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# DEVELOPMENT OF A GOAL-BASED INSTRUMENT FOR MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

## Results of Maritime Autonomous Surface Ships (MASS) trials conducted in the Russian Federation in 2021

**Submitted by the Russian Federation**


| SUMMARY | |
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| *Executive summary:* | This document provides the report of Maritime Autonomous Surface Ships (MASS) trials conducted in accordance with the *Interim Guidelines for MASS trials* in the Russian Federation in 2021 and presents the results and considerations of the trials. |
| *Strategic direction, if applicable:* | 2 |
| *Output:* | 2.23 |
| *Action to be taken:* | Paragraph 17 |
| *Related documents:* | MSC.1/Circ.1604; MSC 102/5/29 and MSC 103/5/9 |


## Introduction

1 This document is submitted in accordance with the *Interim Guidelines for MASS trials* (MSC.1/Circ.1604). It provides information on the results of the MASS trials and proper considerations regarding the issues on the further development of autonomous navigation (a-Navigation).

## Background

2 The Maritime Safety Committee, at its 101st session, approved the *Interim Guidelines for MASS trials* (MSC.1/Circ.1604) with the aim to assist relevant authorities and stakeholders by ensuring that the MASS trials are conducted safely, securely, and with due regard for the protection of the environment.

3 In March 2020, the Russian Federation informed the Committee about the Autonomous and Remote Navigation Trial Project (ARNTP), implemented as part of the "MARINET" road map of the National Technology Initiative with support of the Ministry of Industry and Trade of the Russian Federation and with the involvement of the Ministry of

Transport of the Russian Federation and Russian Maritime Register of Shipping (MSC 102/5/29). The project aimed to develop and test a universal set of technologies for MASS on different commercial vessels with different levels of current automation and with various operation conditions. The general purpose of the project was to open a wide MASS trial operation by shipping companies under the flag of the Russian Federation in accordance with the developed national legislation for conducting of trials and subsequent operation of MASS.

4 The project involves the following commercial vessels by the major Russian shipping companies: **MV Rabochaya** (motor barge owned by "Rosmorport", IMO: 9838371, MMSI: 273436710, home port: Saint Petersburg, project: HB900, operating in the Black Sea and the Azov Sea together with "**Redut"** dredger), **MV Pola Anfisa** (general cargo ship owned by "Pola Rise", IMO: 9851115, MMSI: 273448220, home port: Saint Petersburg, project: RSD-59, currently operating in the Black Sea) and **MV Mikhail Ulyanov** (shuttle tanker owned by "SCF", IMO: 9333670, MMSI: 273328440, home port: Saint Petersburg, project: R-70046, operating in the Barents Sea).

5 During the project, the comprehensive set of a-Navigation systems for high seas (including autonomous navigation system, optical surveillance and analysis system, coordinated motion control system and remote control station) was developed and installed on board the vessels with the proper integration of the existing navigation and engineering systems. Preliminary tests of the systems were conducted ashore using dedicated simulators (including simulations based on the various field data gathered from the vessels during the first stage of the trials). Trials of automatic and remote operations of ships under the crew's supervision and additional control by the shipping company started in February 2021. The Russian Federation provided the interim results of the trials to the Committee in March 2021 (MSC 103/5/9).

6 Through the present document, the Russian Federation informs the Committee on the results of the trial operation conducted in 2021 as prepared by the "Autonomous navigation technologies promotion centre "MARINET RUT".

**General results**

7 The trials conducted in 2021 within the ARNTP aimed to test a-Navigation technical solutions and methods of their implementation not for single experimental voyages, but during continuous operation as part of regular commercial voyages. In addition to the technical details provided in document MSC 103/5/9, this document represents the general results that have been obtained since February 2021 during 28 commercial voyages with a-Navigation systems used.

8 The trials programme includes remote operation (via remote control station (RCS), with permanent contact with the supervising crew on board), automatic navigation (using autonomous navigation system under the supervision of the crew on board and additional control by the remote operator) and automatic navigation in heavy traffic areas. While the implemented approach supposes a symbiosis of automatic, remote, and manual modes of control during the same voyage, depending on the situation, the trials of remote operation and automatic navigation were split to get more clear results about the implementation of each specific system.

9 The trial programme has been completed by **MV Rabochaya**, and currently, "Rosmorport" is continuing experimental use of a-Navigation systems on board **MV Rabochaya** in its regular operation. The trial programme on **MV Pola Anfisa** is near completion and is planned to be fulfilled in March 2022. The trial programme on **MV Mikhail Ulyanov** is postponed due to the requirements for a planned upgrade of the existing systems connected to the a-Navigation systems and to be continued in 2022.

