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**PROPOSAL FOR THE DEVELOPMENT OF GUIDELINE ON TECHNICAL**

**CHARACTERISTICS AND THE USE OF RACON**

**1 SUMMARY**

ENG 2023-2027 work programme plans to develop the guideline on the use of racon. China MSA has carried out a series of trials on the use of radar beacons (RACONs). During the process of active practice, China MSA has gained new insights and achieved significant findings regarding the technical characteristics and operational guidelines of Radar Beacons (RACONs), which will provide valuable references for the development of RACON guidelines.

**1.1 Purpose of the document**

To finalize the development of a new guideline *Technical Characteristics and Guidance on the Use of Racons*. This new guideline aims to implement the strategic concept of R0146 regarding maintaining the service capability of racon, further improving the specifications and requirements for the use of racon. And the introduction of solid-state navigation radar will lay the foundation for its installation and use on vessels.

**1.2 Related documents**

[ 1] R-101 MARINE RADAR BEACONS (RACONS).

**2 BACKGROUND**

The ENG Committee at its 16th session discussed the updating of existing IALA Racon documents (R-101, G1010, R0146) and noted that the work is planned for 2023-2027. During ENG 17, IALA Secretariat proposed to revise Recommendation R-101, since the original version included a very long annex, which does not conform to the new format of the Recommendation. Therefore, it was planned to delete the latter part of the R-101 and convert the content into the new Guideline: Draft IALA Guideline 11xx Technical Characteristics and Guidance on the use of Racons (to accompany Recommendation R-101) Marine Radar Beacons (Racon) . (ENAV20-13.8 Proposal for reformatting Recommendation R-101). Besides, the ENG Committee at its 20th session modified R0101 on “Marine Radar Beacons (Racons)” and R0146- Strategy-for-Maintaining-Racon-Service-Capability, and added a task for the development of a new Guideline G11xx Technical Characteristics and Guidance on the use of Racons.

With the continuous advancement of navigation radar technology, the International Maritime Organization (IMO) has approved the installation and use of S-band solid-state navigation radars on vessels. Meanwhile, RACON developers in China have introduced new-generation RACONs capable of responding to solid-state

1 Input document number, to be assigned by the Committee Secretary

2 Leave open if uncertain

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radars. Therefore, it is necessary to update the existing RACON operational guidelines in light of current technological progress in both radar and RACON systems, so as to meet evolving navigation requirements.

**3 DISCUSSION**

The last revision of IALA R0101 was made in 2004. Over the past 21 years, international organizations and IALA have made revisions to some documents related to racon; meanwhile, there have been significant developments in radar and racon technology. This proposal offers suggestions for new guidelines based on these two aspects.

**3.1 Update of documents**

1 The version of ITU’s document related to racon has been upgraded from ITU-R M824-2 to ITU-R M824-4.

2 IALA’s Recommendation O-113, For the marking of fixed bridges over navigable waters, has been upgraded to IALA Guideline G1172 Ed1.0 The Marking of Bridges and Other Structures Over Navigable Waters.

3 IALA Recommendation O-114, For the marking of offshore structures is adjusted to R0139-Ed3.0-The Marking of Man made Structures.

**3.2 Technical Aspects**

1 Experimental results indicate that nearby strong signal sources and intense reflected signals can interfere with RACON responses. Therefore, environmental factors must be considered during RACON installation, or shielding measures should be implemented.

2 In addition to suppressing sidelobes by identifying the main lobe, sidelobe suppression can also be achieved through a “natural” method, that is, by utilizing the sidelobe suppression function of the radar itself.

3 IALA has adopted new guideline related to ERPS.

4 Experiments have demonstrated that the response of a 25W pulse compression solid-state radar can achieve the same response distance as a 4KW magnetron radar. Consequently, descriptions of both solid-state radar and magnetron radar have been added in Section 5.4.

Please refer to annex of this document for more details: Annex Guideline G11NN Technical Characteristics and Guidance on the use of Racons.

**4 REFERENCES**

[ 1] ENAV20-13.8.2 Draft IALA Guideline 11xx (to accompany Recommendation R-101) Marine Radar Beacons (racon)

[2] R0146 Strategy for Maintaining Racon Service Capability

[3] R0101 Marine Radar Beacons (Racons)

[4] ENAV20-13.8 Proposal for Reformatting Recommendation R-101

[5] G1172 The Marking of Bridges and Other Structures Over Navigable Waters

[6] R0139 The Marking of Man-made Offshore Structures

[7] Recommendation ITU-R M.824-4 (02/2013) Technical Parameters of Radar Beacons

[8] IMO Resolution A.615(15)

[9] IMO Resolution A.530(13)

[ 10] G1010 Racon Range Performance

PROPOSAL FOR THE DEVELOPMENT OF GUIDELINE ON TECHNICAL CHARACTERISTICS AND THE USE OF RACON



[ 11] G1147 The Use of ERPS

**5 ACTION REQUESTED OF THE COMMITTEE**

The Committee is requested to consider the information provided and take action, as appropriate.

