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DEVELOPMENT OF PERFORMANCE STANDARDS FOR RANGING MODE (R-MODE) IN RADIONAVIGATION RECEIVERS

Amendments to resolution A.1046(27) on Worldwide radionavigation system

Submitted by Japan

SUMMARY

<i>Executive summary:</i>	This document proposes amendments to resolution A.1046(27) on <i>Worldwide radionavigation system</i> for the inclusion of Ranging Mode (R-mode) in the system.
<i>Strategic direction, if applicable:</i>	2
<i>Output:</i>	2.17
<i>Action to be taken:</i>	Paragraph 16
<i>Related documents:</i>	Resolution A.1046(27); MSC 109/19/2; MSC 110/21; NCSR 12/20 and NCSR 12/20/Add.1

Background

1 The NCSR Sub-Committee, at its twelfth session, agreed to the draft MSC resolution on amendments to the *Worldwide radionavigation system* (resolution A.1046(27)), revising the annex to resolution A.1046(27) to include relevant requirements for augmentation systems (both ground-based and satellite-based), with a view to adoption by MSC 111 (NCSR 12/20, paragraph 8.8).

2 The Maritime Safety Committee, at its 110th session, agreed to include the development of performance standards for Ranging mode (R-mode) in radionavigation receivers proposed by MSC 109/19/2 (Austria et al.) into the biennial agenda of the NCSR Sub-Committee for the 2026-2027 biennium. In doing so, the Committee agreed with a proposal by the delegation of Japan that the scope of the output should also include consideration of any necessary amendments to resolution A.1046(27) concerning the use of R-mode as part of the worldwide radionavigation system (MSC 110/21, paragraph 18.35).

Discussion

R-mode

3 According to document MSC 109/19/2, R-mode is an alternative positioning, navigation and timing (PNT) system as a contingency system to satellite navigation systems,

utilizing the VHF Data Exchange System (VDES) and the Differential Global Navigation Satellite System (DGNSS) coast stations.

4 The International Organization for Marine Aids to Navigation (IALA) has published the IALA Guideline G 1158 (Edition 2.0) *VDES R-mode** and according to G 1158, R-mode is depicted in the following figure and considered as a terrestrial backup system of Global Navigation Satellite System (GNSS) although the transmission of R-mode signal depends on the judgement by the terrestrial radionavigation authority.

