
 - Precautions (consider safety of crew, environment, ship and other vessels/vehicles). Availability of means to recover the MASS if there is a failure
 - Contact point responsible (see above)
 - Measures for emergency situations/ emergency procedure
- Reporting
 - Information such as sailed time and sailed nautical miles, the description of the manoeuvres including the description of the circumstances of when the human intervention was necessary to bring back to safety the vessels, the description of the trial plan, general architecture of the assets involved, level of automation/autonomy in relation to the specific tasks, etc. should be reported to the Administration.

The Administration may prescribe general and specific limitations to any of the above aspects (e.g. based on GDPR).

The Administration may make available on voluntary basis information relevant for the safe and sound conduct of the trials to relevant stakeholders.

ANNEX II – Principles for Risk Assessment

Main principles

Risk assessment for MASS tests/trials at sea is specific for the combination of equipment/ship/test area and test plan. Several risk assessment techniques may be suitable for MASS tests/trials¹⁶. The purpose of this Annex is to highlight the main elements that a risk assessment should address, irrespective of the technique used.

The technique used should be acceptable to the Administration and suitable to assess the risks arising from the specific tests/trials. An acceptable technique and consequent results obtained by applying such technique includes also the identification of non-tolerable risks, without implying that such risks, if identified, are acceptable.

Risks assessment for MASS should be understood in a wider sense and it should include all the stakeholders in the chain and the ways on how they may be impacted.

Particular emphasis should be put on the initial phase of the safety assessment (Screening approach as per in REF MSC-MEPC.2/Circ.12/Rev.2, para 3.1.2), to calibrate the application of the methodology to be commensurate to the specific request at stake, focussing only on issues relevant to the specific situation to be analysed, under the ‘as low as reasonably practicable and acceptable’ principle.

As stipulated in MSC.1/Circ.1604 as approved by MSC 101, (2.1), particular regard should be given to appropriate and effective emergency plans and measures should be established based on the results of the risk assessment to reduce the impact of any foreseeable incidents or failure. Trials safety should be continuously evaluated, and trials should be suspended or stopped where safety parameters are exceeded.

Risk Assessment - Main elements and steps for the applicant

Phase 1

- Qualification of the personnel carrying out the risk assessment.
- Description of the test area and analysis of the marine traffic, establishing traffic density in the area.
- Preliminary hazards identification.
- Navigational risk assessment and general navigation risks (loss of control, collision, groundings).
- Identify issues which could pose a cyber-threat or a risk to the communication systems and links, on-board software, and bridge systems (including propulsion and machinery management and power control systems which will be remotely controlled).
- Other risks that may be identified in the risk assessment process.

¹⁶-This Annex is subject to updating as appropriate when relevant EU funded research and studies on risk assessment related to MASS operations become available

At the end of this phase, the Applicant should have established whether or not there are risks for which a deeper analysis is needed. The results of this screening should be submitted to the Administration.

Phase 2

- Hazard(s) identification (such as time constraints to operate, over-reliance or distrust in automation, skill degradation, operator not detecting the situation, mode confusion.)
- Risk assessment - The Risk Assessment should include an estimation of direct and indirect consequences of potential failures, such as:
 - Grounding
 - Collision with a fixed or a floating object
 - Communication equipment and links signalling, electrical power, sensor and IT systems breakdown
 - Cyber security (data communication breach, spoofing, etc.)
 - Data inconsistency, failure in automated decision-making
 - Machine, power, steering or propulsion breakdown (becoming an obstacle to navigation of other vessels)
 - Fire and stability problems
 - Pollution, such as leakage of harmful substances etc
- Other cases specific to the type of MASS
- Hazard list
- Risk control and mitigation measures

Risk Assessment - Main elements of consideration for the Administration

The Administration may verify the risk assessment analysis of the applicant:

- Safety requirements have been correctly identified,
- Which rules have not been complied with and how safety has been addressed,
- Acceptability of risk and corrective actions to bring risk into tolerable regime,
- Reasoned arguments.

The risk assessment analysis presented may be:

- Approved,
- Approved with certain additional conditions,
- Request of more information – on hold,
- Reasoned opinion – resubmission.