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MSC.1/Circ.1595
25 May 2018

E-NAVIGATION STRATEGY IMPLEMENTATION PLAN – UPDATE 1

1 The Maritime Safety Committee, at its eighty-first session, recognizing the technological advancement in shipping, agreed on the process of developing a regulatory framework for e-navigation.

2 At its ninety-fourth session, the Committee approved the e-navigation Strategy Implementation Plan (SIP), finalized by the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR), at its first session.

3 At its ninety-ninth session, the Committee, recognizing the need to regularly update the e-navigation SIP to allow for prioritized tasks to be included in the work programme of the NCSR Sub-Committee, approved the *E-navigation Strategy Implementation Plan – Update 1*, prepared by NCSR 5, as set out in the annex.

4 Member States and international organizations are invited to bring the updated e-navigation SIP to the attention of all parties concerned.

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ANNEX

E-NAVIGATION STRATEGY IMPLEMENTATION PLAN – UPDATE 1

Introduction

1 As shipping moves into the digital world, e-navigation is expected to provide digital information and infrastructure for the benefit of maritime safety, security and protection of the marine environment, reducing the administrative burden and increasing the efficiency of maritime trade and transport.

2 The Organization defines e-navigation as *the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment* (as defined in the Strategy for the development and implementation of e-navigation (MSC 85/26/Add.1, annex 20)). E-navigation is intended to meet present and future user needs through harmonization of marine navigation systems and supporting shore services. Hence, the implementation of e-navigation should be based on user needs and not be technology-driven. The user needs were agreed upon by the Sub-Committee on Safety of Navigation,[1] at its fifty-sixth session (NAV 56/WP.5/Rev.1, annexes 2 to 4), and are reproduced in annex 4 of this document.

3 The Strategy for the development and implementation of e-navigation assigns the governance of the e-navigation concept to IMO as the organization responsible for establishing mandatory standards for enhancing the safety of life at sea, maritime security and protection of the marine environment, as well as having global remit. In accordance with the strategy, the implementation of e-navigation is a phased iterative process of continuous development taking into account the evolution of user needs and the lessons learned from the previous phase.

4 It is important to understand that e-navigation is not a static concept and that the development of logical implementation phases will be ongoing as user requirements evolve and as technology develops, enabling more efficient and effective systems. If sufficient progress is made in the implementation, an e-navigation-enabling Performance Standard may be envisaged (see also sub-solution S4.1.10), providing a single-reference for e-navigation solutions.

5 The initial e-navigation Strategy Implementation Plan (SIP) was developed by the Correspondence Group on e-navigation and finalized in 2014 by the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR), at its first session, and subsequently approved by the Maritime Safety Committee (MSC), at its ninety-fourth session. The SIP introduces a vision of e-navigation which is embedded in general expectations for the onboard, onshore and communications elements.

6 The main objective of the SIP is to implement the five e-navigation solutions, resulting from the IMO Formal Safety Assessment (FSA) which identified a number of required tasks. These tasks should, when completed, provide the industry with harmonized information, in order to start designing products and services to meet the e-navigation solutions.

[1] The NAV Sub-Committee was amalgamated with the COMSAR Sub-Committee into the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR).

7 According to paragraph 14 of the original SIP (NCSR 1/28, annex 7), which is also reproduced as paragraph 19 below, the SIP requires periodic updates.

8 The implementation strategy elements should, therefore, remain under review, and in light of recent technological developments, evolved user needs, new trends in the industry and progress made in the implementation of the SIP, NCSR 4 agreed to an update of the plan, including prioritization of the outputs and their reorganization so as to avoid duplication.

9 Consequently, the work to update the SIP was undertaken and completed by NCSR 5 in February 2018 and the updated SIP was approved by MSC 99 in May 2018.

10 Although the need to use existing equipment in a more holistic way was identified early on, some onboard equipment may need modifications to interfaces and controls. However, in the future, the need for new equipment for the deployment of future e-navigation solutions and applications cannot be disregarded.

11 The tasks listed in table 7 should be incorporated as outputs, taking into account the provisions of the *Organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies*, as set out in MSC-MEPC.1/Circ.5, as may be revised (Organization and method of work).

12 In line with the provisions of the Organization and method of work, proposals to undertake e-navigation-related tasks by the Organization will need to be submitted to the Committee for approval and inclusion as output(s).

13 Interested Member States may submit proposals to the Committee for the inclusion of new outputs based on the identified tasks contained in this SIP.

14 Proposals for the further development of e-navigation solutions and tasks which are not listed in the SIP may also be submitted by Member States to the Committee for consideration; however, priority should be given to the tasks identified in the SIP.

15 Member States willing to lead a specific task should ensure the timely delivery of the task by requesting the assistance of other Member States and/or relevant Organizations.

Strategy Implementation Plan (SIP) for the five e-navigation solutions

16 The basis of the SIP are the following e-navigation solutions: [2]

S1: improved, harmonized and user-friendly bridge design;

S2: means for standardized and automated reporting;

S3: improved reliability, resilience and integrity of bridge equipment and navigation information;

S4: integration and presentation of available information in graphical displays received via communication equipment; and

S5: improved communication of VTS Service Portfolio (not limited to VTS stations).

[2] A total of nine e-navigation solutions were considered for the first SIP, contained in NAV 58/WP.6/Rev.1, annex 2, but NAV 59 endorsed just five prioritized potential e-navigation solutions. Since these five prioritized potential e-navigation solutions have been listed in paragraph 16 in this updated SIP, the term "prioritized" has become redundant and has therefore been omitted.

17 Solutions S2, S4 and S5 focus on efficient transfer of maritime information and data between all appropriate users (ship-ship, ship-shore, shore-ship and shore-shore). Solutions S1 and S3 promote the workable and practical use of the information and data on board.

18 As part of each of the above e-navigation solutions, several sub-solutions were identified. These are listed in tables 1 to 5 below.

19 While the first steps involve implementing the five e-navigation solutions, it is important to recognize that the e-navigation development is a continuous process following user needs for additional functionalities of existing and possible future systems (e.g. implementation of onboard and/or ashore navigational decision support systems). As user needs evolve and new technology is introduced, other e-navigation solutions may be incorporated into the strategy, as appropriate.

20 During the FSA process, the following Risk Control Options (RCO) were identified in order to aid the assessment of the e-navigation solutions and some of the sub-solutions:

RCO 1: Integration of navigation information and equipment including improved software quality assurance (related to sub-solutions S1.6, S1.7, S3.1, S3.2, S3.3, S4.1.2, and S4.1.6);

RCO 2: Bridge alert management (related to sub-solution S1.5);

RCO 3: Standardized mode(s) for navigation equipment (related to sub-solution S1.4);

RCO 4: Automated and standardized ship-shore reporting (related to sub-solutions S2.1, S2.2, S2.3 and S2.4);

RCO 5: Improved reliability and resilience of onboard PNT systems (related to sub-solution S3.4);

RCO 6: Improved shore-based services (related to sub-solution S4.1.3 and solution S5); and

RCO 7: Bridge and workstation layout standardization (related to sub-solution S1.1).

21 A number of necessary actions and tasks have been identified in order to progress the development and implementation of the five e-navigation solutions. These are listed below under each respective solution and consolidated in table 7.

Table 1:
Required regulatory framework and technical requirements for implementation (tasks) for solution 1 (Improved, harmonized and user-friendly bridge design)

Sub-Solution	Description	Task Action	Task Identifier (Table 7)
S1.1	Ergonomically improved and harmonized bridge and workstation layout.	Guidelines on Human Centred Design (HCD) for e-navigation systems. Guidelines on Usability testing, Evaluation and Assessment (UTEA) for e-navigation systems. Resolutions A.694(17), A.997(25) and MSC.252(83) and MSC/Circ.982, SN.1/Circ.265, SN.1/Circ.274 and SN.1/Circ.288 are of relevance.	**T1** **T2**
S1.2	Extended use of standardized and unified symbology for relevant bridge equipment.	Develop symbology for relevant equipment, using as a reference resolution MSC.192(79).	**T2**
S1.3	Standardized manuals for operations and familiarization to be provided in electronic format for relevant equipment.	Develop the concept of electronic manuals and harmonize the layout to provide seafarers with an easy way of familiarization for relevant equipment.	**T3**
S1.4	Standard default settings, save/recall settings, and S-mode functionalities on relevant equipment.	Performance or technical standards mandating the features on relevant equipment. Develop a testbed demonstrating the whole concept of standardized modes of operation including store and recall for various situations as well as S-mode functionality on relevant equipment.	**T4**
S1.5	All bridge equipment to follow IMO BAM (Bridge Alert Management) performance standard.	Ensure that all equipment is checked during type approval and that it meets the requirements of resolution MSC.302(87) on Bridge Alert Management, as may be updated.	**T5**
S1.6	Information accuracy/reliability indication functionality for relevant equipment.	Develop a testbed demonstrating technically how accuracy and reliability of navigation equipment may be displayed.	**T6**
S1.6.1	Graphical or numerical presentation of levels of reliability together with the provided information.	From the above develop a harmonized display system indicating reliability levels.	**T6**
S1.7	Integrated bridge display system for improved access to shipboard information.	INS systems which integrate navigation equipment data already exist but are not mandatory (resolution MSC.252(83)). E-navigation relies on integration and	**T7**

Sub-Solution	Description	Task Action	Task Identifier (Table 7)
		without mandatory carriage of INS it would be difficult to achieve the solutions. The carriage of an INS or maybe something simpler performing integration should be investigated.	
S1.8	GMDSS equipment integration – one common interface.	Take into account resolution A.811(19) when integrating GMDSS into one common interface.	

Table 2:
Required regulatory framework and technical requirements for implementation (tasks) for solution 2 (Means for standardized and automated reporting)

Sub-Solution	Description	Task Action	Task Identifier (Table 7)	Status
S2.1	Single-entry of reportable information in single window solution.	Develop testbeds demonstrating the use of single window for reporting along with S2.4.	**T8 T15**	In progress
S2.2	Automated collection of internal ship data for reporting.	Much data is already collected by onboard navigation equipment – investigate the option of facilitating this data transfer for automated reporting of ship information to authorities.	**T9**	In progress
S2.3	Automated or semi-automated digital distribution/communication of required reportable information, including both "static" and "dynamic" information.	Review the original AIS long-range port facility as well as the new long-range frequencies made available at WRC 2012 described in the latest revision of ITU-R M.1371-5, the revised IEC 61993-2, or the developments within VHF Data Exchange System (VDES) and consider if the information could be used at no or low cost for automated or semi-automated reporting. The long-range port was not used during the development of LRIT due to the cost to shipowners of sending this information. Develop Guidelines for the efficient distribution of relevant navigation-related information	**T9 T15**	In progress

Sub-Solution	Description	Task Action	Task Identifier (Table 7)	Status
		from communications equipment to navigation displays (see document NCSR 5/6, paragraph 8)		
S2.4	All national reporting requirements to apply standardized digital reporting formats based on recognized internationally harmonized standards, such as IMO FAL Forms or SN.1/Circ.289.	Liaise with administrations and agree on standardized formats for ship reporting so as to enable "single window" worldwide. In this respect national and regional harmonization is the first step.	**T8**	In progress

Table 3:
Required regulatory framework and technical requirements for implementation (tasks) for solution 3 (Improved reliability, resilience and integrity of bridge equipment and navigation information)

Sub-Solution	Description	Task Action	Task Identifier (Table 7)	Status
S3.1	Standardized self-check/built-in integrity test (BIIT) with interface for relevant equipment (e.g. bridge equipment).	Equipment should be developed with standardized BIIT. The general requirements in resolution A.694(17), as tested by IEC 60945, should be reviewed to determine if additional definitions and testing is required.	**T10**	In progress
S3.2	Standard endurance, quality and integrity verification testing for relevant bridge equipment, including software.	Software quality assurance, especially lifetime assurance methods, need to be developed into guidelines. The type approval process needs to be developed further to ensure that the equipment used in e-navigation is robust in all aspects.	**T11**	Completed
S3.3	Perform information integrity tests based on integration of navigational equipment – application of INS integrity monitoring concept.	This task is very similar to that described for S1.6 and S1.6.1.	**T6**	In progress

Sub-Solution	Description	Task Action	Task Identifier (Table 7)	Status
S3.4	Improved reliability and resilience of onboard PNT information and other critical navigation data by integration with, and backup of, external and internal systems.	MSC.1/Circ.1575 on *Guidelines for shipborne position, navigation and timing data processing* approved by MSC 98. Backup arrangements for critical foundation data, particularly in the event of interruption to cloud-based solutions, should be investigated. Administrations need to indicate their support for terrestrial systems.	**T12**	Part-completed

