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

Draft Interim guidelines for MASS trials

Submitted by Finland, Japan, Norway, Republic of Korea and BIMCO

SUMMARY

<i>Executive summary:</i>	This document informs on the work carried out intersessionally and contains in the annex the initial draft interim guidelines for MASS trials
<i>Strategic direction, if applicable:</i>	2
<i>Output:</i>	2.7
<i>Action to be taken:</i>	Paragraph 4
<i>Related documents:</i>	MSC 100/20 and MSC 101/5/5

Background

1 The Maritime Safety Committee, at its ninety-eighth session, agreed on an output for the "Regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS)", with a target completion date of 2020. MSC 99 gave preliminary consideration to the Interim guidelines for MASS trials and invited interested Member States and international organizations to, inter alia, submit proposals to MSC 100 related to the development of interim guidelines for MASS trials (MSC 99/22, paragraph 5.27.2), with the aim of establishing a harmonized international framework to test MASS operations.

2 In the period between MSC 100 and MSC 101, the submitters have worked together with other interested members and organizations and prepared the initial draft interim guidelines for MASS trials.

3 The draft has been based on the structure proposed in MSC 101/5/5 and can be found in the annex.

Action requested of the Committee

4 The Committee is invited to note the information provided, together with the annex, in conjunction with the discussions on document MSC 101/5/5.

ANNEX

INTERIM GUIDELINES FOR MASS TRIALS

1 Introduction

[With the increasing levels of automation of systems and equipment on board ships operating in international waters and the concept of Maritime Autonomous Surface Ships (MASS), there is an associated increase in need for trials of such ships prior to them being put into operation. Given the risks associated with trials of MASS, in particular with 'higher' levels of autonomy, it has been determined that guidelines for such trials are necessary.

Accordingly, these guidelines are provided to assist with the development of procedures for, and the execution of, MASS trials in such a way as to minimise risks to life, property, and the environment.]

1.1 Aim

These guidelines have been developed to assist authorities, industry and other parties involved in trials of MASS. The intention is to provide minimum prescriptive guidelines for safe, efficient and transparent trials of MASS.

[or]

[These guidelines are intended to be a reference and a guide for good practice in conducting trials of MASS operations. The purpose of these guidelines is to ensure safe, secure and environmentally sound operation of MASS. The guidelines are generic and allows for flexibility, taking into account the uniqueness of MASS trials.

These guidelines are not intended to replace any existing or specific national or regional instruments however, they may be used in conjunction with those other instruments.]

1.2 Scope

The execution of autonomous trials requires demonstration of precautions and requirements that fulfil a safety level which is equal to or higher than that achieved during conventional operations and sailing conditions. A trial may be defined as one singular dedicated voyage from berth to berth, or one from a dedicated geographical point to another being considered as the end of passage (end coordinate).

These guidelines have been developed to assist authorities, industry and other parties involved in trials of MASS. The intention is to provide minimum prescriptive guidelines for safe, efficient and transparent testing of MASS and they are mainly goal based and contain few technical details.

These guidelines only cover possible additional requirements that arise due to the automated operation of ships.

Port formalities related to customs, immigration etc. are not covered in these guidelines and equally ISPS is not included.

These guidelines are mainly intended for single trials and are not intended to form a basis for regular shipping operations, neither are they developed for specific test areas, but they may be used in the development of operational procedures for such.

(Alt.1a)[These guidelines have been developed for ships that fall under IMO instruments, but may also be used for other ship types]

Or;

(Alt.1b) These guidelines may be applicable for all ships in international waters]

1.2.1 Geographic areas

These guidelines are not intended to cover issues that are under the control of port or port State authorities. Coastal State authorities should also be given attention.

Accordingly, while recognizing that these guidelines will in general be useful for all authorities, one needs to recognize that local (port, coast) may have more extensive and area specific requirements that need more specific addressing.