PROPOSAL FOR THE DEVELOPMENT OF GUIDELINE ON TECHNICAL CHARACTERISTICS AND THE USE OF RACON



ANNEX



**IALA GUIDELINE**

G11NN

TECHNICAL CHARACTERISTICS AND GUIDANCE ON THE USE OF RACONS

**Edition 1.0**

**Date (of approval by council)**



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International Association of Marine Aids to Navigation and Lighthouse Authorities Association Internationale de Signalisation Maritime



**DOCUMENT REVISION**

Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

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**IALA Guideline G11NN – Technical Characteristics and Guidance on the use of Racons**

**Edition 1.0 Date (of approval by council) P 2**



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**1 lNTRODUCTlON**

when used with a ship's radar, Radar beacons (racons) work as a secondary aid to navigation (AtoN) system. Many Aids to Navigation Authorities use racons as a general-purpose aid to navigation. Taking ITU-R M824-4, *Technical Parameters for Radar Beacons (Racons)* into account, the document is divided into four parts.

. Guidance on the use of Racons.

. Applications of Racons.

. Description of the characteristics of Racons.

. Guidance on operating ranges.

**2 GUlDANCE ON THE USE OF RACONS**

This guidance has been developed to assist Aids to Navigation Authorities to consider the provision of Racons or the replacement of existing devices, and to amplify the technical requirements as set out in Table 1 in IALA Recommendation R-101 Marine Radar Beacons (Racons). For a more detailed description of Racons, see section 4.

. Racons should conform to Table 1 in IALA Recommendation R-101 Marine Radar Beacons (Racons).

. Racons operating on both 9 GHz and 3 GHz bands should normally be provided.

. To avoid unnecessary radar screen clutter, Racons should be programmed with OFF periods. To prevent processing circuits in radars from rejecting the Racon signal, ON periods should be no less than fifteen seconds. To maintain an adequate update rate on the display, there should be at least one ON period in every sixty seconds, unless there are special operating requirements.

. Racons should be fitted with side-lobe suppression.

. Coding of Racons should be in accordance with international recommendations (Ref. IMO Resolution A.615(15)).

. Racons emit microwave radiation. Installation and service personnel should be properly trained for working with microwave equipment. Authorities should ensure that the Racon installation is safe and in accordance with local laws. However, it should be noted that the effective radiated power of a Racon is quite low and that safe installations usually do not require any special effort.

**3 APPLlCATlONS OF RACONS**

**3.1 GENERAL**

Swept frequency Racons are now obsolete.

For frequency agile Racons, the power output is part of the Racon design and cannot be changed. In some cases, the antenna characteristics can be selected, for example, a higher gain antenna can be used for longer range. Other characteristics (see Note 1 to Table 1 in IALA Recommendation R-101 Marine Radar Beacons (Racons)) can usually be adjusted for individual Racons. The siting of a Racon must take into account the required range performance (see section 4).



**3.1.1 lNLAND WATERWAYS**

Racons used on inland waterways have applications similar to coastal Racons. Although the settings for the two uses may be different, they are not to be considered separately here. It should be noted that, 9 GHz band radars are normally used on inland waterways at present.

**3.1.2 FLOATlNG AlDS**

When a Racon is fitted to a floating aid, various factors such as the motion, available electrical power, mounting height, and size and weight constraints need to be considered. An omni-directional antenna with a broad vertical beamwidth is required.

**3.1.3 FREQUENCY BANDS**

Although most vessels have radars that operate in the 9 GHz band, an increasing number are fitted with both 9 GHz and 3 GHz band radars. The provision of dual band Racons is important, since at times, particularly during bad weather, many vessels use 3 GHz band radars in preference to 9 GHz band radars because the 3 GHz band radars provide better clutter rejection. A vessel equipped with a radar for each band will tend to use the one that produces the better display in any given situation. Therefore, Racon service should be available at all times in both the 3 GHz and 9 GHz bands.

**3.1.4 OTHER SlGNAL lNTERFENCE**

When installing radar beacons near VTS radars, radar observation stations, 5G base stations or other areas where signals are easily affected, the issue of other signal interference should be fully considered.

**3.2 SPEClFlC APPLlCATlONS**

A number of specific applications of Racons are considered:

**3.2.1 LONG RANGE NAVlGATlON**

A Racon can be used to identify a navigation mark at long range. The racon should be chosen for long working range.

**3.2.2 LANDFALL**

A Racon can be sited to enhance the response of a mark that is the first to be seen during an approach from the open sea to a part of the coast. The racon should be chosen for long working range.