Table 4:
Required regulatory framework and technical requirements for implementation (tasks) for solution 4
(Integration and presentation of available information in graphical displays received via communication equipment)

Sub-Solution	Description	Task Action	Task Identifier (Table 7)
S4.1	Integration and presentation of available information on graphical displays (including MSI, AIS, nautical charts, radar, etc.) received via communication equipment.	The INS has a display that could be used for displaying this information. Work done by IALA et al. shows that additional information on existing displays, such as ECDIS and radar, might obliterate critical information on these displays. Investigate and demonstrate via a testbed the feasibility of integration and portrayal of this information and develop associated guidelines on the harmonization of display. Resolution MSC.252(83) and SN.1/Circ.265 are related.	**T13** In progress
S4.1.1	Implement a Common Maritime Data Structure (CMDS) for Maritime Service Portfolios (MSP) and include parameters for priority, source and ownership of information.	CMDS is at the core of e-navigation. It has been already agreed to use the IHO S-100 data model. Develop both the shore-based data models and also the shipboard data models including firewalls, as necessary, and	**T14**

Sub-Solution	Description	Task Action	Task Identifier (Table 7)
		harmonize via the IMO-IHO Harmonization Group on Data Modelling (HGDM).	
S4.1.2	Standardized interfaces for data exchange should be developed to support transfer of information from communications equipment to navigational systems (INS).	Most equipment already complies with one of the IEC 61162 series interface standards, although IMO only refers to them by footnote. The testing standards for shipboard equipment developed by IEC refer to this standard. The interfaces should meet the S-100 principle although it may not be necessary to use this standard between simple equipment.	**T14**
S4.1.3	Provide mapping of specific services (information available) to specific regions (e.g. maritime service portfolios) with status and access requirements.	Ensure that the correct and up-to-date information for the area of operation is provided by the shore side and that the seafarer receives the information for the area of operation. MSI could be viewed on relevant or defined displays, such as on ECDIS, radar or INS task displays.	**T13**
S4.1.4	Provision of a system for automatic source and channel management on board for the selection of most appropriate communication means (equipment) according to criteria such as bandwidth, content, integrity and costs.	Least cost routeing systems are available and could be demonstrated. The communication means should be transparent to the user. Available communication systems need to be identified, including how they can be used, based on range, bandwidth, etc. and what systems are currently being developed and will be in use when e-navigation is fully implemented. The task should look into short-range systems such as VHF, 4G and 5G. Develop Guidelines for the efficient distribution of relevant navigation-related information from communications equipment to navigation displays (see document NCSR 5/6, paragraph 8).	**T15**

Sub-Solution	Description	Task Action	Task Identifier (Table 7)
S4.1.5	Routeing and filtering of information on board (weather, intended route, etc.).	Review of the performance standards for INS with a view to determine how these facilities can be addressed in a revised INS performance standard. Develop Guidelines for the efficient distribution of relevant navigation-related information from communications equipment to navigation displays (see document NCSR 5/6, paragraph 8).	**T7**
S4.1.6	A quality assurance process to be followed to ensure that all data is reliable and based on a consistent common reference system (CCRS) or converted to such before integration and display.	Ensure data quality and CCRS meets with new Quality Assurance, set out in MSC.1/Circ.1512.	**T11**
S4.1.7	Implement harmonized presentation concept of information exchanged via communications equipment including using standard symbology and text, taking into account human element and ergonomic design principles to ensure useful presentation and prevent information overload.	Harmonize displays.	**T6** **T13** In progress
S4.1.8	Develop a holistic presentation library as required to support accurate presentation across displays.	Harmonize displays.	**T6**
S4.1.9	Provide alert functionality of INS concepts to information received by communications equipment and integrated into INS.	Ensure that all bridge equipment meets the Bridge Alert Management performance standards.	**T7**
S4.1.10	Harmonization of conventions and regulations for navigation and communication equipment.	The task to go through all the IMO performance standards may be very large. It would be advisable to consider drafting an "e-navigation enabling Performance Standard" which would identify the changes to interfaces, control symbology and other details which would be used as an add-on for adoption for use in e-navigation.	**T16**

Table 5:
Required regulatory framework and technical requirements for implementation (tasks) for solution 5
(Improved communication of VTS service portfolio (not limited to VTS stations))

Solution	Description	Task Actions	Task Identifier (Table 7)
S5	Improved communication of VTS service portfolio (not limited to VTS stations)	Communications is a key factor in the e-navigation concept. This task needs to identify the possible communications methods that might be used and testbeds which need to be built to demonstrate which systems are best in different areas of operation. (e.g. deep sea, coastal and port). Much of this work is appropriate to S4.1.4.	**T15** **T17**

Maritime Services

22 As part of the improved provision of services to vessels through e-navigation, maritime services have been identified as the means of providing electronic information in a harmonized way, which is part of solution 5. The proposed list of Maritime Services is presented in table 6 below. The following definition is currently being reviewed under the e-navigation output on the harmonization of the format and structure of maritime services within a maritime service portfolio:

> *Maritime Service Portfolio (MSP) is a set of operational Maritime Services and associated technical services provided in digital format.*

Further information about Maritime Services to be used in a MSP is set out in annex 2. The further development of the MSP is the subject of task **T17**.

23 The following six areas have been identified for the delivery of MSP:

.1 port areas and approaches;

.2 coastal waters and confined or restricted areas;

.3 open sea and open areas;

.4 areas with offshore and/or infrastructure developments;

.5 Polar areas; and

.6 other remote areas.

Table 6

List of proposed Maritime Services for use in MSP

Service No	Identified services	Domain coordinating body	Identified responsible service provider
1	VTS Information Service (INS)	IALA	VTS Authority
2	Navigational Assistance Service (NAS)	IALA	VTS Authority
3	Traffic Organization Service (TOS)	IALA	VTS Authority
4	Local Port Service (LPS)	IHMA	Local Port/Harbour Authority
5	Maritime Safety Information Service (MSI)	IHO	National Competent Authority
6	Pilotage service	IMPA	Pilotage Authority/Pilot Organization
7	Tug service	TBD	Tug Authority
8	Vessel Shore Reporting	TBD	National Competent Authority and appointed service providers
9	Telemedical Assistance Service (TMAS)	TBD	National Health Organization/dedicated health Organization
10	Maritime Assistance Service (MAS)	TBD	Coastal/Port Authority/Organization
11	Nautical Chart Service	IHO	National Hydrographic Authority/ Organization
12	Nautical Publications Service	IHO	National Hydrographic Authority/ Organization
13	Ice Navigation Service	WMO	National Competent Authority/Organization

Service No	Identified services	Domain coordinating body	Identified responsible service provider
14	Meteorological Information Service	WMO	National Meteorological Authority/Public Institutions
15	Real-time hydrographic and environmental information Service	IHO	National Hydrographic and Meteorological Authorities
16	Search and Rescue Service	TBD	SAR Authorities

Development of related guidelines

24 The combination of the five e-navigation solutions supported by the FSA, and the *Guideline on Software Quality Assurance and Human-Centred Design for e-navigation* (MSC.1/Circ.1512), propose an e-navigation implementation that facilitates a holistic approach to the interaction between shipboard and shore-based users.

25 The development of an e-navigation reference model for the five solutions, including possible proposed legal framework, governance structures and funding models for relevant infrastructures, could involve establishing a globally cooperating network of regional testbeds.

26 As part of the development of e-navigation, the use of testbeds is crucial as they are pivotal to the progressive implementation of e-navigation solutions. Whenever feasible and appropriate, there should be international cooperation in the establishment of testbeds as a vital component to ensure that e-navigation solutions can successfully operate on a global scale and to leverage the benefits of pooled resources and expertise.

27 Further testbeds may be used and evaluated, in line with MSC.1/Circ.1494 on *Guidelines on harmonization of testbed reporting* which were developed under task **T18** which is completed.

Identification of tasks, deliverables and schedule

28 Table 7 outlines the identified tasks with a short definition including deliverables and transition arrangements, if considered necessary, and an indication of the prioritized implementation schedule.

Table 7

Tasks, expected deliverables, transition arrangements and implementation schedule

Task No	Task	Expected Deliverable	Transition Arrangements	Prioritized Implementation Schedule	Status/Remark
T1	Development of draft Guidelines on Human Centred Design (HCD) for e-navigation systems.	Guidelines on Human Centred Design (HCD) for e-navigational systems.	None		Completed MSC.1/Circ.1512[3]
T2	Development of draft Guidelines on Usability Testing, Evaluation and Assessment (UTEA) of e-navigation systems.	Guidelines on Usability Testing, Evaluation and Assessment (UTEA) of e-navigation systems.	None		Completed MSC.1/Circ.1512
T3	Develop the concept of electronic manuals and harmonize the layout to provide seafarers with an easy way of familiarization for relevant equipment.	Guidelines on electronic equipment manuals.	Provide existing manuals as .pdf		Under consideration
T4	Formulate the concept of standardized modes of operation, including store and recall for various situations, as well as S-mode functionality on relevant equipment.	Guidelines on S-mode.	None	2019	In progress
T5	Investigate whether an extension of existing Bridge Alert Management Performance Standards (PS) is necessary. Adapt all other alert relevant PSs to the to Bridge Alert Management PS.	(a) Guidelines on implementation of Bridge Alert Management. (b) Revised Performance Standards on BAM.	None None		Under consideration

[3] NCSR 1 agreed to consolidate the draft Guidelines on Human Centred Design (HCD) for e-navigation systems, the draft Guidelines on Usability Testing, Evaluation and Assessment (UTEA) for e-navigation systems, and the draft Guidelines on Software Quality Assurance (SQA) in e-navigation into a single Guideline (MSC.1/Circ.1512).

Task No	Task	Expected Deliverable	Transition Arrangements	Prioritized Implementation Schedule	Status/Remark
T6	Develop Guidelines on the display of accuracy and reliability of navigation equipment.	Guidelines on the display of accuracy and reliability of navigation equipment.	None		In progress
T7	Investigate if an INS, as defined by resolution MSC.252(83), is the right integrator and display of navigation information for e-navigation and if so, what amendments are needed, including, inter alia, communication ports and a PNT module. Refer to resolution MSC.191(79) and SN/Circ.243/Rev.1.				Completed
T8	Member States to agree on standardized format guideline for ship reporting so as to enable "single window" worldwide (SOLAS regulation V/28, resolution A.851(20) and SN.1/Circ.289)	Updated Guidelines on single window reporting.	National/Regional Arrangements		Under consideration
T9	Investigate the best way to automate the collection of internal ship data for reporting including static and dynamic information.	Technical report on the automated collection of internal ship data for reporting.	None		In progress
T10	Investigate the general requirements in resolution A.694(17) and IEC 60945 to determine how Built In Integrity Testing (BIIT) can be incorporated.	(a) Revised resolution on the general requirements including Built In Integrity Testing. (b) Revised IEC Standard on General Requirements including Built In Integrity Testing.	None None		Under consideration

Task No	Task	Expected Deliverable	Transition Arrangements	Prioritized Implementation Schedule	Status/Remark
T11	Development of Guidelines for Software Quality Assurance (SQA) in e-navigation**.** This task should include an investigation into the type approval process to ensure that software lifetime assurance (software updates) can be carried out without major re-approval and consequential additional costs. Refer to SN.1/Circ.266/Rev.1 and MSC.1/Circ.1389.	Guidelines for Software Quality Assurance (SQA) in e-navigation.			Completed MSC.1/Circ.1512
T12	Develop Guidelines on how to improve reliability and resilience of onboard PNT systems by integration with external systems. Liaise with Administrations to ensure that relevant shore-based systems will be available.	Guidelines on how to improve reliability and resilience of onboard PNT systems by integration with external systems.			Completed MSC.1/Circ.1575
T13	Develop Guidelines showing how navigation information received by communications equipment can be displayed in a harmonized way and what equipment functionality is necessary.	Guidelines on the harmonized display of navigation information received from communications equipment.	**Interim** To be finalized after completion of **T4** and **T17**	2021	Interim Guidelines completed
T14	Develop a Common Maritime Data Structure and include parameters for priority, source and ownership of information based on the IHO S-100 data model. Harmonization will be required for both use on shore and use on the ship, and the two must be coordinated (Two Domains).	(a) Guidelines on a Common Maritime Data Structure.	None		(a) HGDM to consider