[There may also be instances that some port states may decide to NOT accept these guidelines, in which case, the regulations or specific port State guidelines should be followed.]

1.2.2 Level of autonomy

Taking into account the development of different levels of autonomy, these guidelines are written to be independent of the ship's level of autonomy and therefore specific degrees of automation are not considered. There is also an assumption that the autonomous ship under trial has some automatic functions, replacing corresponding human responsibilities, that prevent compliance with current rules and regulations.

(Note: Should human responsibilities be addressed in the guidelines?)

1.3 Structure of the document

Four phases: Preparatory[3], Permissions[4], Execution[5] and Post-mission[6]
Appendices are examples of how things can be done,

2 Definitions

To be developed

3 Preparatory phase

3.1 [Definition] [specification] of management and responsibility

The MASS trials documentation should specify the parties involved and respective responsibilities of the parties. The Company should designate a responsible person for the operation in advance to ensure the safety of the operation. The designated person should have authority to change or interrupt the test activities, under the overriding competence of the responsible/competent authority (see appendix 3). Emergency response should be a part of this specification (see ch. 4.4 and appendix 13).

Internal reporting procedures.

[3.1bis Documented responsibility

Prior to commencement of the MASS trial, the parties involved and their respective responsibilities should be clearly defined. Achievement of this should be by way of a documented and repeatable process that determines Administrative structure, who is/shall be:

- responsible – for execution of the work and taking operational decisions;
- accountable – ultimately responsible for the overall completion of the task;
- consulted – the person, role or group expected to provide information necessary for the completion of the task;
- informed – people or groups to be kept up to date on the task, its progress, and potential impacts upon them including internal reporting procedures.
- decision making structure.
- supervision; and
- control on ship, following ship and on shore.

3.2 Test plan for voyage and phases

Specify what the ship will do throughout the trial in different phases. For each phase describe:

- General description of phase and operations (simplified ConOps), e.g. for following phases:
 - Departure and arrival
 - Near coast operation
 - Channel operation, inland waterways
 - Open sea operations
 - Ship to ship operations
- Operational constraints for each phase
 - Expected geographic and traffic situation
 - Limitations in operational parameters, weather and visibility issues (forecasts).
 - Area and/or time related restrictions (must be checked with relevant authorities)

Exemptions

- (alt 2a) Where compliance with prescriptive mandated regulations is not achieved, an equivalent means of compliance for the purpose of trial should be demonstrated to meet the objective of the mandatory instrument

OR

- (alt 2b) [equivalent arrangements described and communicated to relevant stakeholders]

3.3 Develop operation principles

In general, a ship that intends to proceed on an autonomous trial (voyage or part of voyage) should be equipped and suited for the intended sailing passage (Voyage) as a conventional ship. Seaworthiness and sufficient manning (*dependent on degree of automation*) should be accomplished at any time of the planned route or trail.

For each phase the following should be considered:

- Identify possible support functions in infrastructure (see also appendix 4)
- Manning level on ship and/or support ship and/or shore etc.
- Required sensors, automation and communication
- Human factor issues, sufficient situation awareness, skills and knowledge
- Ensure adequate supervision and backup control from ship and/or shore
- Infrastructure [**may/should be considered in appendix 4: Possible infrastructure support**]
 - o Communication – Adequate communications to support safe operations – The competent authority and industry operator should ensure that any communications infrastructure established to support MASS trials should be sufficient, and contain appropriate redundancy to ensure the safe, secure and environmentally sound conduct of the trials.
 - o The competent authority should ensure that the operator;
 - establishes an appropriate level of infrastructure to provide for the safe, secure and environmentally sound conduct of MASS trials.
 - [of MASS] takes reasonable steps to ensure all waterway users are informed of any MASS trials. In ensuring mariners are aware, the geographic area should be selected and defined so as to reduce the unsafe encounter with other vessels.
 - Have established an adequate cyber management and takes appropriate steps to enhance the cybersecurity of the systems and infrastructure used in the trials of MASS. Such steps should align to best practice and reduce, to as low as is reasonably practicable, the chance of a cyberattack.
 - o [Role and Responsibilities of the applicant and of other involved parties]