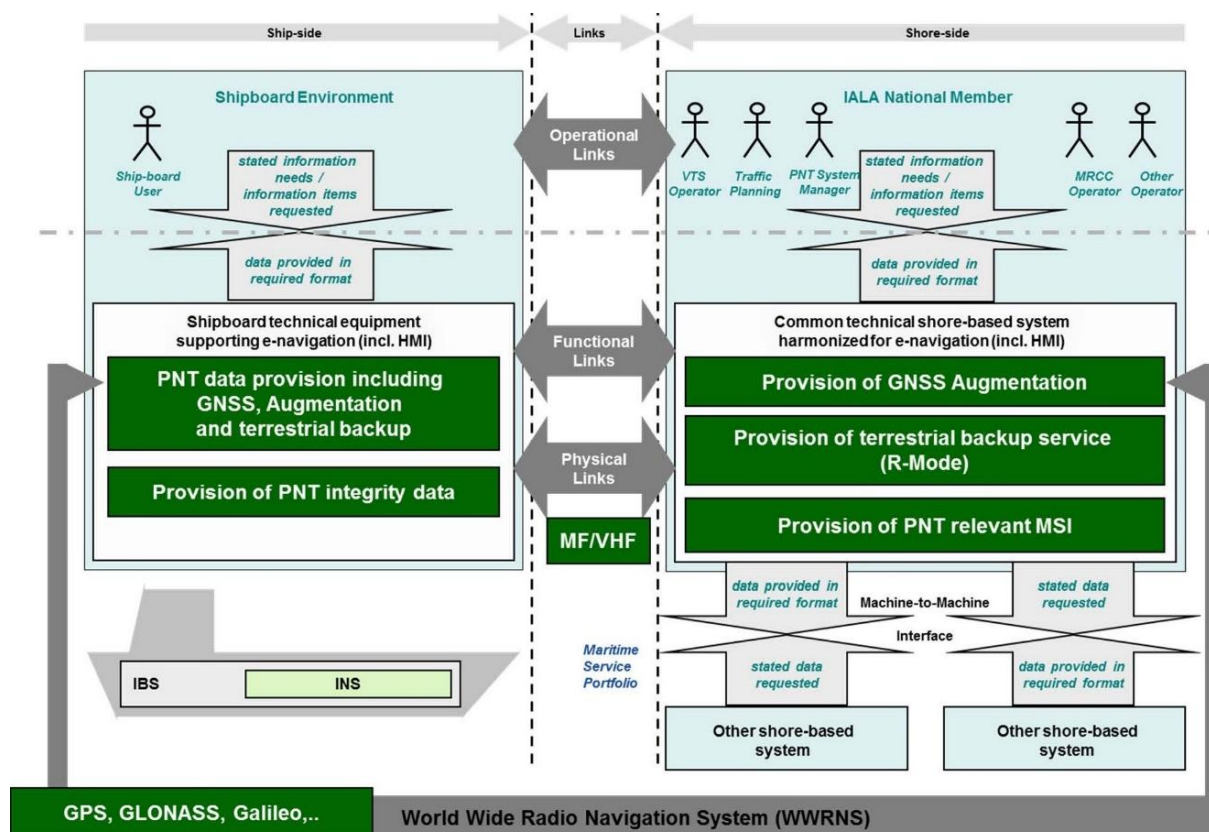


Figure: R-mode embedded in the overarching e-navigation architecture

5 If R-mode is considered as a terrestrial backup system of GNSS, Japan considers that the inclusion of a R-mode receiver or module in radionavigation receivers is voluntary.

Recognition

6 The Sub-Committee, at its twelfth session, discussed if IMO recognition of augmentation systems was necessary or not, and agreed that recognition of augmentation systems was not necessary as they were considered to be a method of improving GNSS attributes, such as accuracy, integrity, continuity and availability, not forming part of the worldwide radionavigation system (WWRNS) (NCSR 12/20, paragraph 8.8).

7 Japan considers that although R-mode is forming part of WWRNS, its usage is to provide a terrestrial backup system of GNSS as the above figure indicates and the usage of R-mode is temporary. In addition, other terrestrial radionavigation systems such as Loran-C and Chayka have been operated and maintained for a long time as one of aids to navigation regulated by SOLAS regulation V/13 without any recognition by the Organization.

* IALA Guideline G1158 ed.2.0 can be freely downloaded at <https://www.iala.int/product/g1158/>

8 Therefore, Japan is of the opinion that IMO recognition of R-mode is not necessary.

Operational requirements

9 The operational requirements of the WWRNS are set out in the appendix to the annex of resolution A.1046(27). The operational requirements define that the system error is not greater than 100 m with a probability of 95% in ocean waters and not greater than 10 m with a probability of 95% in harbour entrances, harbour approaches and coastal waters.

10 However, according to section 6 (Summary and conclusions) of the R-mode Baltic 2 final report, the VDES R-mode results are reported "For VDES R-mode two static measurements were conducted in summer and autumn. The summer results were with a ranging performance of 20.5 m (RMS) better than the performance in the autumn with 43.2 m (RMS)."

11 Regarding MF R-mode, according to the presentation (Germany) made at the IALA workshop on future radionavigation and radiocommunication, 9 - 13 February 2026, Edinburgh, the positioning performance (95%) is 16 - 38 m in day-time and 51 - 86 m in night-time.