Task No	Task	Expected Deliverable	Transition Arrangements	Prioritized Implementation Schedule	Status/Remark
	Support the further development of the standardized interfaces for data exchange used on board (IEC 61162 series) to support transfer of information from communication equipment to navigational systems (INS) including appropriate firewalls (IEC 61162--450 and 460).	(b) support the further development of the IEC standards for data exchange used on board, including firewalls.	Use latest IEC standards		(b) Completed
T15	Identify and draft guidelines on seamless integration of all currently available communications infrastructure and how they can be used (e.g. range, bandwidth, etc.) and what systems are being developed (e.g. maritime connectivity platform) and could be used for e-navigation. The task should look at short-range systems such as VHF, 4G and 5G as well as HF and satellite systems taking into account the 6 areas defined for the MSP. Develop Guidelines for the efficient distribution of relevant navigation-related information from communications equipment to navigation displays (see document NCSR 5/6, paragraph 8)	Guidelines on seamless integration of all currently available communications infrastructure and how they can be used and what future systems are being developed along with the revised GMDSS. Guidelines for the efficient distribution of relevant navigation-related information from communications equipment to navigation displays (see document NCSR 5/6, paragraph 8)	Use existing onboard communications infrastructure		Under consideration

Task No	Task	Expected Deliverable	Transition Arrangements	Prioritized Implementation Schedule	Status/Remark
T16	Investigate how the harmonization of conventions and regulations for navigation and communication equipment would be best carried out. Consideration should be given to an all-encompassing e-navigation performance standard containing all the changes necessary rather than revising over 30 existing performance standards.	Report on the harmonization of conventions and regulations for navigation and communication equipment would be best carried out.	None		Under consideration
T17	Further develop the MSP to refine services and responsibilities ahead of implementing transition arrangements.	Resolution on Maritime Services within a Maritime Service Portfolio.	National/Regional Arrangements	2019	In progress
T18	Development of Draft Guidelines for the harmonization of testbeds reporting.	Guidelines for the harmonization of testbeds reporting.	None		Completed MSC.1/Circ.1494

29 Table 8 shows the timelines for each task and an indication of the schedule to clarify common understanding necessary for the implementation.

Table 8:
Indication of the schedule to clarify common understanding necessary for the implementation

No	Task	Remark	Prioriti-zation	2017 NCSR 4	2018 NCSR 5	2019 NCSR 6	2020 NCSR 7	2021 NCSR 8
1	Development of draft Guidelines on **Human Centred Design (HCD)** for e-navigation systems	completed						
2	Development of draft Guidelines on **Usability Testing, Evaluation and Assessment (UTEA)** of e-navigation systems.	completed						
7a	Investigate if an **INS, as defined in res. MSC.252(83)**, is the right integrator and display of navigation information for e-navigation and identify the modifications it will need, including a communications port and a PNT module. Refer to resolution MSC.191(79) and SN/Circ.243. (a) Report on the suitability of INS.	completed						
7b	Investigate if an **INS, as defined in res. MSC.252(83)**, is the right integrator and display of navigation information for e-navigation and identify the modifications it will need, including a communications port and a PNT module. Refer to resolution MSC.191(79) and SN/Circ.243. (b) New or additional modules for the Performance Standards for INS	completed						
11	Development of draft Guidelines for Software Quality Assurance (SQA) in e-navigation. This task should include an investigation into the type approval process to ensure that software lifetime assurance (software updates) can be carried out without major re-approval and consequential additional costs. Refer to SN/Circ/266/Rev.1 and MSC.1/Circ.1389	completed						
12	Develop guidelines on how to improve reliability and **resilience of onboard PNT systems** by integration with external systems. Liaise with Administrations to ensure that relevant shore-based systems will be available	completed						
18	Development of Draft Guidelines for the Harmonization of testbeds reporting	completed						

No	Task	Remark	Prioriti-zation	2017 NCSR 4	2018 NCSR 5	2019 NCSR 6	2020 NCSR 7	2021 NCSR 8
13	Develop Guidelines on the harmonized display of navigation information received from communications equipment showing how navigation information received by communications equipment can be displayed in a harmonized way and what equipment functionality is necessary	Interim Guidelines To be finalized after completion of T4 and T17	HIGH					
4	Formulate the concept of standardized modes of operation, including store and recall for various situations, as well as **S-mode** functionality on relevant equipment	Guidelines under development (2019)						
17	Further develop the MSPs to refine services and responsibilities ahead of implementing transition arrangements. Resolution on Maritime Service Portfolios.	Guidelines under development (2019)						
8	Member States to agree on standardized format guideline for ship reporting so as to enable "single window" worldwide (SOLAS regulation V/28, resolution A.851(20) and SN.1/Circ.289) Updated Guidelines on single window reporting	requires new output	MEDIUM					
14	Develop a Common Maritime Data Structure and include parameters for priority, source, and ownership of information based on the IHO S-100 data model. Harmonization will be required for both use on shore and use on the ship and the two must be coordinated (Two Domains). Develop further the standardized interfaces for data exchange used on board (IEC 61162 series) to support transfer of information from communication equipment to navigational systems (INS) including appropriate firewalls (IEC 61162- 450 and 460). (a) Guidelines on a Common Maritime Data Structure.	requires new output						
15	Identify and draft guidelines on seamless integration of all currently available communications infrastructure and how they can be used (e.g. range, bandwidth, etc.) and what systems are being developed, along with the revised GMDSS (e.g. maritime connectivity platform) and could be used for e-navigation. The task should look at short range systems such as VHF, 4G and 5G as well as HF and satellite systems taking into account the 6 areas defined for the MSPs. Guidelines for the efficient distribution of relevant navigation-related information from communications equipment to navigation displays (see NCSR 5/6, par.8)	requires new output						

No	Task	Remark	Prioriti-zation	2017 NCSR 4	2018 NCSR 5	2019 NCSR 6	2020 NCSR 7	2021 NCSR 8
3	Develop the concept of **electronic manuals** and harmonize the layout to provide mariner with an easy way of familiarization for relevant equipment	requires new output	LOW					
5a	Investigate whether and extension of existing Bridge Alert Management Performance Standards (PS) is necessary. Adapt all other alert relevant PS to the to **Bridge Alert Management PS**. (a) Guidelines on implementation of Bridge Alert Management.	requires new output						
5b	Investigate whether and extension of existing Bridge Alert Management Performance Standards (PS) is necessary. Adapt all other alert relevant PS to the to **Bridge Alert Management PS**. (b) Revised Performance Standards on BAM.	requires new output						
6	Develop a methodology of how accuracy and reliability of navigation equipment may be displayed. This includes a **harmonized display** system Guidelines on the display of accuracy and reliability of navigation equipment	requires new output						
9	Investigate the best way to automate the collection of internal ship data for reporting including static and dynamic information	requires new output						
10a	Investigate the general requirements resolution A.694(17) and IEC 60945 to see how **Built In Integrity Testing (BIIT)** can be incorporated (a) Revised resolution on the general requirements including Built In Integrity Testing.	requires new output						
10b	Investigate the general requirements resolution A.694(17) and IEC 60945 to see how Built In Integrity Testing (BIIT) can be incorporated (b) Revised IEC Standard on General Requirements including Built In Integrity Testing	requires new output						
16	Investigate how the Harmonization of conventions and regulations for navigation and communication equipment would be best carried out. Consideration should be given to an all-encompassing e-navigation performance standard containing all the changes necessary rather than revising over 30 existing performance standards.	requires new output						

Relevant key enablers for e-navigation

30 During the development of the SIP, a number of actions have been identified as key enablers for e-navigation. Some of them are listed below.

Table 9:
Examples of key enablers of e-navigation

Key enabler	Initial action	Status
Globally Standardized Data Exchange	Data providers to adapt to IMO recognized data standards such as IHO's S-100 data model	IMO/IHO Harmonization Group on Data Modelling (HGDM), activated at MSC 98
A harmonized data communication standard	International Organizations with industry; IALA is developing a standard for VHF data Exchange System (VDES) in collaboration with ITU	Ongoing
Maritime Service Portfolios	Further develop the proposed maritime services as shown in table 6 and annex 2	See Task T17
Providers and onboard systems for resilient PNT	IMO is developing Performance standards for multi-system shipborne radionavigation receivers	Completed resolution MSC.401(95), as amended by res.MSC.432(98)
Connect all relevant equipment and functionality	IEC is developing a family of standards including a firewall with the support of the industry	Ongoing
Software Quality Assurance	Guidelines to be developed	Completed MSC.1/Circ.1512
Ensure that relevant e-navigation functions will be accepted as complying with the relevant IMO performance standards for shipborne navigational and radiocommunications equipment	NCSR Sub-Committee to undertake as the need arises	See Task T16
Connect all relevant equipment and functionality for VTS	Member States to address individually. IALA and IEC may assist in developing standards	Ongoing
Coastal States to provide the required infrastructure	IALA, IHO and CIRM may assist in developing required infrastructure, including relevant standards	Ongoing
Establish Human-Centred Design principles	Continue to refine INS and IBS performance standards and guidelines respectively	Ongoing Part-completed MSC.1/Circ.1512

Description of the ship and shore architecture for the solutions

31 Figure 1 shows the principle of an information/data flow in the e-navigation architecture. The figure shows the complete overarching e-navigation architecture, and defines two additional important features:

.1 the Common Maritime Data Structure (CMDS) that spans the whole of the horizontal axis; and

.2 the World Wide Radio Navigation System (WWRNS).

32 The architecture also:

.1 brings into focus the "operational service" level and the "Functional links used by Technical services" and the "Physical links used by Technical services";

.2 highlights the fundamental distinction between information and data domains, explaining the relationship between the user requested information items and introducing the concepts of Operational and Technical Services, as well as Functional and Physical Links into a hierarchical perspective;

.3 identifies the concept of "Maritime Service Portfolios"; and

.4 unfolds the relationship of shore-to-shore data exchange.

33 The detailed shore and ship side architecture will be further developed in the light of the completion of some of the relevant tasks.

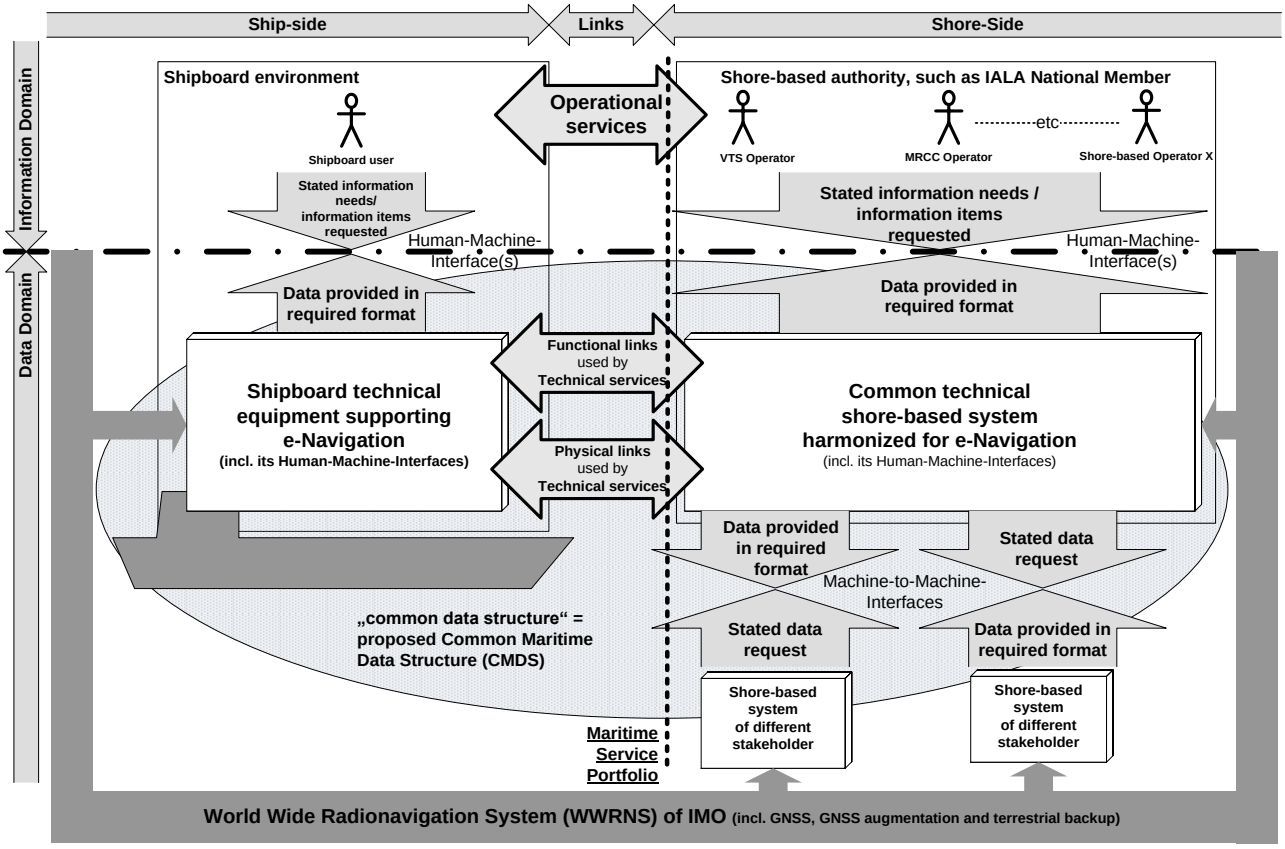

Figure 1 – Overarching e-navigation architecture

Identification of communication systems for e-navigation

34 Communications are key for e-navigation. Any communications systems used should be able to the deliver appropriate MSP in the six areas defined, as per S5, as well as delivering reliable ship reporting as identified in S2.