3.4 Requirements for establishing test trails [/areas]

3.5 Plan for interaction with other ships

- Consider special marking
 - o Visual (lights and shapes)
 - o AIS?
 - o ASM
 - o VHF (other voice communication)
 - o Consider a naming convention for MASS trial ships (i.e. 'unmanned.....', 'autonomous'....., 'uninhabited.....')
- Based on the risk assessment, the need for specific lights and shapes management (e.g. "limited maneuverability"), clear labelling of test vessels, and the need for general notification of the activity of other vessels in the area (e.g. on maritime VHF) should be considered. Monitoring and control
- Emergency situations – The applicant provides a procedure for the management of emergency situations specifying how the tests can be aborted at any given time to gain at the same time full control of the vessel (by stopping it, or controlling its course and speed). (see ch. 3.1 under em. resp. and proposed appendix 12)

3.6 Risk analysis and mitigation

The owner/ operator/ industry of the vessel is responsible for conducting a thorough risk assessment, and for addressing any of the risks associated with their particular trial. The owner/ operator of the vessel is best placed to assess the risk and put in place relevant risk controls. Risk assessments should be comprehensive and address all risk associated with the trial, including any risk that the vessels presents to the presence of other vessels, people, and the protection of the environment. And competent persons should carry out the risk assessment. Owner/Operator should be responsible for implementation of agreed risk controls.

Risk analysis:

- What can go wrong and how to fix it. HazId, HazOp etc. See risk analysis checklist.
- Probability of consequence – need for mitigation.
- Alternatives are needed to comply with prescriptive mandated regulations.
- Assist in determining equivalent means of compliance through mitigation techniques.

Mitigation:

- Avoidance
- Additional physical barriers (redundancy, additional systems)
- Human barriers
- Operational barriers
- Minimum risk condition
- Recovery

3.7 Determine regulatory gaps related to planned mission

STCW

4 Permissions for trial

Before conducting a MASS trial the Company and vessel should ask permission for the trial to the competent authority and consult with relevant stakeholders and inform them about the details of the intended operation. Relevant and affected stakeholders such as coastal administrations; maritime authorities; the coast guard; ports and harbours authorities if relevant should be involved before setting up the MASS trials. A single point of contact available to relevant stakeholders in the planned route should be established well before, during and after the trial.

Information on trials should be duly and timely disseminated to all ships in and around the test area through appropriate communication channels.

The applicant of the trial should provide details of the intended trial, including specification of the scope (e.g. mooring, navigation, equipment testing, etc.).

4.1 Approvals from authorities

Flag State, coastal and port State authorities

4.2 Consider other installations and activities

Offshore installations (e.g. safety zones). Offshore wind farms.

Seismic, fisheries.

Internationally accepted TSS, ship reporting.

Naval exercises. Notice to mariners – AtB (Areas to be Avoided)

(To promulgate the trial activity in Navtex, EGC msgs to all ships in the area. The message should include the presence of seafarers onboard and possibly the number of seafarers onboard. This will be useful in case of an emergency]

4.3 Insurance and liability

One should as a minimum require that a MASS (under trial) have third-party liability insurance cover, and to set the minimum level of that cover. Therefore, owners/managing agents of a MASS should take out an appropriate policy of insurance. It is advised, if a policy of insurance is in force, that a copy of the Certificate of Insurance be displayed (if practicable) or available for inspection during the MASS trials or verifiable online.

(Note that ships of more than 300 GT are required to have in place third party insurance under EU Directive 2009/20/EC on the Insurance of Shipowners for Maritime Claims which is in turn based on IMO Assembly Resolution A.898(21) of 4 February 2000 Guidelines on Shipowners' Responsibilities in respect of Maritime Claims. The insurance requirement is therefore already in place so a clause is not strictly necessary though it does no harm to spell it out. An alternative would have been a Clause referring to the EU Directive and/or the IMO Guidelines.)