12 Both VDES and MF R-mode do not meet the operational requirements in harbour entrances, harbour approaches and coastal waters. Japan considers that it is better to develop the different operational requirements in harbour entrance, harbour approaches and coastal waters for R-mode as a backup system and would like to propose to add paragraph 3.1*bis* in the appendix of resolution A.1046(27), as set out in the annex.

Other terrestrial radionavigation system

13 Japan recognizes that some authorities operate other terrestrial radionavigation systems such as Loran, Chayka and more advanced systems including e-Loran and e-Chayka are under development. Japan considers that these terrestrial radionavigation systems also form part of the WWRNS.

14 However, Japan notes that the scope of this agenda item is limited to the development of performance standards for Ranging mode (R-mode) in radionavigation receivers. In this context, Japan is of the view that the inclusion of other terrestrial radionavigation systems is outside of the current scope of the work. Therefore, Japan is of the view that if the consideration of other terrestrial radionavigation systems is necessary, the change of the scope of this agenda item or the inclusion of new output is needed.

Proposal

15 Based on the above consideration, Japan has prepared a draft amendment to the resolution A.1046(27) based on the draft MSC resolution on amendments to the *Worldwide radionavigation system* (resolution A.1046(27)) (NCSR 12/20/Add.1, annex 9), which is expected to be adopted by MSC 111. The proposed draft amendment is provided in the annex to this document.

Action requested of the Sub-Committee

16 The Sub-Committee is invited to consider the proposed draft amendments to resolution A.1046(27), as set out in the annex of this document, and take action as appropriate.

ANNEX

**PROPOSED DRAFT AMENDMENTS TO
THE WORLDWIDE RADIONAVIGATION SYSTEM (RESOLUTION A.1046(27))
(Based on document NCSR 12/20/Add.1, annex 9)**

THE MARITIME SAFETY COMMITTEE,

RECALLING article 28(b) of the Convention on the International Maritime Organization regarding the functions of the Committee,

RECALLING ALSO resolution A.1046(27), by which the Assembly adopted the *Revised report on the study of a Worldwide Radionavigation System*,

RECALLING FURTHER resolution A.915(22), by which the Assembly adopted the *Revised maritime policy and requirements for a future global navigation satellite system (GNSS)*,

RECOGNIZING the need for a worldwide radionavigation system to provide ships with navigational position-fixing throughout the world,

RECOGNIZING ALSO the need for an augmentation system, where required, to provide ships with a higher accuracy than what may be provided by a stand-alone worldwide radionavigation system,

RECOGNIZING FURTHER that radionavigation and augmentation systems share common technical features, however they are different and separate systems,

RECOGNIZING the need for Ranging mode (R-mode), one of terrestrial radionavigation systems which independently works from satellite radionavigation system, taking account of the increase in GNSS interference worldwide,

RECOGNIZING that a radionavigation system as a stand-alone system allows a user equipped with the appropriate receiver to compute a positioning, navigation and timing (PNT) solution,

RECOGNIZING ALSO that an augmentation system cannot alone provide a position, however complements the radionavigation system by enhancing the accuracy of the computed PNT solution and providing integrity warnings,

RECOGNIZING FURTHER that resolution A.915(22), while acknowledging available augmentation techniques which enhance navigation performance, does not address the recognition of augmentation techniques for GNSS,

RECOGNIZING the need to amend the aforementioned revised report, and that by resolution A.1046(27), the Assembly requested the Maritime Safety Committee to keep the above-mentioned revised report under review for adjustment as necessary,

HAVING CONSIDERED the recommendation made by the Sub-Committee on Navigation, Communications and Search and Rescue at its [...] session,

1 ADOPTS, as the revised IMO policy for the recognition and acceptance of suitable radionavigation systems intended for international use, the revised "Report on the Study of a Worldwide Radionavigation System", as set out in the annex to the present resolution, which revises in its entirety the existing text of the annex to resolution A.1046(27);

2 INVITES Governments to keep the Organization informed of the operational development of any suitable radionavigation systems conforming to the policy referred to above which might be considered by the Organization for use by ships worldwide;

3 INVITES ALSO Governments and organizations providing radionavigation systems to consent to recognition of these systems by the Organization;

4 INVITES FURTHER the Assembly to endorse the action taken by the Maritime Safety Committee.

[5 REVOKES resolution MSC.[...].]