35 Existing available communications can be broadly divided into those:

.1 used for distress and safety-related communications such as for the promulgation of maritime safety information (MSI), as is currently mandated under SOLAS; and

.2 commercially available systems, such as various satellite solutions (e.g. Inmarsat, Iridium and VSAT) as well as terrestrial telephone and data networks, such as GSM / 3G /4G.

36 Future communication systems could include VHF data (VDES) and NAVDAT, and be developed for Internet-based solutions, such as a maritime connectivity platform, facilitating system-wide information management solutions.

37 Existing and future communication links could be integrated via a maritime intranet, although each technical service will be limited by the capabilities of the available communication links. This infrastructure will primarily be based on IP communications links but will enable the utilization of free communication links for safety and mandatory reporting where appropriate, enabling a seamless integration and transition between available communications technologies.

38 The gap analysis, when considering effective and robust shipboard communications, identified that a communications system should be developed in the future based on IP technology.

39 Relevant requirements for commercial communication links for e-navigation should have certain availability and latency criteria for the defined service area, and should provide a two-way data communication channel, enabling acknowledgement of information delivery.

40 This could enable automatic quality assurance of:

.1 service efficiency;

.2 availability and coverage of the communication service; and

.3 the shipborne communication installation and capability.

41 It is assumed that the communication for various MSP increases for a ship as it approaches the coast and, therefore, it is likely that more bandwidth/speed may be needed in these areas.

42 Task **T15** addresses these issues and is critical to the implementation of e-navigation. The ability to send, receive and ensure the required quality by the MSP depends on the availability of the right solution.

43 The possible further development of the existing LRIT shore-based infrastructure has the potential to provide a data link between authorities ashore using secure communications links, for use for certain MSP (as an example MSP16 (search and rescue)). This does not impact on the mandatory LRIT ship reporting system nor does it add to the ship-to-shore cost for an LRIT message.

44 The concept of the "Maritime Cloud" or named in this document as the "Maritime Connectivity Platform" should be further investigated, including its development and funding, operational and legal issues, including liability, quality and accessibility of information, and global functional operation.

Proposals on enhancing public awareness of the e-navigation concept to key stakeholder and user groups

45 E-navigation is relevant and important to a broad range of stakeholders. The aim of the proposals on enhancing awareness of e-navigation is to improve the overall knowledge of the e-navigation concept among different stakeholders, and to enlist their cooperation and assistance in the implementation of e-navigation.

46 In this respect, five stakeholder groups have been identified as important and influential recipients, including key messages for each e-navigation solution. The key messages should be actively used to inform different stakeholders of the potential outcome and benefits of e-navigation, as well as the process of implementing e-navigation.

47 The development of an e-navigation website is also proposed in order to provide a coordinated and dynamic approach for distributing and sharing information related to the further development of e-navigation.

48 Regional/technical cooperation activities could be held in various parts of the world to promote and provide information on the status of the implementation of e-navigation initiatives. It would also provide a meeting arena for knowledge exchange on the process.

49 An e-navigation communication plan is provided in the SIP approved by MSC 94.

Regulatory impact

50 The provision and further development of e-navigation should consider relevant international conventions, regulations and guidelines, national legislation and standards. The development and implementation of e-navigation should build upon the work of IMO.[4]

51 E-navigation is intended to be based on the use of the existing equipment, however any changes in carriage requirement for some of the elements needed to make the system work may have an impact on ship certification.

52 Certain elements in the e-navigation strategy plan have not yet been fully investigated as they depend on the outcome of some of the tasks.

[4] Including, but not limited to, the requirements of the FAL, SOLAS, MARPOL and STCW Conventions.

Funding

53 Solution 2 (Means for standardized and automated reporting) and Solution 5 (Improved communication of VTS service portfolio) both refer to improved shore-based facilities which may need funding for e-navigation to be successfully implemented.

54 The funding may comprise two components: regional and international contributions. The former being normally provided by participating government agencies or national or regional grants, and the latter by donors operating under the support of institutions such as the World Bank or national agencies providing international development assistance. The funding can be grants, loans or important technical advisory services.

55 In addition, there are bilateral agreements between regions and countries which may contribute to the successful funding of e-navigation solutions.

56 The identification of potential sources of funding for development and implementation, particularly in developing regions and countries, and any actions to secure that funding, including resource management, could, as an example, look at previous successfully funded international maritime projects.

57 According to World Bank statistics, in the case of the Marine Electronic Highway (MEH) in the Straits of Malacca and Singapore, the budget was $17 million which was split as 51% regional (Littoral States and private) and 49% international (GEF/World Bank as grants for IMO and Indonesia).

ANNEX 1

BACKGROUND INFORMATION RELATED TO THE IDENTIFIED RISK CONTROL OPTIONS (RCOs)

1 Relevant background information related to the Risk Control Options (RCOs) identified during the Formal Safety Assessment (FSA) is provided in the following paragraphs.

RCO 1: Integration of navigation information and equipment including improved software quality assurance

2 There is a potential for various navigational information to be available in an increasingly centralized way enabling presentation on relevant task-orientated workstations. This reduces the workload of the navigating officer, master or pilot and otherwise eases the task of navigation.

3 Sophisticated bridge navigational systems are increasingly integrated with each other and with other kinds of systems on the ship. This, as well as the implicit ability of these systems to influence each other, increases complexity. As such it is of increasing importance that these systems are usable and available at all times in a reliable and resilient fashion.

RCO 2: Bridge alert management

4 On a bridge with no centralized alert management system, problems in properly identifying alerts may arise. Additionally, alerts from various sources may not be prioritized by importance with regards to safe navigation. Potentially unnecessary distractions of the bridge team by redundant and superfluous audible and visual alarm announcements may occur, increasing the cognitive load on the bridge team.

5 The relevant performance standards for central alert management are specified in resolutions MSC.252(83) on *Adoption of the revised performance standards for Integrated Navigation Systems (INS)* and MSC.302(87) on *Adoption of performance standards for Bridge Alert Management.*

RCO 3: Standardized mode(s) for navigation equipment

6 In order to aid the navigating officer, navigation equipment manufacturers and suppliers are continuously developing their products to include a rapidly increasing number of sophisticated functionalities. As the different suppliers follow different generation and presentation philosophies, and in part different terminology, this introduces the risk of the bridge team not being able to access or use all the available functions, not being able to produce a familiar setup of the equipment, and consequently not being able to obtain information required for navigational decision-making.

7 Safe navigation relies on the ability of key personnel of the bridge team to easily operate navigational equipment as well as to comprehend the information that is presented to them. Without proper familiarization, which can sometimes take a significant period of time due to the current differences between operating systems, this is not always the case when someone is new to a particular setup. Lack of familiarity with bridge equipment can result in slow or inappropriate responses due to not finding correct information, system, control function or alarm, and is therefore adversely affecting the safe navigation of the ship.

8 Standard modes or default display configurations are envisaged for relevant navigational equipment. Such standard mode(s) should be selectable at the task station and would reset presentation and settings of information to provide a standardized and common display familiar to all users. The standard mode should be accessible by a simple operator action. The standard or default settings would act as a starting point for a user to build the optional settings appropriate for a particular task. Those optional settings could be then saved by the user and be recalled later by a single operator action.

9 Standardized information presentation, symbols and coding should be used according to resolution MSC.191(79) on *Performance standards for the presentation of navigation-related information on shipborne navigational displays*. There should be a standard or default user interface mode (accessible by a simple operator action) and associated display configuration for relevant navigational equipment.

RCO 4: Automated and standardized ship-shore reporting

10 A potential for reducing workload due to filling out and delivering reportable information has been identified. Forms are usually manually filled out and sent individually to each authority requesting the information. Hence there is a significant potential for reduction of paper work and administrative burden.

11 Standardized ship-shore electronic reporting has been the subject of recent work done by the Facilitation Committee and by the European Commission.

RCO 5: Improved reliability and resilience of onboard PNT systems

12 The primary aim of position fixing is to ensure a ship is correctly following its passage plan. Systems such as Global Navigational Satellite Systems (GNSS) provide position and timing information. Other information can be derived from multiple position fixes and timing such as velocity or course and speed over the ground. Changes in velocity and course over time can also yield other information such as rate of turn. Together this set of information is commonly referred to as Position Navigation and Timing (PNT). Ensuring reliable and resilient PNT data is particularly important for safe navigation at sea.

13 Resilience is the ability of a system to detect and compensate for external and internal sources of disturbances, malfunction and breakdowns in parts of the system. Achieving resilient PNT does not imply any setting up of additional GNSS or terrestrial systems, but may use information from such systems, should they exist. Reliability is the probability that the PNT system, when it is available, performs a specified function without failure under given conditions for a specified time.

14 Provision of resilient PNT information can be achieved through a combination of existing space-based and terrestrial systems, modernized and future radio navigation systems, ship-based sensors and other services.

15 Caution must be exercised against the use of differing systems for PNT in different regions of the world. Such a move would potentially create circumstances resulting in new risks for navigation, as seafarers will potentially need to change their practices when travelling between regions. Another issue is that ships could be optimized to navigate only in particular regions with certain types of PNT solutions. This also could impact upon achieving a uniform training regime for seafarers. The implementation of e-navigation should as much as possible employ a consistent approach to the provision of PNT for marine navigation worldwide.

16 In order to increase the reliability and resilience of PNT information on board, an appropriate functional, goal-based performance standard for a PNT data processing unit might be drafted, which would operate using sensor fusion techniques. This performance standard should not be tied to particular technologies.

17 In addition to GNSS/regional satellite systems and potential satellite-independent terrestrial systems, the following could assist in ensuring resilient PNT:

.1 inertial navigation systems;

.2 signals of opportunity, such as radio, radar, sonar, echo sounder, etc.;

.3 electronically-enabled human-observed bearings and distances (i.e. modern electronic coastal navigation using an e-pelorus, radar and ECDIS);

.4 autonomous celestial navigation; and

.5 other possibilities that could arise from research, for example in the areas of defence and robotic vehicle navigation.

RCO 6: Improved shore-based services

18 VTS, ports and other shore-based stakeholders gather and hold various information regarding navigational warnings, incidents, operations, tide, AIS, traffic regulations, chart updates, meteorological conditions, ice conditions, etc., which is often referred to as the Maritime Services.

19 Implementation of a system for automatic and digital distribution of shore support services would make information more available, updated and relevant for navigation officers.

20 Firstly, Maritime Safety Information (MSI) received by the ship should be relevant to the ship's specific voyage. Today, broadcasted MSI is delivered as printed text from a NAVTEX receiver and must be considered for action. As the Officer of Watch (OOW) may potentially receive several MSI messages daily, a large portion of which may not be of concern to the voyage, there is the risk of missing vital MSI. Important MSI could easily be overlooked. The MSI should be displayed in relation to the information it relates to and is being used on the bridge in the correct place.

21 Secondly, Notices to Mariners, updates to ENC's and corrections to all nautical publications should be received electronically without any delays in the delivery. Distribution via post is time-consuming and may introduce risks to the ships sailing in waters, for which the nautical charts are not up to date.

22 As e-navigation evolves, broadband communications need to become more cost-effective and readily available. Changes that should be made to current regulatory regimes (e.g. performance standards) should be done in a structured way, so that new systems can be included. This will ensure their use is compliant with the various existing navigational equipment and services, while not limiting the possibilities for new approaches that could offer benefits such as reduced costs and improvements in efficiency and effectiveness.