4.4 Emergency response

By means of emergency relevant stakeholders need to have a plan. And the following should be described; (see appendix 12)

- Action to be taken by all stakeholders during an emergency.
- Action to be taken by the persons responsible for operations and the person involved in the operations (Remote operations controller, seafarers on board,
- SAR duties of others to be mentioned. This particularly important when the ship is being tested in automatic mode but with seafarers onboard for back up.

4.5 Other Commercial

(Anything?).

5 Execution

5.1 Inform relevant authorities and other parties

See section 4 and appendix 5

5.2 Monitor technical and operational systems

Check that we have adherence to specified safety standards.

System to detect malfunctions outside specified operational requirements (see sec. 3.4).

5.3 Monitor traffic and situation around ship

Assess situational complexity against automation system capabilities.

- Ensure that external signals are acted on
 - Transfer all mandatory communication, including mandatory shore reporting, GMDSS etc. to a human operator.
 - Visible and audible signals from AtoN and ships

5.4 Execute corrective actions or abort in case of failures.

- Minimum Risk Condition
- Safe State
- [Abort procedures see appendix 10]

5.5 Register data from trials

- all important events, traffic situations etc. (extended VDR?) for later assessment of trial results.

5.6 Conduct of MASS trials

- When testing autonomous solutions, there should be an opportunity to take local control of the vessel. [*For remote-controlled solutions where there are no personnel on board, solutions that ensure that the vessel does not expose its own or other ships to danger of loss of control and signal should be implemented*]
- Relevant authority should be notified of test and trials activities before they take place, including a geographical indication of the specific area that will be used, the duration of the activity, and contact information.
- To execute MASS trials we need precautions and requirements that envisage a safety level which should be at least equal to conventional operations and sailing conditions. A trial may be defined as one singular dedicated voyage from berth to berth, or from one dedicated geographical point to another (end coordinate), including waypoints and course alterations/differentiations (Not a sequence of voyages or intermitting voyage?)

6 Post-mission analysis and reporting

6.1 Analysis of data recorded during trials

- Report from recordings
- Report from observed deviations
- Report on efficiency of operational principle
- ...

6.2 Reporting and information sharing

- To whom
 - Involved parties
 - IMO (see appendix 5)
- What

Appendices:

- Appendix 1: Risk analysis checklist
- Appendix 2: System requirements checklists
- Appendix 3: Regulatory requirements checklist
- Appendix 4: Possible infrastructure support
- Appendix 5: Guidance for reporting to IMO [and other relevant stakeholders]
- Appendix 6: Possible additional data collection
- Appendix 7: Possible AIS coding
- Appendix 8: Visual markings
- [Appendix 9: Definitions]
- [Appendix 10: Abort checklist]
- [Appendix 11: Communication checklist]
- [Appendix 12: Requirements for establishing test areas/trials Checklist]
- [Appendix 13: Emergency response checklist]

APPENDIX 1
RISK ANALYSIS CHECKLIST

- Complexity of operations
- Safety
- Cyber security
- Security
- Technical failures: Anticipated and non-anticipated
- Equivalents and alternative design

APPENDIX 2

SYSTEM REQUIREMENTS CHECKLISTS

- Sufficient sensors and automation to execute mission safely as planned
- Sufficient shore supervision and control to complement automation when necessary
- sufficient sensors and sensor processing to satisfy shore personnel requirements
- Alarm functions to satisfy good human-automation interface
- Transfer of voice, [visuals] and sound from ship to shore control (including GMDSS)
- Assistance in SAR – assistance other ships (not normally relevant)
- If ship is unmanned, ensure provisions to recover ship in a safe manner.
- ...