**3.2.3 lNCONSPlCUOUS COASTLlNE MARKlNG**

A Racon can be mounted near the shore to mark a coastline that has no significant features or is difficult to distinguish or identify on a radar display.

**3.2.4 SHORT RANGE NAVlGATlON**

A short-range Racon can be used to identify a local feature of interest (e.g. a harbour entrance).

**3.2.5 LEADlNG LlNE**

Two Racons, or a Racon and radar reflector, separated by an adequate distance, can be used to define a leading line on a radar display. A vessel using the leading line can then follow an accurate course even in poor visibility. Guideline xxxx on leading lights can be used as a reference in the use of leading lines.

**3.2.6 NEW DANGER**

A Racon can be used to mark a new danger, such as a wreck. When a Racon is used in this way it should be coded with the Morse letter 'D' and show a signal length of one nautical mile on the radar display.



**3.2.7 BRIDGE MARKING**

A Racon can be used to indicate the navigable channel under a bridge by placing it above the best point of passage (IALA Guideline G1172-Ed1.0-The-Marking-of-Bridges-and-other-structures-over-navigable-waters).

Although bridges crossing fairways are usually clearly recognizable on a radar display, channel boundaries or bridge piers are seldom displayed so clearly. Racons, shielded to provide directional responses, can also be provided to mark traffic separation lanes between bridge piers.

**3.2.8 OFFSHORE STRUCTURES**

A Racon can be fitted where there is a requirement to identify a particular offshore structure. The relevant authority will determine its range and code. Any Racon on a temporary uncharted structure shall be coded with the Morse letter "D" and show a signal length of one nautical mile on the radar display. (IALA Recommendation R0139-Ed3.0-The-Marking-of-Man-made-Structures-0-139-December-2021).

**3.2.9 ROUTING SCHEMES**

A Racon can be used in a traffic routing scheme, or to mark an area to be avoided.

**3.2.10 TURNING MARK**

A Racon can be used to control the radius of a turn by keeping it at a fixed range during the manoeuvre.

**3.2.11 ERPS – ENHANCED RADAR POSITIONING SYSTEM**

ERacons, together with eRadars, can be be used for an alternative PN(T) system in an area. Please see G1147.

**3.3 ENVIRONMENT**

The environment in which a Racon operates will also affect its usefulness in the following ways.

**3.3.1 NORMAL ENVIRONMENT**

In this situation, the Racon can be expected to perform in accordance with the parameters set out in IMO Resolution A.615(15).

**3.3.2 SEA CLUTTER MASKING**

This effect is variable and depends on the sea conditions and the height of the radar antenna. The response from a Racon can be obscured by radar returns from the waves in the sea.

**3.3.3 LAND AND PACK ICE MASKING 1**

Land or pack ice near a Racon can cause sufficient clutter to mask a Racon response. Pack ice can also distort the appearance of a shoreline on a radar display.

**3.3.4 RADAR TARGET MASKING IN CONGESTED WATERWAYS 1**[**1**](#bookmark44)

Under certain conditions, in busy waterways, Racon responses may mask important radar targets.

**3.3.5 RACON TARGET BLOCKING IN CONGESTED WATERWAYS**

Under certain conditions in busy waterways, racon signals (outgoing and return) can be blocked by vessels with the result of poor racon performance on the radar display.

**4 CHARACTERISTICS OF RACONS**

1 Improved siting of racons and/or selection of an appropriate ON period/ OFF period ratio may provide solutions to these problems.



This section describes the characteristics of Racons.

**4.1 EFFECTIVE SENSITIVITY AND EFFECTIVE RADIATED POWER**

The radar detection range of a Racon can be increased or decreased by changing the effective sensitivity of the Racon. An increase in the Racon antenna gain increases the effective sensitivity and the effective radiated power. As a consequence there may be reductions in the vertical and horizontal beam widths of the Racon antenna.

**4.2 SIDELOBE SUPPRESSION**

A vessel passing a Racon at close range, perhaps 0.5 nautical miles or less may trigger the Racon with the radar antenna sidelobes, hence causing interference on the radar display. Sidelobe interference can be suppressed by special Racon circuitry. The Racon identifies the strongest signal as being from the main lobe and suppresses the rest. Or by utilizing radars' sidelobe suppression function, racon responds with weak signals upon receipt of weak signals to realize sidelobe suppression.

**4.3 ENERGY CONSUMPTION**

Energy consumption is a feature of the Racon design, but can be reduced, to some extent, by decreasing the ON period to OFF period ratio.

**4.4 UPDATE RATE**

The rate at which the response from a Racon is updated on the radar display is determined by the ON period/ OFF period ratio of the Racon response and the rotational rate of the radar antenna.