23 The most appropriate platform to present MSI may be either the INS tasks "Route monitoring" and "Status and data display" (resolution MSC.252(83)) or the ECDIS unit and optionally on another shipborne navigational display. Notices to Mariners, updates and

corrections to ENCs and all nautical publications should be able to be received electronically with minimal delay in delivery. Such updates and corrections should, in the future, be fully integrated into the INS tasks *route monitoring and status and data display* (resolution MSC.252(83)) or the ECDIS unit and optionally on another navigational displays. Thus, such updates and corrections should not be reliant on formats such as pdf or require the navigation officer to manually transfer updates and corrections between source and navigation device.

RCO 7: Bridge and workstation layout standardization

24 Cumbersome equipment layout on the bridge adversely influences the seafarer's ability to optimally perform navigational duties. Although some good bridge layout designs exist with respect to ergonomics, this is an area identified as insufficiently regulated so as to ensure a consistent acceptable level of functionality.

25 Reference should be made to SOLAS regulation V/15 on *Principles relating to bridge design, design and arrangement of navigational systems and equipment and bridge procedures,* MSC/Circ.982 on *Guidelines on Ergonomic Criteria for Bridge Equipment and Layout,* SN.1/Circ.265 on *Guidelines on the Application of SOLAS regulation V/15 to INS, IBS and bridge design,* SN.1/Circ.288 on *Guidelines for bridge equipment and systems, their arrangement and integration (BES)* and ISO8468 on *Ships Bridge layout and associated equipment.*

26 The *Guideline on Software Quality Assurance and Human-Centred Design for e-navigation* (MSC.1/Circ.1512), already developed under the IMO e-Navigation Strategic Implementation Plan (SIP), is relevant to this RCO.

27 Seafarers may experience difficulties in accessing necessary information because of ergonomic problems, such as inappropriate physical bridge locations of navigational equipment. Ergonomic problems of navigation equipment also exist in the sense that there is a lack of intuitive human-machine interface for communication and navigation means. Bridge layouts, equipment and systems have not been consistently and sufficiently designed from an ergonomic and usability perspective. Lack of familiarity with bridge equipment and/or slow response due to not finding correct information/control/alarm is considered to adversely affect safe navigation.

ANNEX 2

DETAILED EXPLANATION OF THE PROPOSAL OF THE MARITIME SERVICES TO BE USED IN MARITIME SERVICE PORTFOLIOS

Maritime service No	Identified services	Identified service provider	Short description
1	VTS Information Service (INS)	VTS Authority	The VTS Information Service (INS) is defined as "a service to ensure that essential information becomes available in time for onboard navigational decision making". Relevant information is broadcast at fixed times and intervals or provided when deemed necessary by the VTS or at the request of a vessel. A VTS INS involves maintaining a traffic image and allows interaction with traffic and response to developing traffic situations. An Information Service should provide essential and timely information to assist the onboard decision-making process, which may include but is not limited to: • the position, identity, intention and destination of vessels; • amendments and changes in promulgated information concerning the VTS area such as boundaries, procedures, radio frequencies, reporting points; • the mandatory reporting of vessel traffic movements; • meteorological and hydrological conditions, Notices to Mariners, status of aids to navigation; • manoeuvrability limitations of vessels in the VTS area that may impose restrictions on the navigation of other vessels, or any other potential hindrances; or • any information concerning the safe navigation of the vessel. The INS is designed to improve the safety and efficiency of vessel traffic and to protect the environment. Among others, such services include routeing, channel info, security level, berthing, anchorage, time slot, traffic monitoring and assessment, waterway conditions, weather, navigational hazards, any other factors that may influence the vessel's transit, reports on the position, identity and intentions of other traffic.

Maritime service No	Identified services	Identified service provider	Short description
2	Navigational Assistance Service (NAS)	VTS Authority	The NAS is defined as "a service to assist onboard navigational decision-making and to monitor its effects". NAS may be provided on request by a vessel in circumstances such as equipment failure or navigational unfamiliarity. Specific examples of developing situations where NAS may be provided by the VTS include: risk of grounding; vessel deviating from the recommended track or sailing plan; vessel unsure of its position or unable to determine its position; vessel unsure of the route to its destination; assistance to a vessel to an anchoring position; vessel navigational or manoeuvring equipment casualty; inclement conditions (e.g. low visibility, high winds); potential collision between vessels; potential collision with a fixed object or hazard; assistance to a vessel to support the unexpected incapacity of a key member of the bridge team, on the request of the master.
3	Traffic Organization Service (TOS)	VTS Authority	The TOS is defined as "a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area". The purpose of the TOS is to prevent hazardous situations from developing and to ensure safe and efficient navigation through the VTS area. TOS should be provided when the VTS is authorized to provide services, such as when: • vessel movements need to be planned or prioritized to prevent congestion or dangerous situations; • special transport or vessels with hazardous or polluting cargo may affect the flow of other traffic and need to be organized; • an operating system of traffic clearances or sailing plans, or both, has been established; • the allocation of space needs to be organized; • mandatory reporting of movements in the VTS area has been established; • special routes should be followed; • speed limits should be observed; • the VTS observes a developing situation and deems it necessary to interact and coordinate vessel traffic; and • nautical activities (e.g. sailing regattas) or marine works in-progress (such as dredging or submarine cable-laying) may interfere with the flow of vessel movement.

Maritime service No	Identified services	Identified service provider	Short description
4	Local Port Service (LPS)	Local Port/Harbour Operator	LPS is applicable to those ports where it has been assessed that a VTS, as described above, is excessive or inappropriate. The main difference arising from the provision of LPS is that it does not interact with traffic, nor is it required to have the ability and/or the resources to respond to developing traffic situations and there is no requirement for a vessel traffic image to be maintained. Provision of LPS is designed to improve port safety and coordination of port services within the port community by dissemination of port information to vessels and berth or terminal operators. It is mainly concerned with the management of the port, by the supply of information on berth and port conditions. Provision of LPS can also act as a medium for liaison between vessels and allied services, as well as providing a basis for implementing port emergency plans. Examples of LPS may include: • berthing information; • availability of port services; • shipping schedules; and • meteorological and hydrological data. A number of web-based LPS services are being developed. An example is AVANTI, an initiative of the International Harbour Masters Association (IHMA).
5	Maritime Safety Information Service (MSI)	National Competent Authority	The Global Maritime Distress and Safety System (GMDSS) as described in SOLAS chapter IV defines the seventh functional requirement as: "Every ship, while at sea, shall be capable of transmitting and receiving maritime safety information". The MSI service is an internationally coordinated network of broadcasts of Maritime Safety Information from official information providers, such as: • National Hydrographic Offices, for navigational warnings and chart correction data; • National Meteorological Offices, for weather warnings and forecasts; • Rescue Co-ordination Centres (RCCs), for shore-to-ship distress alerts; and • the International Ice Patrol, for Oceanic ice hazards.

Maritime service No	Identified services	Identified service provider	Short description
			Specific information on Aids to Navigation and restrictions on safe navigation are part of MSI services provided by national authorities. This can include, but is not limited to, the following type of information to be available to seafarers: • status of Aids to Navigation; • status of GPS and DGPS; • buoy tendering operation; and • restriction on safe navigation such as bridge/hydro cable air gap, new hazards, construction or dredging operations.
6	Pilotage Service	Pilotage Authority/ Pilot Organization	The aim of the pilotage service is to safeguard traffic at sea and protect the environment by ensuring that vessels operating in pilotage areas have pilots with adequate qualifications and local knowledge for safe navigation. Each pilotage area needs highly specialized experience and local knowledge on the part of the pilot. Efficient pilotage depends, among other things, upon the effectiveness of communications and information exchanges between the pilot and the master as well other bridge team members with the understanding that each has functions and duties related to each other. The Pilot's Portable Unit (PPU) is a useful tool for safe navigation in clear and restricted visibility. Data accessible by the PPU should be made available in a structured, harmonized and reliable manner, and the interface for accessing such e-navigation information should be standardized. Establishment of effective coordination between the pilot, the master and the bridge personnel, taking due account of the ship's systems and equipment available to the pilot, will aid a safe and expeditious passage (see resolution A.960(23)).
7	Tugs Service	National Competent Authority; Local Port/Harbour Authority	Efficient tug operations depend on, among other things, the effectiveness of the communications and information exchanges between relevant stakeholders. The aim of the tug services is to safeguard traffic at sea and protect the environment by conducting operations such as: • transportation (personnel and staff from port to anchorage) operations; • ship assistance (i.e. mooring) operations; • salvage (grounded ships or structures) operations; • shore operations;

Maritime service No	Identified services	Identified service provider	Short description
			• towage (harbour/ocean) operations; • escort operations; and • oil spill response operations.
8	Vessel Shore Reporting	National Competent Authority and appointed service providers	The aim of vessel shore reporting is to safeguard traffic at sea, ensure personnel safety and security, protection of the marine environment and increase the efficiency of maritime operations. Single window is one of the most important solutions to reduce the seafarer's workload (amount of time spent on preparing and submitting reports to shore-based authorities). To achieve this, reports should be automatically generated as much as possible from onboard systems. Some other important possibilities for a vessel shore reporting system may include: • single-entry of reportable information in single window solution; • automated collection of internal ship data for reporting; • all national reporting requirements to apply standardized digital reporting formats based on IMO FAL forms; and • automated or semi-automated digital distribution/communication of required reportable information.
9	Telemedical Assistance Service (TMAS)	National health Organization/ dedicated health Organization	TMAS centres provide medical advice for seafarers 24 hours/day, 365 days/year. TMAS are permanently staffed by physicians qualified in conducting remote consultations and who are well versed in the particular nature of treatment on board ship. Within the maritime medicine the prevailing view has for a long time been that a standardization of the TMAS services is both necessary and wanted. This would firstly enhance the quality of the medical practice, and secondly, a standardization of reporting and registering of medical treatments provides the basis for advancement.
10	Maritime Assistance Service (MAS)	Coastal/Port Authority/ Organization	The primary mission of MAS is to receive reports from ships in the event of an incident involving a ship and/or where a ship is in need of assistance. The MAS is operational on a 24-hour basis to organize rapid assistance and professional support for ships in connection with combating pollution, fire and explosions on board, collision, grounding, etc., but not requiring rescue of persons (see resolution A.950(23)).

Maritime service No	Identified services	Identified service provider	Short description
			The MAS is responsible only for receiving and transmitting communications and monitoring the situation. It serves as a point of contact between the master and the coastal State concerned if the ship's situation requires exchanges of information between the ship and the coastal State. Situations where the MAS apply are as follows: • ship involved in an incident (loss of cargo, accidental discharge of oil, etc.) that does impair its seakeeping ability but nevertheless has to be reported; • ship in need of assistance according to the master's assessment, but not in a distress situation that requires the rescue of personnel on board; and • ship in a distress situation and those on board have already been rescued, with the possible exception of those who have remained aboard or have been placed on board to attempt to deal with the ship's situation. The MAS entails the implementation of procedures and instructions enabling the forwarding of any given information to the competent organization and requiring the organizations concerned to go through the MAS in order to make contact with the ship.
11	Nautical Chart Service	National Hydrographic Authority/ Organization	The aim of the nautical chart service is to provide nautical chart information such as nature and form of the coast, water depth, tides table, obstructions and other dangers to navigation, location and type of aids to navigation. The Nautical Chart service also ensures the distribution, update and licensing of electronic charts to vessels and other parties.
12	Nautical Publications Service	National Hydrographic Authority/ Organization	The term nautical publications refers to the set of nautical information available for a particular sea area or port. It comprises nautical charts, information on ports, navigational aids ashore and at sea as well as the contact information of authorities and services for a sea area or port, such as sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage (SOLAS regulation V/27).
13	Ice Navigation Service	National Competent Authority Organization	The ice navigation service is critical to safeguard the ship navigation in ice-infested waters, given how quickly the ice maps become outdated in the rapid changing conditions of ice-covered navigational regions. Such services include: • ice condition information and operational recommendations/advice; • ice condition around a vessel;

Maritime service No	Identified services	Identified service provider	Short description
			• vessel routeing; • vessel escort and ice breaking; • ice drift load and momentum; and • ice patrol.
14	Meteorological Information Service	National Meteorological Authority/ Public Institutions	The meteorological service is essential to safeguard the traffic at sea by providing weather and climate digital forecasts and related information to seafarers who use these types of information to support their decision-making. Such information includes: • weather routeing, solar radiation and precipitation; • cold/hot durations and warnings; • air temperature, wind speed and direction; and • cloudiness and barometric pressure.
15	Real-time hydrographic and environmental information service	National Hydrographic and Meteorological Authorities	The real-time hydrographic and environmental information service is essential to safeguard navigation at sea and protect the environment. The services provided include: • current wind speed and direction; • wave height; • marine habitat and bathymetry; • sailing Directions (or pilots): detailed descriptions of areas of the sea, shipping routes, harbours, aids to navigation, regulations, etc.; • lists of lights: descriptions of lighthouses and lightbuoys; • tide surge prediction tables and tidal stream atlases; • ephemerides and nautical almanacs for celestial navigation; and • Notices to Mariners: periodical (often weekly) updates and corrections for nautical charts and publications.
16	Search and Rescue Service (SAR)	SAR Authorities	The SAR service performs distress monitoring, communication, coordination and search and rescue functions, including provisions of medical advice, initial medical assistance or medical evacuation, through the use of initial medical assistance. A Maritime Rescue Coordination Centre (MRCC) provides reliable communication links to the system's network for efficient handling of shore-to-ship distress alert relays and distress traffic.