APPENDIX 3

REGULATORY REQUIREMENTS CHECKLIST

Test subjects (MASS) should operate in accordance with COLREG. For each trial, it should be considered whether the activity affects the safety and the accessibility of the waters and whether the activity requires a separate permit from the coastal administration. The following should be considered and conducted:

- .1 basic preparation for a trial;
- .2 basic conditions under which a trial should be conducted; and
- .3 considerations for areas where trials are conducted.

Safety for crew, environment and ship should be ensured and in accordance with current regulations and standards. Any regulatory deviations should be approved by the Flag and Coastal Administrations, as appropriate.

The Company should designate a responsible person for the operation in advance to ensure the safety of the operation. The designated person should have authority to change or interrupt the test activities, under the overriding competence of the responsible/competent authority. Before the operation is initiated, the operation should be subject to a risk assessment. All stakeholders should be familiar with the results of the risk assessment, and personnel involved in the operation should be qualified for the assessment with regard to operation. In addition, the risk assessment should be made available for the coastal administration or relevant stakeholders.

When testing autonomous or remote-controlled solutions where personnel are required on board during normal operations, there should be an opportunity to take local control of the vessel. When testing autonomous and remote-controlled solutions where there are no personnel on board, precautions to ensure that the vessel does not expose itself or other ships to danger as a result of loss of control and/or signal should be implemented.

Where applicable, it should be possible for the VTS to communicate with responsible person who is able to control the vessel at any given time.

Involved Coastal and maritime Authorities should be notified of test activities before they take place, including a geographical indication of the specific area that will be used, the duration of the activity, and contact information.

Based on the risk assessment, the need for separate lantern management (e.g. "limited manoeuvrability"), clear labelling of test vessels, and the need for general notification of the activity to other vessels in the area (e.g. on maritime VHF) should be considered. The VTS if applicable and appropriate, should always be notified in advance when test activities are to take place within its service area

A ship that intends to proceed on an autonomous trial (voyage or part of voyage) should comply with applicable requirements under IMO instruments and national law and be equipped and suited for the intended voyage. Safety of the crew, seaworthiness, and protection of the environment should be maintained throughout the planned trial. Any regulatory deviations should be approved by the Flag and Coastal Administrations, as appropriate.

Special considerations should be given to the following areas to conduct safe MASS trials:

- .1 Compliance with the International Regulations for Preventing Collisions at Sea (COLREG) including appropriate display of navigation lights and shapes. (There could be a need for special lights and shapes for MASS).
- .2 Proper identification of the ship being engaged in MASS trials using all available means (e.g. Automatic Identification System).
- .3 Notification of MASS trials to other ships operating in the area through all available means (e.g. VHF broadcast, navigation warnings, notice to mariners).
- .4 For each test activity, it should be considered whether the activity affects the safety and the accessibility of the waters and if the activity requires a separate permit from the coastal administration.
- .5 Any regulatory deviations should be approved by the Flag- and Coastal Administrations, as appropriate.

APPENDIX 4

POSSIBLE INFRASTRUCTURE SUPPORT

- 1 The physical area where tests can be conducted.
- 2 Infrastructure supporting the tests, e.g.: Various infrastructure for use by test vessels, e.g.:
 - .1 Communication, adequate communications to support safe operations – The competent authority and industry operator should ensure that any communications infrastructure established to support MASS trials should be sufficient, and contain appropriate redundancy to ensure the safe, secure and environmentally sound conduct of the trials.
 - .2 Radar, video or other land-based sensors.
 - .3 Planning and control systems, including office spaces and similar shore-based control centres for testing interoperable MASS systems and solutions.
 - .4 The competent authority should ensure that the operator:
 - .4.1 establishes an appropriate level of infrastructure to provide for the safe, secure and environmentally sound conduct of MASS trials; and
 - .4.2 [of MASS] takes reasonable steps to ensure all waterway users are informed of any MASS trials. In ensuring mariners are aware, the geographic area should be selected and defined so as to reduce the unsafe encounter with other vessels.
 - .5 Have established an adequate cyber management and takes appropriate steps to enhance the cybersecurity of the systems and infrastructure used in the trials of MASS. Such steps should align to best practice and reduce, to as low as is reasonably practicable, the chance of a cyberattack.
 - .6 Other.
- 3 Services related to risk assessment, reporting and approval of tests. This may include warning systems for other ships, leisure craft or others or users in the area or its vicinity. [It seems to me that we could merge these 2 architecture components]
- 4 Historical data provision services for analysis and planning of trials. This could be services providing, AIS data, Charts data, MetOcean information including bathymetric data, etc. It could also include data provisions for calibration or test of sensor processing or navigation systems. This requires standardized media formats for AIS, MetOcean, Video, radar or other data sources.