ANNEX

REPORT ON THE STUDY OF A WORLDWIDE RADIONAVIGATION SYSTEM

1 INTRODUCTION

1.1 Studies on a worldwide radionavigation system have been taking place since 1983. These studies have provided a basis on which chapter V of the 1974 SOLAS Convention has been amended to include a requirement for ships to carry means of receiving transmissions from suitable radionavigation systems throughout their intended voyage.

1.2 It is understood that the worldwide radionavigation system includes global and regional radionavigation systems and may include corresponding augmentations systems.

1.3 The operational requirements for worldwide radionavigation system and augmentation systems, which may have global or regional coverage, are given in the appendix.

1.4 It is not considered feasible for IMO to fund a worldwide radionavigation system. Existing and planned systems which are being provided and operated by Governments or organizations have therefore been studied, in order to ascertain the conditions under which such systems might be recognized or accepted by IMO.

1.5 The Revised Maritime Policy and Requirements for a Future Global Navigation Satellite System (GNSS) (resolution A.915(22)) sets out that IMO will recognize a GNSS as a system which meets the carriage requirements for position-fixing equipment for a Worldwide Radionavigation System (WWRNS).

1.6 Although augmentation systems do not require recognition by IMO, when used by ships for position-fixing, they should also meet the operational requirements set out in the appendix to this document to be accepted by flag Administrations, and should be taken into account by organizations providing these augmentation services.

1.7 In addition, considering the increasing occurrence of GNSS interference, there is a clear need for R-mode, a terrestrial radionavigation system that operates independently of GNSS. However, R-mode does not require recognition by IMO, as it functions outside the GNSS framework and the carriage of R-mode receiving equipment is not mandated. R-mode should also meet the operational requirements set out in the appendix to this document to be accepted by flag Administrations, and should be taken into account by organizations providing these R-mode services.

2 PROCEDURES AND RESPONSIBILITIES CONCERNING THE RECOGNITION OF SYSTEMS

2.1 Procedures and functions of IMO

2.1.1 The recognition by IMO of a radionavigation system would mean that the Organization recognizes that the system is capable of providing adequate position information within its coverage area and that the carriage of receiving equipment for use with the system satisfies the relevant requirements of the 1974 SOLAS Convention.

2.1.2 IMO should not recognize a radionavigation system without the consent of the Government or organization which has provided and is operating the system.

2.1.3 In deciding whether or not to recognize a radionavigation system, IMO should consider whether:

- .1 the Government or organization providing and operating the system has stated formally that the system is operational and available for use by merchant shipping;
- .2 its continued provision is assured;
- .3 it is capable of providing position information within the coverage area declared by the Government or organization operating and providing the system with a performance not less than that given in the appendix;
- .4 adequate arrangements have been made for publication of the characteristics and parameters of the system and of its status, including amendments, as necessary; and
- .5 adequate arrangements have been made to protect the safety of navigation should it be necessary to introduce changes in the characteristics or parameters of the system that could adversely affect the performance of shipborne receiving equipment.

2.1.4 In deciding, in the light of any changes to a recognized system, whether the system should continue to be recognized, the criteria listed in paragraph 2.1.3 should be applied.

2.2 Responsibilities of Governments or organizations

2.2.1 The provision and operation of a radionavigation system is the responsibility of the Governments or organizations concerned.

2.2.2 Governments or organizations willing to have a radionavigation system recognized by IMO should formally notify IMO that the system is operational and available for use by merchant shipping. The Government or organization should also declare the coverage area of the system and provide as much other information as practicable to assist IMO in its consideration of the factors identified in paragraph 2.1.3.