10 The trials of remote operation were made from February to April 2021 and indicated that a remote operator can provide watchkeeping and control of MASS in normal conditions in high seas at the same level of safety as a navigator on board. The major issues limiting a broad commercial use of the remote control concern telecommunication reliability and night vision:

.1 Reliable telecommunication between the RCS and the controlled MASS is vital for remote operation: even a few-seconds break during manual maneuvering by a remote operator may cause danger for safe navigation. While there are WiMAX and LTE technologies available for a short distance (up to 25 miles) that can provide a sufficient level of reliability, it is obvious that the only option for long distances is satellite communication. The standard level of sea mobile satellite services hardly maintains the required reliability, so it is necessary to agree with telecommunication providers on specific services for MASS remote operations at significantly higher costs.

.2 Currently, the only way to provide a sufficient level of visual observation by a remote operator during nighttime is to use thermal cameras. This will substantially increase the equipment price for autonomous ships and require the remote operator to have dedicated skills in environment assessment relying on infrared images. It should be additionally mentioned that currently, there are no remotely operated marine radars, while the only data transmission from onboard radar to RCS is not enough to ensure functional equivalence to the navigator on the bridge. While most engineering systems installed on ships with unattended machinery spaces can be controlled via RCS, the currently used marine radars do not have such functionality.

11 The trials of automatic operation have been conducted since February 2021 in combination with remote control and since May 2021 with the only use of automatic control. The overall duration of automatic navigation during the trials in 2021 was more than 100 hours during different voyages. The general results of the trials, with some reservations, indicate that in normal conditions an automatic navigation can provide the same level of efficiency as human control, and the autonomous navigation system mostly can recognize on its own the situations when the automatic control is restricted (as it is prescribed by the Recommendations on COLREGs applications for MASS use by the Federal Agency of Maritime and River Transport of the Russian Federation). At the same time, it is currently inferior in quality to control by a highly qualified navigator. The major issues relate to non-standard situations:

.1 Collision avoidance algorithms based on direct COLREGs provisions are properly working in standard situations while in non-standard cases (with various possible interpretations of the COLREGs provisions, especially in heavy traffic areas) either human control or algorithm based on "good seamanship" is required. Since currently there are no common formal explanations of the "good seamanship", this opens a way for different approaches for collision avoidance in non-standard situations by various manufacturers, which may lead to risks for safe navigation.

.2 Since automatic control is limited in some circumstances, it is necessary to plan in advance when during the voyage a human control (either by the crew on board or a remote operator) might be required. Such planning is one of the new competencies for seafarers operating MASS.

.3 Understanding of signs and triggers of non-standard situations when automatic control is restricted, or its efficiency is limited, as well as failures of a-Navigation systems, is another important new competence for seafarers operating MASS. Also, this shall be reflected in the Safety Management System of the shipping company operating a MASS.

.4 Integration of a-Navigation systems with the existing control systems on board retrofitted conventional vessels could be challenging since the last ones are not designed for control by external computer systems. That requires implementation of integration on case-by-case scenario with potentially necessary changes in the existing systems, which increase complexity and cost of implementation of a-Navigation on retrofit vessels.

**Considerations based on the results**

12 The results of the MASS trials can indicate that from the point of view of seafarers, shipowners and Administration, a MASS can be considered as a conventional ship, but with more capabilities of supervision and control options. The shipowner and the master continue to play their roles as responsible persons while the options available allow them to use autonomous and remote control means to add or replace the traditional ones in the cases when safety and efficiency of shipping can be increased. Also, triple supervision on board (automatic systems, remote operator and crew onboard) can substantially increase safety, especially on large passenger ships and ships carrying dangerous goods.

13 The implementation of the principle of full functional equivalence, including the compliance with the current COLREGs requirements, provides that other participants in navigation do not need to pay any special attention to MASS. From the point of view of other navigators, such MASS do not differ from the conventional ships in terms of interactions that ensure their coexistence within the current safety regulations as well.

14 At the same time, for the effective development of a-Navigation, it would be reasonable to contribute to the enhancement of the safety regulations for all vessels by formalizing "good seamanship", which will allow avoiding risks identified in paragraph 11.1 and improve seafarers' training and also by expanding mandatory AIS use to all ships and offshore platforms/constructions. Such an approach will substantially improve the situation awareness not only for MASS, but for conventional ships and monitoring services as well. Also, sharing of the real-time information on MASS maneuvers via AIS (VDES) with other autonomous and conventional ships could be a promising opportunity for safer and more transparent MASS operations.

15 Use of MASS will require new competencies and standards of seafarers' training, first of all on technical means of a-Navigation and non-standard situations requiring human interference. This should be based on a practical experience and with the involvement of the universities and training centres into the actual experience of MASS operations by shipping companies.

16 The practical experience has also allowed defining a number of further tasks for control systems to be automated. In the future, such automation of control systems could be applied and expand the experience of highly skilled seafarers, the experience that is currently not only not formalized, but missed by the majority of average seafarers, for example, impact of slamming, understanding of changing of vessel parameters depending on the load, assessment of subjective manner of navigation of surrounding ships, etc.

**Action requested of the Committee**

17 The Committee is invited to take note of the information regarding MASS trials in the Russian Federation for the benefit of MASS trials worldwide.