This may be part of an official test area or not.

APPENDIX 5

GUIDANCE FOR REPORTING TO IMO

- Time period, place, ship details, manning levels, remote supervision ...
- What kind of automatic functions was tested to what functionality level
- What rules and regulations were considered as "problematic" in relationship to trials including gaps related to compliance with mandatory instruments.
- Any problems that occurred and how it was solved – risk elements
- Relevant parts of risk assessment

APPENDIX 6

POSSIBLE ADDITIONAL DATA COLLECTION

A test area can also be a valuable source of data, either for planning of tests or for verification of new algorithms, e.g. for object detection or classification or for manoeuvring. Data types that may be useful are:

- Video recordings from tests in the area. These can be used to check object detection or classification algorithms. This may be visual light recordings or various forms of low light or IR recordings.
- Radar recordings from same type of test runs. This has similar applications as previous. It is also interesting if simultaneous recordings of video and radar are available.
- AIS data from various periods. Should probably have anonymized ship identities. This can be used to test manoeuvring algorithms, possibly in conjunction with video or radar data.
- MetOcean data.
- Charts and bathymetric data.

General description formats for test areas

It is useful if a general description of [test areas is available to prospective users locally or in other regions, if the area has resources or test possibilities for the larger community. Information that should be available is:] or [Test areas is duly described for the purpose of prospective users Information that should be available is:]

- Location and delimitation of the area. Scope/Types of tests that are allowed Requirements for the use of the area. Application procedures if relevant, as appropriate. Availability of historical data.
- Contact point details of responsible authorities - Prevailing environmental conditions in the area.
- Responsibilities and competent authorities

APPENDIX 7

POSSIBLE AIS CODING

AIS coding for autonomous ships

This issue was discussed in deliverable D4.6 (Final interfaces) and this section only contains the main conclusions from that discussion.

The AIS technical specification is maintained by ITU as recommendation ITU-R M.1371-4 **Error! Reference source not found.** There are several theoretical ways to handle more specific coding of unmanned ships:

- .1 Through the special manoeuvre indicator bits in the position messages.
- .2 Through the ship type code in the static information message.
- .3 Through navigational status in position messages (1-3).
- .4 Using spare bits in any of the two messages.

In general, it would be useful to have information both in the static and in position messages specifying respectively that the ship can be operated remotely or autonomously and what operational mode it is in.

The method suggested in MUNIN is to use the navigational status in the position message (method 3), possibly with special coding of autonomous ship type in the static message (method 2).

For completeness, each of the above alternatives is discussed in more detail in the following sections.

Special manoeuvre indicator bits

There are two bits in the position message allocated to special manoeuvre information. The codes are listed below.

Table 2 – Special manoeuvre codes

Code	AIS-Status
0	Not available, default
1	Not engaged in special manoeuvre
2	Engaged in special manoeuvre (for inland waterways)
3	Not in use (Could be autonomous/remote mode)

Here, code 3 could be used to indicate remote control or autonomous operation where the navigational status gives additional information.

Ship type code

The ship type code in the static message (5) has eight bits to code ship type. The codes are allocated as described in table 3.