**4.5 CODING**

Identification should take the form of a Morse code letter. The letter should normally be one with an initial dash and not more than three dots or dashes. To conform to the Morse code structure, one dash should equal the sum of three dots, with one dot equal to one space.

Groups of equally spaced dots are used as identification codes for search and rescue transponders (IMO Resolution A.530(13)), and therefore they should not be used as identification codes for Racons.

**5 RACON OPERATING RANGE**

The method recommended by IALA for publishing the nominal range of a radar beacon (Racon) installation, is to quote the distance at which the Racon is likely to be first detected, with assumed values for heights and powers of radars as fitted typically to a range of vessels.

**5.1 FACTORS AFFECTING NOMINAL RANGE**

The most significant parameters affecting the nominal range are the heights of the Racon and the radar scanning antenna above sea level, and the strength of the radar signal received at the Racon.

The Racon nominal ranges discussed in this section should be taken only as an approximate guide. IALA Guideline 1010 on Racon Range Performance provides a more detailed and technical discussion on Racon range estimation.



**5.2 ENVlRONMENTAL FACTORS**

In addition to the effective output power of the radar and the heights of the radar and Racon, there are two environmental factors that have a major influence on whether the Racon can be seen on the radar display.

The propagation characteristics of the atmosphere can have a major influence on detection range, in particular at distances greater than 10 NM.

Temperature, humidity and precipitation can alter the performance factor of the atmosphere. The performance factor is difficult to measure and impossible to predict, and the factor's wide range in value makes Racon range prediction difficult.

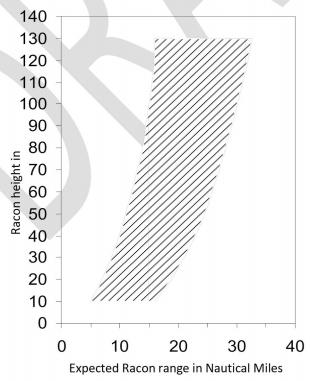
**5.3 MULTlPATH FADlNG**

Multi-path fading is another major factor in range performance. Multi-path fading is self-interference of the radar signal at the Racon and is caused by reflection of the signal from the sea surface. Fading caused by out-of-phase signals reduces the radar signal strength at the Racon. If the signal strength is below the Racon's detection threshold, the Racon will not respond. Fading occurs at varying distances from the radar. Radar and Racon antenna heights are factors in determining where the faded areas are located. Therefore, fading zones will be at different distances for different vessels. The widths of the fading zones are dependent on sea state, atmospheric propagation and radar signal strength. Fading zones may not be a problem for moving vessels as they will soon move through the faded areas. Please see G1010.

**5.4 EXPECTED DETECTlON RANGES**

Neglecting fading zones and using a world-wide average value for atmospheric propagation, [Figure 1](#bookmark45) shows expected detection ranges at various heights above sea level. Fading zones will occur at distances less than the

expected detection range.



***Figure 1 Expected Racon detection ranges***



The left edge of the shaded area represents the expected distance for a small vessel using a 4kW magnetron radar (or 25W pulse compression solid state radar) with its antenna mounted at 3 meters above sea level. The right edge of the shaded area represents the expected distance for a large vessel using a 25kW magnetron radar (or 200W pulse compression solid state radar) with its antenna mounted at 35 metres above sea level. Figure can be used in two ways. The first is for determining range for a Racon that is already installed. For example, a Racon height of 60 metres would yield an expected range of 12 NM to about 26 NM. The second use of the chart is for planning. For example, the goal is to service primarily large vessels at 25 NM and secondarily small vessels at 10 NM. A racon mounting height of greater than 40 metres would be expected to accomplish both goals.

**6 DEFlNlTlONS**

*Suggested text:* The definitions of terms used in this IALA Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at <http://www.iala-aism.org/wiki/dictionary> and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

**7 ACRONYMS**

GHz Gigahertz

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities - AISM

IMO International Maritime Organization

ITU-R International Telecommunications Union – Radiocommunications Bureau

kW kilowatt

NM nautical mile

**8 REFERENCES**

[1] R0101 Marine Radar Beacons (Racons).

[2] ENAV20-13.8 Proposal for Reformatting Recommendation R-101

[3] R0146 Strategy for Maintaining Racon Service Capability

[4] Recommendation ITU-R M.824-4 (02/2013) Technical parameters of radar beacons

[5] G1172 The Marking of Bridges and Other Structures Over Navigable Waters

[6] R0139 The Marking of Man-made Offshore Structures

[7] IMO Resolution A.615(15)

[8] IMO Resolution A.530(13)

[9] G1162 The Marking of Offshore Man-made Structures.

[10] G1147 The Use OF Enhanced Radar Positioning Systems.