Maritime service No	Identified services	Identified service provider	Short description
			In maintaining a state of full readiness the MRCC may perform rescue functions for the following: • survivors of any aircraft (not in an act of war) crashes or forced landings at sea; • crew and passengers of vessels in distress; and • survivors of maritime accidents or incidents. The SAR services must also coordinate the evacuation of a seriously injured or ill person from a vessel at sea when the person requires medical treatment sooner than the vessel would be able to get him or her to a suitable medical facility. MRCCs may also be pro-actively involved in activities such as: • information collection, distribution and coordination; • monitoring towing operations; • monitoring and evaluating levels of risk from Maritime Safety Information (MSI) broadcasts to ensure an immediate response in case of life-threatening situations developing; • monitoring vessels not under command; and • pollution reports and vessels aground. E-navigation can provide additional information such as number of persons on board, type of ship, port of destination, etc. and enable provision of additional information such as available SAR resources on board ships, etc. Information on other vessels in the area can be crucial for an effective rescue. Communication solutions used for e-navigation will be able to exchange information about SAR areas and allocate search patterns and provide facilities for MRCCs to set up a common information sharing log or chatroom for MRCCs, on-scene coordinators and other resources to share and update information during a SAR incident.

ANNEX 3

USER NEEDS AND PRIORITIES

Shipboard user needs and priorities

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Human Machine Interface Issues				
Improved Ergonomics Seafarers have expressed a desire for bridge layouts, equipment and systems to be better designed from an ergonomic and user-friendly perspective.	Many ship bridges have been designed without much thought given to the effective layout of equipment or workstations. Seafarers have expressed that in an e-navigation era, work stations, navigation displays, communication devices and other bridge equipment must be designed to improve effective bridge operation. Such layouts should take into account expanded bridge teams, including the pilot.	• Human-Machine Interface • Human-centred presentation needs	Harmonize and apply existing documentation. Take note of: IMO documents: • Resolution MSC.252(83) (*Adoption of the Revised performance standards for Integrated Navigation Systems (INS)* – valid for equipment installed on or after 1 January 2011) • Resolution MSC.86(70), annex 3 (*Performance standards for an Integrated Navigation System (INS)* – valid for equipment installed on or after 1 January 2000 but before 1 January 2011) • MSC/Circ.982 (*Guidelines on Ergonomic Criteria for Bridge Equipment and Layout*) • Resolution MSC.191(79) (Performance standards for the presentation of navigation-related information on shipborne navigational displays) • Other industry standards.	It should be noted that much work has been done in this area, however not widely applied. Consideration of more prescriptive bridge layout requirements. Consideration of more prescriptive work station requirements. Better application of centralized and effective dimming of screens. Innovations and new technology solutions should concentrate on the needs and capabilities of the users. Promotion of access to information at one place where appropriate (multi-functional workplaces). Methodology to consider usability of navigational equipment.

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Standard Interface Seafarers expressed a desire for greater standardization of functionality for navigation displays (human-machine interface).	Navigation system functions, operations and presentation (including ECDIS, Radar, AIS, GPS, GMDSS, etc.) can vary widely between manufacturers and even between models by a single manufacturer. The differences include where certain information is displayed (i.e. Speed and Course), how it is displayed, menu functions and interface devices such as knobs or joysticks. This makes type specific training difficult, and leads to ineffective use of features particularly by those watchkeepers who are new to a ship.	• Human-centred presentation needs • Human-machine interface • Analysis	Research should be conducted regarding the functionality of standard interfaces. Take note of: IMO documents: • Resolution MSC.191(79) (Performance standards for the presentation of navigation-related information on shipborne navigational displays) • Resolution MSC.252(83) (Adoption of Revised performance standards for Integrated Navigation Systems (INS)) Other industry standards.	Design specification for current equipment. Note should be made of concept of S-Mode. Need to update and establish balance between standardization and innovation.
Familiarization Requirements Seafarers need all safety-related equipment to be provided with familiarization material specific to the model and installation.	Seafarers often join ships where non-standard equipment and functions exist. It was thought that if these pieces of equipment or systems could be provided with familiarization material or tutorials, safety would improve.	• Human-machine interface • Analysis • Implementation issues	Identify where familiarization material specifications need to be developed for existing and developing performance standards. Take note of: IMO document (SN.1/Circ.274) *Guidelines for application of the modular concept to performance standards*.	Consideration should be given to requiring such familiarization material to be provided by the manufacturer. Consider for example using *INS Performance Standards* (resolution MSC.252(83)).

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
User-selectable presentation of information received via communication equipment	Seafarers expressed a desire to have the possibility to present user-selectable information received via communication equipment on the navigational displays (e.g. ship in distress, wind speed/ direction, AtoN status, restricted areas). They further requested the possibility to filter some transmitted data for presentation according to user-set parameters (e.g. only information from user-selected sea areas).	• Effective communication: • Human-centred presentation needs • Human-machine interface • Analysis	Research should be conducted regarding the type of information, equipment and systems involved and how to present and/or filter such information.	Availability of information in real-time with possible presentation on the shipborne navigational displays. Information overload needs to be prevented, therefore, presentation of information should be user-selectable to filter required information. Task-oriented presentation based on INS-tasks (resolution MSC.252(83)).
Maritime Safety Information (MSI) Seafarers expressed a desire to sort and display MSI, such as NAVTEX, SafetyNET, more effectively.	On most ships, NAVTEX information is displayed on a separate screen or printed on a scroll of paper. The Latitude and Longitude of the MSI must then be compared to that of the ship by the watchkeeper to identify whether the information is relevant and poses a risk. For example, notifications of new and dangerous wreck carriers are not prioritized over drifting buoys, possibly hundreds of miles away from the ship's intended route. This is a very time-consuming and distracting task, and susceptible to human error. Seafarers considered that presenting such safety information on the ship's navigation display would be far more effective and a clear benefit of e-navigation.	• Effective communication • Human-centred presentation needs • Human-machine interface • Analysis	Work with relevant stakeholders to address technical requirements for presenting MSI on shipborne navigation displays. Take note of Methodology for developing e-navigation user needs using a task-based approach (NAV 55/11/4).	Possible re-formatting of NAVTEX data and continuing with transmitting data on same frequencies. Transition from old to new format. Task-oriented presentation based on INS-tasks (resolution MSC.252(83)).

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Alert Management Bridge alerts (emergency alarms, alarms, warnings and cautions) must be coordinated, weighted, and support decision-making without undue distraction.	It is not uncommon for the bridge of a ship to have in excess of 500 alarms pertaining to navigation, propulsion, cargo and communication systems. These alarms are usually uncoordinated, physically located all over the bridge, and give little indication of severity without interrogation, which distracts the navigator. As systems become increasingly complex, all bridge alarms must be coordinated to avoid undue distraction.	• Human-centred presentation needs • Data and system integrity • Analysis	Investigate possibility to apply existing IMO regulations to INS alert management and bridge alert management. Take note of: IMO documents: • Resolution A.1021(26) on *Code on Alerts and Indicators, 2009* • Resolution MSC.252(83) (INS) • Resolution MSC.302(87) on *Performance standards for Bridge Alert* Management	
Indication of Reliability	Seafarers have expressed a concern that on systems such as ECDIS, the ship's position is always indicated as an absolute, leaving seafarers to rely on their understanding of technically complex systems to assess the accuracy of such indicated positions. Seafarers have expressed a desire for systems to automatically assess the accuracy and integrity of hydrographic data, position fixing data, radar, and other ship sensors to return a graphical indication of assessment.	• Human-centred presentation needs • Human-machine interface • Data and system integrity • Analysis	Investigate effective ways to indicate levels of reliability using graphical representation. Take note of: • Resolution MSC.252(83) (INS) • Other industry standards.	Consideration of using, e.g. ellipses of uncertainty to indicate expected accuracy. Consideration of using, e.g. colour or shading changes to indicate integrity of information.

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Operational Issues				
Improved Reliability Before seafarers are confident in e-navigation systems, they must prove far more reliable than many of the present systems.	Seafarers today often struggle with electronic equipment that fails or malfunctions in some respect. This may relate to poor performance from radar; electronic chart software faults; incorrect AIS data, GMDSS alerts or loss of position fixing systems. Even a 99% reliability rating would result in a problem for 1 voyage in every 100. This has resulted in many seafarers distrusting electronic systems, and now having grave doubts about relying on e-navigation. It must be recognized that there is little competence for fixing such systems on board, and obtaining the services of a qualified technician in some ports can be difficult.	• Effective and robust communications • Data and system integrity	It will be necessary to carry out an assessment to quantify reliability parameters. To include specific assessment of reliability of electronic position fixing systems.	Design specification for current equipment. Type approval process. Competence of installation and repair technicians. Better control and visibility of software and hardware updates.
Standardized and automated reporting Seafarers have expressed a keen desire to reduce the amount of ship/shore reporting and to adopt the principle of single entry for any information into the system. They have further expressed a desire for globally standardized reporting procedures and forms to avoid repetition of reporting and to reduce workload.	A major frustration and distraction for seafarers is the repeated reporting of static and dynamic information pertaining to the ship, cargo, crew, and voyage to shore authorities. A major benefit of e-navigation would be for a ship's crew to enter such information into their system only once and for it to be shared by authorized authorities without further intervention by the ship.	• Common maritime information/data structure • Automated and standardized reporting functions • Effective and robust communications	Investigate methods for global standardization of reporting procedures and technology. Investigate the legal aspects associated with access and sharing of information.	Possible increased use of AIS. Possible increased demands on communication means, i.e. spectrum and bandwidth.

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Improved Target Detection Seafarers would be grateful if e-navigation could facilitate better detection of targets.	Seafarers are constantly concerned with identifying targets, including leisure and fishing craft, pirates, flotsam and jetsam, ice, etc. Better detection of small targets is considered a priority.	• Effective and robust communications • Human-centred presentation needs • Data and System Integrity • Analysis	Investigate technologies to assist with better detection of targets and risk of collision.	High resolution X-band NT radar has potential benefit in this area.
Guard Zones Seafarers expressed a desire to have more effective Guard Zones to notify watchkeepers of hazards pertaining to collisions and groundings.	As target detection become more effective, MSI becomes integrated, and passage plans are programmed in ECDIS, seafarers feel that guard zones in three dimensions can be an effective way to warn watchkeepers of undetected hazards. This should include hazards of grounding taking into account UKC in a dynamic environment; air draft; and risk of collision. Warnings from this Guard Zone feature should be integrated into the bridge alert system.	• Human-centred presentation needs • Human-machine Interface • Data and system integrity • Analysis	Research effective means of implementing the use of Guard Zones or other means in order to avoid collisions and groundings.	It should be noted that the use of such Guard Zone facility will need to be intrinsic in the training syllabus. Use of Guard Zones must be taught as a decision support feature. Many ships have aspects of Guard Zones on present equipment but don't use them due to poor training with reference to their function and their value.
Reduction of administrative burden and increase use of electronic documentation	Seafarers expressed the need to reduce the amount of administrative work on board. They also expressed a desire to replace paper information and documentation by electronic means for easy location of information.	• Human-centred presentation needs • Data and system integrity	Investigate the best way to harmonize and present maritime documentation in an electronic format to improve efficiency and reduce administrative burden.	Electronic documents should support: easy localization of information (e.g. with the help of a search function); automatic updates (e.g. of Notices to Mariners); possible integration of information from multiple sources; the integration of information in other systems on the bridge (e.g. ECDIS) electronic documents should be printable or be additionally provided as paper version; the need for traceability and ability to audit.