Table 3 – AIS ship type codes

Code	AIS-Status
0-9	Not defined
10-19	Reserved for future use
20-24/29	Wing in Ground (WIG)
30-37	Special operations or pleasure crafts
40-44/49	High Speed Craft (HSC)
50-54/59	Special ships
60-64/69	Passenger ships
70-74/79	Cargo ships
80-84/89	Tanker
90-94/99	Other types of ships
100-199	Reserved for regional use
200-255	Reserved for future use

The group from 40 to 94 uses the second decimal to encode information about cargo. Currently only values 1-4 is used for specific cargos and where 9 means no additional information.

It would be possible to encode autonomous operation by using the codes 5-8 to indicate same type of cargo as 1 to 4, but indicating that the ship is able to operate in autonomous or partly remote mode. The navigational status would then take on special meaning according to the table in the next section.

Navigational status

For the position reports (messages 1, 2 and 3) there is a 4 bit field for navigational status where codes 11, 12 and 13 are reserved for future use.

It is possible to use navigational status codes to inform of various degrees of remote or autonomous control in the position report messages. The current navigational status codes are listed below.

Table 4 – AIS status codes, proposed extension and relation to COLREG

Code	AIS-Status	Proposed UAS-modes	COLREG
0	Under way using engine	Manned under way	§23
1	At anchor		§30 (a) – (c)
2	Not under command	Fail to safe stop	§27 (a)
3	Restricted manoeuvrability		§27 (b)
4	Constrained by draught		§28
5	Moored		-
6	Aground		§30 (d) – (f)
7	Engaged in fishing		§26
8	Under way sailing		§25
9	Reserved for future specific extensions for HSC		
10	Reserved for future specific extensions for WIG		
11	Reserved for future use	Remote control	§23
12		Unmanned monitored	
13		Unmanned fail to safe	
14	AIS-SART		
15	Not defined/default		

One can use codes 11 to 13 for the different autonomous modes. The codes would then be 11 for remote control, 12 for monitored remote control (normal autonomous mode) and 13 for ship continuing on voyage although SCC connection has been lost. The latter can be allowed under a fail to safe regime in some special cases.

For ship static data (message 5) there is a number of ship types defined, but as discussed in the previous section it would be possible to put in codes here for autonomous ships of various types. This could be used to give additional meaning to some of the status codes, e.g. using code 0 for autonomous mode, 2 for fail to safe and 3 for remote control.

However, this may cause uncertainty in interpretation of status codes, particularly as the ship may be manned in some situations. Thus, a better approach under this regime would be to allocate the reserved codes for autonomous or remotely controlled ship as discussed above and use code 0 for "manned under way" and code 2 indicate also "fail to safe stop".

In MUNIN we propose to use the codes 11 to 13 to indicate the autonomous mode. Extending the static data to indicate autonomous capabilities may be useful in some cases, but is not strictly speaking necessary.

Using spare bits

The position report has three spare bits and the static information message one. This could also be used to code the type of ship and thus, giving both actual navigational status and an indication of general autonomous capabilities. However, it is probably better to do this through the ship type in the static message. The reserved bits may not be consistently implemented as either zeros or ones in existing AIS units.

Implications for COLREG

The implementation of unmanned vessels should go in line with an update of the COLREGs according to state-of-the-art of the technologic capabilities **Error! Reference source not found.** Determining the navigational status of a vessel is a prerequisite to define the responsibilities between the vessels according to rule 18 and thus to adequately follow COLREGs. However, COLREG only requires displaying a vessel's navigational status by lights and shapes according to COLREG part C, thus making it complicated and costly to reliably visually determine a vessels status by technical means like image processing of video pictures. Of course, AIS provides the capability to provide the navigational status information of vessels in a machine-readable format and this information is even sooner available than a light or a shape can reliably be detected either by human or technical means, but AIS is not incorporated in COLREG.