2.2.3 Governments or organizations that have a system recognized by IMO should not allow changes to the operational characteristics of the system under which the system was recognized without notifying IMO (see resolution A.577(14)).

3 SHIPBORNE RECEIVING EQUIPMENT

3.1 To avoid the necessity of carrying more than one set of receiving equipment on a ship, the shipborne receiving equipment should be suitable for operating either with a worldwide radionavigation system, or with radionavigation systems which cover the area in which the ship trades.

3.2 Shipborne receiving equipment should conform to the relevant performance standards not inferior to those adopted by the Organization.

3.3 Radionavigation systems should make it possible for shipborne receiving equipment automatically to select the appropriate stations for determining the ship's position with the required performance.

3.4 Shipborne receiving equipment should be provided with at least one output¹ from which position and augmentation information can be supplied in a standard form to other equipment.

¹ Refer to the recommendation of the International Electrotechnical Commission, in particular, IEC publication 61162, Digital interface for Navigational Equipment within a ship.

APPENDIX

OPERATIONAL REQUIREMENTS

1 INTRODUCTION

1.1 The operational requirements for worldwide radionavigation and augmentation systems should be general in nature and capable of being met by a number of systems. All systems should be capable of being used by an unlimited number of ships.

1.2 The requirements may be met by individual radionavigation systems or by a combination of such systems, including the combination of stand-alone global or regional navigation satellite systems and augmentation systems.

1.3 For the purpose of these requirements, the term *radionavigation system* refers to a stand-alone radionavigation system or a combination of a radionavigation system and an augmentation system.

1.4 The radionavigation system should be considered available when it provides the required integrity for the given accuracy level.

2 NAVIGATION IN OCEAN WATERS

2.1 Where a radionavigation system is used to assist in the navigation of ships in ocean waters, the system should provide positional information with an error not greater than 100 m with a probability of 95%. This degree of accuracy is suitable for purposes of general navigation and provision of position information in the GMDSS.

2.2 In view of the fact that merchant fleets operate worldwide, the information provided by a radionavigation system must be suitable for use for general navigation by ships engaged on international voyages in any ocean waters within the system's coverage area.

2.3 Taking into account the radio frequency environment, the coverage of the radionavigation system should be adequate to provide position-fixing throughout this phase of navigation.

2.4 The radionavigation system should permit an update rate of the computed position data not less than once every 2 s².

2.5 Signal availability should exceed 99.8%.

2.6 An integrity warning of radionavigation system malfunction, non-availability or discontinuity should be provided to users as soon as practicable by maritime safety information (MSI) systems.

2.7 Augmentation systems may also provide notification of radionavigation system integrity or malfunction. However these should not override, or replace the requirement for, integrity warnings provided to users by MSI systems in accordance with paragraph 2.6 above.

² This applies to the computed and displayed position data, but not to the update rate of any correction data, which may remain valid for 30s or more.

3 NAVIGATION IN HARBOUR ENTRANCES, HARBOUR APPROACHES AND COASTAL WATERS³

3.1 Where a radionavigation system is used to assist in the navigation of ships in such waters, the system should provide positional information with an error not greater than 10 m with a probability of 95%.

[3.1*bis* Where a backup of the radionavigation system such as R-mode is used to assist in the navigation of ships in such waters, the system should provide positional information with an error not greater than XX m with a probability of 95%. (TBD)]

3.2 Taking into account the radio frequency environment, the coverage of the radionavigation system should be adequate to provide position-fixing throughout this phase of navigation.

3.3 The radionavigation system should permit an update rate of the computed position data not less than once every 2 s².

3.4 Signal availability should exceed 99.8%.

3.5 When the radionavigation system is available, the service continuity should be ≥99.97% over a period of 15 minutes.

3.6 An integrity warning of radionavigation system malfunction, non-availability or discontinuity should be provided to users within 10 s.

3.7 The radionavigation system should be considered available when it provides the required integrity for the given accuracy level.