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Automated Updating of Baseline Data and Documents Seafarers expressed a desire for documents such as charts and voyage planning publications to be automatically updated, with minimal shipboard intervention.	Seafarers are required to use a plethora of publications associated with voyage planning and monitoring. These include, but are not limited to: charts, lights list, lists of radio signals, sailing directions, port guides, etc. Currently, most of these are kept on board in paper format and require a considerable amount of time to keep constantly updated. Seafarers believe that e-navigation can be of benefit if it ensures that all these sources of information are automatically maintained up to date, and all of this information is accessible from a centralized location. Seafarers have also expressed a desire for this information to be easy to access, sort and make sense of. This may be achieved by standard formats or smart systems. Seafarers are very concerned that e-navigation may lead to more information being made available to them, leading to further overburdening. It is essential that the provision of information via e-navigation should be managed and presented effectively.	• Common maritime information/data structure • Effective and robust communications • Human-centred presentation needs • Analysis	Investigate and harmonize means for automated updating of baseline data and documents, including consideration of legal aspects communication costs.	Consideration should be given to a proper electronic format for the data rather than digital copies of existing paper publications. This would allow the presentation of relevant data in a succinct manner. The need for traceability and ability to audit.
Effective and robust communications	A clear need was expressed for there to be an effective and robust means of communications for ship and shore users. Shore-based users require an effective means of communicating with ships to facilitate safety, security and environmental protection and to provide operational information. To be effective, communication with and	• Automated and standardized reporting functions • Effective and robust communications • Common marine/data structure	Research into how voice and digital communication can be made more effective. Plan for greater use of IMO SMCP (resolution A.918(22)). Identify reliability standards for communication technology.	Route exchange. Use of AIS application specific messages. Use of Wireless technology (Wi-Fi and Wi-MAX).

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
	between ships should make best use of audio/visual aids and standard phrases to minimize linguistic challenges and distractions to operators. Research has indicated that a high percentage of seafarers regard language incompatibility and non-standard phrases as a major problem. They also highlighted equipment failure and busy communication channels a concern that needed to be addressed.	• Data and system integrity • Human-centred presentation needs	Identify communication capacity issues to ensure adequate bandwidth for essential communication needs.	

Shore-based user needs

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Collection of information	Complete marine domain awareness is essential for the early identification of risks and effective response. The collection of information is necessary to build an enhanced domain awareness, to support safety, security, environment protection and efficiency. This allows for faster and more informed decisions. There are rules that require coastal States to maintain domain awareness. There is currently a gap between the information collected and information required. A change in the type of service offered by a VTS (i.e. Information Service, Navigational Assistance Service or a Traffic Organization Service) may change the functional requirements of the domain awareness system.	• Common maritime information/ data structure • Automated and standardized reporting functions • Effective and robust communications • Data and system integrity • Analysis	Identify the data that will be required. Identify the data sources that will be required. Identify the key data providers, the standards that apply, the types of data they provide and any limitations. Identify the relationship between key data providers and users. Identify relevant legislation. Identify harmonization needs for standards, formats and protocols. Develop a system to allow the global exchange of ship and other maritime reporting data.	Such information may include both static and dynamic information including hydrographic, environmental, vessel data, AtoN information and known hazards. Take into account AIS and GMDSS standards. Take into account the functionality of existing web-based systems. Take into account the development of Service Level Agreements with data providers. Take into account existing ship reporting systems. There are a multitude of communication methods that should be considered. Consideration will need to be given to legal and liability issues, specifically with regard to the handling of data. Take into account the lessons learnt from development of ECDIS.

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Management of information	Shore authorities need tools for managing increased levels of information pertaining to the maritime domain awareness. A harmonized and holistic approach to information management will enable shore authorities to manage resources more efficiently. The harmonized and enhanced presentation of domain awareness will improve situational awareness for allied[1] and other support services. Enhanced information management is required for improving logistics management and in support of safety, security and environment protection. Currently, there are major challenges to managing and sharing a diverse range of information from dissimilar systems. Current systems suffer without a harmonized approach to quality and structure.	• Common maritime information/data structure • Automated and standardized reporting functions • Effective and robust communications • Human-centred presentation needs • Data and system integrity • Analysis	Identify the sources and ownership of information to be managed. Identify communication methods/ variety of communication methods. Identify quality parameters for different types of information, including accuracy, reliability, latency, etc. Identify specific requirements for alerting for the loss of integrity or system failure. Identify the legal issues pertaining to capturing, storing and sharing data. Seek to harmonize policies for the security and use of data.	A gap analysis should be used to identify the capability of present information management systems to deal with an increasing amount of information in a timely manner. Take into account best practice for information management and examples from other industries, such as aviation. Take into account the benefits of open architecture systems.

[1] Allied services are services actively involved in the safe and efficient passage of the vessel through the VTS area (IMO resolution A.857(20)).

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Provision of information to ships	Shore authorities have an obligation to provide maritime information to ships. There is a need to improve the delivery and presentation of such information to enhance onboard decision-making. Effective and harmonized communication should allow for the provision of such information in an operationally effective manner.	• Common maritime information/ data structure • Automated and standardized reporting functions • Effective and robust communications • Human-centred presentation needs • Data and system integrity • Analysis	Identify the information necessary to be provided to vessels, taking into account the responsibility assigned to the shore-based provider. Identify the means of communicating the information to vessels.	Consider the efficient provision of relevant information pertaining to logistics and commercial activities. Consider how to provide information to the seafarers efficiently and effectively. This pertains to traffic information, MSI, security-related information, updates to nautical publications, met-ocean information, etc. Take into account the need for scalability. Consider a facility for shore authorities to assess the real time status of shore systems and to disseminate this information as appropriate. Take into account the use of AIS binary messages.
Quality assurance	The shore authority needs to have confidence that the navigation systems being used on board are operating correctly. Shore authorities need to be confident that the information which they receive from and send to the ship is correct. Shore authorities have a need to be capable of establishing effective communication with bridge teams and other shore users.	• Common maritime information/ data structure • Automated and standardized reporting functions • Effective and robust communications • Data and system integrity • Analysis	It will be necessary to carry out an assessment to quantify reliability parameters, taking into account existing IEC standards/IMO Performance Standards for onboard equipment. Investigate the technical and procedural capabilities for monitoring quality. Consider how information can have a quality rating.	Consider how shore authorities are assured of the navigation system status on board ships in real time. And for system faults ashore to be brought to the attention of seafarers as appropriate. Consider the effectiveness of communications in terms of technology and language. Consider legal and liability issues.

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
Shore-to-shore information exchange	Shore authorities need an enhanced ability to share maritime information amongst authorized shore users to ensure consistency and reduce the reporting burden by ship personnel. More effective shore-to-shore information exchange will aid safety, security, the identification of risk, environmental protection and improve logistics management.	• Common maritime information/ data structure • Automated and standardized reporting functions • Effective and robust communications • Human-centred presentation need • Data and system integrity • Analysis	Identify and/or develop necessary protocols, formats and data structures. Investigate methods for global data sharing. Identify relevant legal and regulatory implications.	Consider the need for data security and ownership issues. Consider work done in other relevant industries. Consider the use of standard data exchange protocols.
Effective and robust communications	A clear need was expressed for there to be an effective and robust means of communication for ship and shore users. Shore-based users require an effective means of communicating with ships to facilitate safety, security and environmental protection and to provide operational information. To be effective, communication with and between ships should make best use of audio/visual aids and standard phrases to minimize linguistic challenges and distractions to operators. Research has indicated that a high percentage of seafarers regard language incompatibility and non-standard phrases as a major problem. They also highlighted equipment failure and busy communication channels as concerns that needed to be addressed.	• Automated and standardized reporting functions • Effective and robust communications	Research into how voice and digital communication can be made more effective. Plan for greater use of IMO SMCP (resolution A.918(22)). Identify reliability standards for communication technology. Identify communication capacity issues to ensure adequate bandwidth for essential communication needs.	

SAR authority user needs for e-navigation

User need	Justification	Relation to IMO strategy	Priority in terms of work required	Issues to consider
SAR should have access to relevant information contained within the e-navigation domain.	SAR need a full range of information pertaining to ships and their domain to support the saving of lives.	• Common data structure • Automated reporting • Robust communications data integrity		
Effective Communication and information sharing.	SAR must be able to use the e-navigation infrastructure to communicate and share information effectively with all parties involved in an incident.	• Common data structure • Automated reporting • Robust communications data integrity		
Priority for distress communications.	Within the e-navigation domain, distress communications should take priority over all other communications.	• Common data structure • Automated reporting Robust communications data integrity		
SAR Authorities need access to the details of all relevant onboard communication equipment and capabilities.	To maximize incident response, SAR need to be able to determine the best means for communications.			

ANNEX 4

LIST OF STANDARDS THAT COULD BE EVALUATED FOR E-NAVIGATION

Some of the IMO performance standards already have interfaces and displays which might be suitable for use in an e-navigation context. However, some existing equipment standards do not currently have all the appropriate interfaces or use the appropriate up-to-date display standards, but manufacturers may be providing them as an extra feature. For example, it is not currently an IMO requirement to be able to display AIS information on an ECDIS but some manufacturers' equipment has this facility.

The following tables list the communications and navigation equipment currently required by SOLAS chapters III, IV and V. This equipment is mandatory depending on the configuration of the ship (tonnage, etc.) and GMDSS sea area (A1, A2, A3 or A4). The INS has been added because, although it is not currently a carriage requirement, it might be an essential element of e-navigation.

The fifth column of the tables indicates if the equipment might be used for e-navigation (i.e. has appropriate interfaces, etc.).

E = may be used without modification to the existing standards
F = future upgrade may be needed for interfacing
M = standards may need to be modified for e-navigation
P = presentation rules may apply

Note: Some equipment standards are subject to clarification from circulars from MSC, NAV and COMSAR.

Until the Organization's review of the GMDSS is complete, the communications devices in the table below are based on the current GMDSS.

Where the equipment is radio-based, the appropriate ITU recommendations are not cited, as none have been identified yet that may need changing.

Table 1 – Communications equipment from SOLAS chapter IV
(including those required by SOLAS chapter III on Life-saving appliances and arrangements)

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	International Testing standards	Suitability for e-navigation
VHF radio capable of transmitting and receiving DSC and radiotelephony	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/7, Reg. X/3, Res. A.385(X), Res. A.524(13), Res. A.694(17), Res. A.801(19), Res. A.803(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, MSC/Circ.862, COMSAR Circ.32,	IEC 61097-3 (1994), IEC 61097-7 (1996), IEC 61162 series, IMO MSC/Circ.862.	**E** **P**
VHF DSC watchkeeping receiver	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/7, Reg. X/3, Res. A.694(17), Res. A.801(19), Res. A.803(19), Res. MSC.36(63)-(1994 HSC Code) 14, MSC.97(73)-(2000 HSC Code) 14, COMSAR Circ.32,	IEC 60945 (2002), IEC 61097-3 (1994), IEC 61097-8 (1998).	**E**
Navtex receiver	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/7, Reg. X/3, Res. A.694(17), Res. A.801(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, Res. MSC.148(77), COMSAR Circ.32,	IEC 60945 (2002), IEC 61097-6 (2005-12).	**M** **P**
EGC receiver	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/7, Reg. X/3, Res. A.570(14), Res. A.664(16), Res. A.694(17), Res. A.801(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, COMSAR Circ.32.	IEC 60945 (2002), IEC 61097-4 (1994).	**M** **P**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	International Testing standards	Suitability for e-navigation
HF marine safety information (MSI) equipment (HF NBDP receiver)	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14	Reg. IV/7, Reg. X/3, Res. A.694(17), Res. A.699(17), Res. A.700(17), Res. A.801(19), Res. A.806(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, COMSAR Circ.32,	ETSI ETS 300067 Ed.1 (1990-11), ETSI ETS 300067/A1 Ed.1 (1993-10), EN 60945 (2002), EN 61162 Series.	**M** **P**
MF radio capable of transmitting and receiving DSC and radiotelephony	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/9, Reg. IV/10, Reg. X/3, Res. A.694(17), Res. A.801(19), Res. A.804(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, COMSAR Circ.32,	IEC 60945 (2002), IEC 61097-3 (1994), IEC 61097-9 (1997), IEC 61162 series, IMO MSC/Circ.862.	**M** **P**
Inmarsat-C SES	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/10, Reg. X/3, Res. A.570(14), Res. A.664 (16), (applicable only if Inmarsat C SES comprises EGC functions), Res. A.694(17), Res. A.801(19), Res. A.807(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, MSC/Circ.862, COMSAR Circ.32.	IEC 60945 (2002), IEC 61097-4 (2007), EN 61162 series, IMO MSC/Circ.862.	**E** **P**
MF/HF radio capable of transmitting and receiving DSC, NBDP and radiotelephony	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/10, Reg. X/3, Res. A.694(17), Res. A.801(19), Res. A.806(19), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, MSC/Circ.862, COMSAR Circ.32,	IEC 60945 (2002), IEC 61097-3 (1994), IEC 61097-9 (1997), IEC 61162 series, IMO MSC/Circ.862.	**M** **P**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	International Testing standards	Suitability for e-navigation
Inmarsat-F SES	Reg. IV/14, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14.	Reg. IV/10, Res. A.570 (14), Res. A.801(19), Res. A.808 (19), Res. A.694 (17), Res. MSC.36(63)-(1994 HSC Code) 14, Res. MSC.97(73)-(2000 HSC Code) 14, MSC/Circ.862, COMSAR Circ.32.	IEC 60945 (2002), IEC 61097-13 (2003), IMO MSC/Circ.862.	**E**