Therefore, it is suggested to consider an amendment to Part C in order to allow for an alignment of obligations with those described in SOLAS V Regulation 19 in relation to nautical data sent by AIS*. Of course, the data may still need to be manually entered in the AIS, thus human errors might occur, but it gives the unmanned vessel as well as masters and nautical officer of manned vessels the security, that if a navigational status is displayed by AIS, then it also has a legal meaning for determining its COLREG-obligations.

* Currently, Part C allows to display the additional navigational statuses *Towing and Pushing* (Rule 24) and *Pilot vessels* (Rule 29) that are not covered by the actual AIS-statuses, but also don't affect the responsibilities according to Rule 18.

APPENDIX 8
VISUAL MARKINGS

Lights and shapes

APPENDIX 9

DEFINITIONS

Test Areas: In this document it is assumed that the test areas may have mutually sustaining two distinct functions:

- .1 They are a facility for carrying out in situations tests of MASS and MASS systems which may or may not be open for any user, other than the one carrying out the tests/responsible for the test subject; and
- .2 They can also be a source of historical data sets, e.g. covering MetOcean, traffic density, sensor data recordings or others that can be of use to developers of MASS or MASS systems. Again, this may or may not be available to any users, other than the one carrying out the tests.

Test trials

Shore centre

Remote operator

Administration

Applicant

Contact point

MASS

MASS trials: it may be defined as one singular dedicated voyage from berth to berth, or from a dedicated geographical point to end of passage (end coordinate).

Remote operator:

Sea Area/Sea Monitoring Zone

Shore center:

Test plan

Test trials:

test location

Organisation responsible for the test

Approving authority

Testing team

Phases of test

Type of test

Remote operation centre

Level of Autonomy (this is very important to ensure proper COLREGs will be followed by other ships in the area)

APPENDIX 10
ABORT CHECKLIST

APPENDIX 11
COMMUNICATION CHECKLIST

- 1 Parties to be informed
 - 1.1 Port state administration
 - 1.2 Coastal state administration
 - 1.3 Relevant VTS authorities
 - 1.4 All users of the test areas (military, commercial, fishing traffic)
- 2 Information to be communicated
 - 2.1 Detailed information regarding the type of test
 - 2.2 Geographical boundaries of the test area
 - 2.3 Times of test
 - 2.4 Areas to avoided by other traffic (if relevant)
- 3 Action required by other parties
 - 3.1 VTS operators – to allow for the additional test operation and risks
 - 3.2 Other traffic in the area – to take the extraordinary circumstances in consideration

[APPENDIX 12

**[IMPLEMENTATION] REQUIREMENTS FOR
ESTABLISHING TEST AREAS/TRIALS CHECKLIST]**

Consideration for the selection of test areas (included as appendix):

- .1 It is recommended that test areas to be away from area of heavy maritime traffic, offshore installation such as oil and gas platforms, and military areas;
- .2 It is recommended that two neighbouring coastal states or more may jointly agree to establish a joint test area would be encouraging to carry out the test in international context;
- .3 It is recommended that special and clear marking for test vessels and announcements to be made for awareness and safety purposes;
- .4 It is recommended to ensure safe depth of test areas for the operations; and
- .5 It falls within the communication coverage (coastal and satellite coverage);
- .6 Implementation requirements: (It has been proposed adding a new item '4 Implementation requirement' which deals with the regulations that apply only to the MASS trials below. If our proposed item '4 Implementation requirement' is accepted, we suggest deleting item '4 applications' and include its contents in other items such as scope, definition, and implementation requirement.)

Implementation requirement:

- .1 General (e.g. Identification of hazards, etc.);
- .2 Test area (e.g. Available communication systems, Shore centre, other infrastructure);
- .3 Test trials (e.g. Trial scope, Remote operator, Object detection, Control override);
- .4 Data collections;
- .5 Communication (with relevant and affected stakeholders);
- .6 Others (e.g. Emergency measures).

**[APPENDIX 13
EMERGENCY RESPONSE CHECKLIST]**