Table 2 – Navigation equipment
(Including those required by SOLAS chapter III)

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Suitability for e-navigation
Integrated Navigation System (INS)	Reg. V/18 Not currently a carriage requirement	Reg. V/19 Res.A.694(17) Res. MSC.252(83)	IEC 60945 (2002) IEC 61924 ed 2 (tba)	**M, P**
Magnetic compass	Reg. V/18.	Reg. V/19, Res. A.382(X), Res. A.694(17).	ISO 449 (1997), ISO 694 (2000), ISO 1069 (1973), ISO 2269 (1992), IEC 60945 (2002).	**E**
Transmitting heading device THD (magnetic method)	Reg. V/18, Reg. V/19, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, — Res. A.694(17), — Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.116(73).	IEC 60945 (2002), IEC 61162 series. ISO 22090-2 (2004), including Corrigendum 2005.	**E** **F**
Gyro compass	Reg. V/18.		ISO 8728 (1997), IEC 60945 (2002), IEC 61162 series, IEC 62288 Ed.1.0 (2008).	**E** **F**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Suitability for e-navigation
Echo Sounding Equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.424(XI), Res. A.694(17), Res. A.224(VII), Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.74(69) Annex 4, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79). Res. MSC.191(79).	ISO 9875 (2000), IEC 60945 (2002), IEC 61162 series, IEC 62288 Ed.1.0 (2008).	**E** **P** **F**
Speed and Distance Measuring Equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694(17), Res. A.824(19), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.96(72), Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79).	IEC 60945 (2002), IEC 61023 (2007), IEC 61162 series, IEC 62288 Ed.1.0 (2008)	**E** **P** **F**
Rate of Turn Indicator	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.526(13), Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79).	IEC 60945 (2002), IEC 61162 series, ISO 20672 (2007), IEC 62288 Ed.1.0 (2008).	**E** **P** **F**
GPS equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code), Res. MSC.97(73)-(2000 HSC Code), Res. MSC.112(73), Res. MSC.191(79).	IEC 60945 (2002), IEC 61108-1 (2003), IEC 61162 series, IEC 62288 Ed.1.0 (2008).	**E** **F** **P**
Glonass equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.113(73), Res. MSC.191(79).	IEC 60945 (2002), IEC 61108-2 (1998), IEC 61162 series, IEC 62288 Ed.1.0 (2008).	**E** **F** **P**
Galileo	Reg V/18 res [...]			**E** **F** **P**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Suitability for e-navigation
Rudder angle indicator	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.526(13), Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79).	IEC 60945 (2002), ISO 20673 (2007), IEC 62288 Ed.1.0 (2008).	**M** **F** **P**
Propeller revolution indicator	Reg. V/18,	Reg. V/19, Res. A.694(17), Res. MSC.191(79),	IEC 60945 (2002), ISO 22554 (2007), IEC 62288 Ed.1.0(2008).	**M** **F** **P**
Pitch indicator	Reg. V/18,	Reg. V/19, Res. A.694(17), Res. MSC.191(79).	IEC 60945 (2002), ISO 22555 (2007), IEC 62288 Ed.1.0 (2008).	**M** **F** **P**
Voyage data recorder (VDR)	Reg. V/18, Reg. V/20, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/20, Res. A.694 (17), Res. A.861 (20), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.214(81), Res. MSC.191(79).	IEC 60945 (2002), IEC 61162 Series, IEC 61996-1 (2007-11), IEC 62288 Ed.1.0 (2008).	**M** **F**
Electronic chart display and information system (ECDIS) with backup, and raster chart display system (RCDS)	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code) 13 Res. MSC.64(67), Res. MSC.86(70), Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79), Res. MSC.232(82). ECDIS back-up and RCDS are only applicable when this functionality is included in the ECDIS. The module B certificate shall indicate whether these options were tested.	IEC 60945 (2002), IEC 61162 Series, IEC 61174 (2008), IEC 62288 Ed.1.0 (2008).	**E** **F** **P**
Gyro compass for high-speed craft	Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Res. A.694(17), Res. A.821(19), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79).	ISO 16328 (2001), IEC 60945 (2002), EN 61162 Series, IEC 62288 Ed.1.0 (2008).	**E** **F**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Suitability for e-navigation
Universal automatic identification system equipment (AIS)	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694 (17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.74(69), Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79), ITU-R M. 1371-3(2007). *Note:* ITU-R M. 1371-3(2007) Annex 3 shall only be applicable in accordance with requirements of Res. MSC.74(69).	IEC 60945 (2002), IEC 61162 Series, IEC 61993-2 (2001), IEC 62288 Ed.1.0 (2008).	**E** **P** **F**
Track control system (working at ship's speed from minimum manoeuvring speed up to 30 knots)	Reg. V/18.	Reg. V/19, Res. A.694(17), Res. MSC.74(69).	IEC 60945 (2002), IEC 61162 Series, IEC 62065 (2002).	**E** **F** **P**
Radar equipment CAT 1	Reg. V/18.	Reg. V/19, Res. A.278(VIII), Res. A.694(17), Res. A.823(19), Res. MSC.191(79), Res. MSC.192(79), ITU-R M. 628-3(11/93), ITU-R M. 1177-3(06/03).	IEC 60945 (2002), IEC 61162 Series, IEC 62288 Ed.1.0 (2008), IEC 62388 Ed.1.0 (2007).	**E** **F** **P**
Radar equipment CAT 2	Reg. V/18.	Reg. V/19, Res. A.278(VIII), Res. A.694(17), Res. MSC.191(79), Res. MSC.192(79), ITU-R M. 628-3(11/93), ITU-R M. 1177-3(06/03).	IEC 60945 (2002), IEC 61162 Series, IEC 62288 Ed.1.0 (2008), IEC 62388 Ed.1.0 (2007).	**E** **F** **P**
Radar equipment CAT 3	Reg. V/18.	Reg. V/19, Res. A.278(VIII), Res. A.694(17), Res. MSC.191(79), Res. MSC.192(79), ITU-R M. 628-3(11/93), ITU-R M. 1177-3(06/03).	IEC 60945 (2002), IEC 61162 Series, IEC 62288 Ed.1.0 (2008), IEC 62388 Ed.1.0 (2007).	**E** **F** **P**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Suitability for e-navigation
Radar equipment for high-speed craft applications (CAT 1H, CAT 2H and CAT 3H)	Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Res. A.278(VIII), Res. A.694(17), Res. A.820(19), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79), Res. MSC.192(79), ITU-R M. 628-3(11/93), ITU-R M. 1177-3(06/03).	IEC 60945 (2002), IEC 61162 Series, IEC 62288 Ed.1.0 (2008), IEC 62388 Ed.1.0 (2007).	**E** **F** **P**
Radar equipment approved with a chart option (CAT 1HC, CAT 2HC and CAT 3HC)	Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Res. A.278(VIII), Res. A.694(17), Res. A.820(19), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79), Res. MSC.192(79), ITU-R M. 628-3(11/93), ITU-R M. 1177-3(06/03).	IEC 60945 (2002), IEC 61162 Series, IEC 62288 Ed.1.0 (2008), IEC 62388 Ed.1.0 (2007).	**E** **F** **P**
Transmitting heading device THD (GNSS method)	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694(17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.116(73), Res. MSC.191(79).	ISO 22090-3 (2004), IEC 60945 (2002), IEC 61162 series, IEC 62288 Ed.1.0 (2008).	**E** **F**
Differential beacon receiver for DGPS and D Glonass equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694 (17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.114(73).	IEC 60945 (2002), IEC 61108-4 (2004), IEC 61162 series.	**E**
Chart facilities for shipborne radar	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694(17), Res. A.817(19), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.64(67), Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.191(79), Res. MSC.192(79).	IEC 60936-3 (2002), IEC 60945 (2002), IEC 61162 series, IEC 62288 Ed.1.0 (2008), IEC 62388 Ed.1.0 (2007).	**?**

Item designation	SOLAS 74 where "type approval" is required	Regulations of SOLAS 74 and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Suitability for e-navigation
Transmitting heading device THD (gyroscopic method)	Reg. V/18. Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694 (17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.116(73).	ISO 22090-1 (2002) including Corr.1 (2005), IEC 60945 (2002), IEC 61162 series.	**E** **F**
DGPS equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694 (17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.114(73), Res. MSC.191(79).	IEC 60945 (2002), IEC 61108-1 (2003), IEC 61108-4 (2004), IEC 61162 series, — IEC 62288 Ed.1.0 (2008).	**E** **F** **P**
D Glonass equipment	Reg. V/18, Reg. X/3, Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13.	Reg. V/19, Res. A.694 (17), Res. MSC.36(63)-(1994 HSC Code) 13, Res. MSC.97(73)-(2000 HSC Code) 13, Res. MSC.114(73), Res. MSC.191(79).	IEC 60945 (2002), IEC 61108-2 (1998), IEC 61108-4 (2004), IEC 61162 series, IEC 62288 Ed.1.0 (2008).	**E** **F** **P**

ANNEX 5

LIST OF REFERENCED DOCUMENTS IN THE SIP

Number	Title	Date of approval /adoption	Remark
A.694(17)	General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids	06/11/1991	
A.811(19)	Performance standards for a shipborne integrated radiocommunication system (IRCS) when used in the GMDSS	23/11/1995	
A.851(20)	General principles for ship reporting systems and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants	27/11/1997	
A.950(23)	Maritime Assistance Services (MAS)	05/12/2003	
A.960(23)	Recommendations on training and certification and operational procedures for maritime pilots other than deep-sea pilots	05/12/2003	
A.1053(27)	Survey guidelines under the harmonized system of survey and certification (HSSC), 2007	30/11/2011	
MSC.191(79)	Performance standards for the presentation of navigational related information on shipborne navigational displays	06/12/2004	
MSC.192(79)	Adoption of the Revised performance standards for radar equipment	06/12/2004	
MSC.252(83)	Revised performance standards for integrated navigation systems (INS)	08/10/2007	
MSC.302(87)	Performance standards for Bridge Alert Management	17/05/2010	
MSC.401(95), amended by MSC.432(98)	Performance standards for multi-system shipborne radionavigation receivers	08/06/2015 16/06/2017	

Number	Title	Date of approval /adoption	Remark
IEC 60945	Maritime navigation and radiocommunication equipment and systems – general requirements – methods of testing and required test results	01/04/2008	
IEC 61162	Maritime navigation and radiocommunication equipment and systems – Digital interfaces	2016	
IEC 61993-2	Maritime navigation and radiocommunication equipment and systems – Automatic identification systems (AIS) – Part 2: Class A shipborne equipment of the automatic identification system (AIS) - Operational and performance requirements, methods of test and required test results	2012	
ISO 8468	Ships and marine technology – Ship's bridge layout and associated equipment – Requirements and guidelines	2007	
ITU-R M.1371-5	Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile frequency band	02/2014	
MSC/Circ.982	Guidelines on ergonomic criteria for bridge equipment and layout	20/12/2000	
MSC.1/Circ.1389	Guidance on procedures for updating shipborne navigation and communication equipment	07/12/2010	
MSC.1/Circ.1503/Rev.1	ECDIS – Guidance for Good Practice	16/06/2017	
MSC.1/Circ.1512	Guidelines on software quality assurance and human-centred design for e-navigation	13/07/2015	
MSC.1/Circ.1575	Guidelines for shipborne position, navigation and timing (PNT) data processing	16/06/2017	
SN.1/Circ.265	Guidelines on the Application of SOLAS Regulation V/15 to INS, IBS and Bridge Design	19/10/2007	
SN.1/Circ.274	Guidelines for application of the modular concept to performance standards	10/12/2008	
SN.1/Circ.288	Guidelines for bridge equipment and systems, their arrangement and integration (BES)	02/06/2010	

Number	Title	Date of approval /adoption	Remark
SN.1/Circ.289	Guidance on the use of AIS application-specific messages	02/06/2010	
SN.1/Circ.243/Rev.1	Amended Guidelines for the Presentation of navigation-related symbols, terms and abbreviations	23/05/2014	