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MARINE RADAR BEACONS (RACONS)

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DOCUMENT REVISION

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

Date	Details	Approvals
January 1995	1st issue	
December 2000	Edition 1.1	
September 2004	Edition 2 General Revision including updating information and clarification of terms. Discussions underway at IMO and ITU on S band radars; concern over future of Racons.	
September 2020	Edition 2.1 Editorial corrections.	

THE COUNCIL

RECALLING the function of IALA with respect to Safety of Navigation, the efficiency of maritime transport and the protection of the environment

NOTING that the International Maritime Organization, in Assembly Resolution A.615(15) on "Radar Beacons and Transponders", has recommended operational standards for radar beacons;

NOTING ALSO that the International Maritime Organization is developing revised performance standards for Radars;

NOTING FURTHER that the International Telecommunication Union in ITU-R M.824-2 gives the technical characteristics of a general purpose maritime radar beacon;

RECOGNIZING that many Aids to Navigation Authorities have installed maritime radar beacons as general purpose aids to navigation;

HAVING CONSIDERED the proposals made by the IALA Radionavigation Committee;

RECOMMENDS:

a) That radar beacons (racons) provided by Aids to Navigation Authorities should conform to the technical characteristics set out in Part 1 of the Annex to this recommendation.

b) That Aids to Navigation Authorities take into account the guidelines on the use of racons set out in Part 2 of the Annex to this Recommendation when establishing racon sites.

c) That Aids to Navigation Authorities take into account the Guidelines on Racon Range Performance set out in Part 4 of the Annex of this Recommendation.

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ANNEX A TECHNICAL CHARACTERISTICS AND GUIDANCE ON THE USE OF RACONS

Radar beacons (racons), when used with a ship's radar, form a secondary aids to navigation (AtoN) system. Many Aids to Navigation Authorities use racons as a general purpose aid to navigation. The document takes ITU-R M824-2, *Technical Parameters for Radar Beacons (Racons)* into account and is divided into five parts.

Annex Part 1 - specifies the minimum technical characteristics for general-purpose racons. These technical characteristics are similar to those set out in Annex 1 to ITU-R Recommendation M.824-2 and include:

1. Antenna polarisation which has been specified with reference to the interrogating radar characteristics.
2. The frequency tolerances which reflect current technology.
3. The duration of the response.

Annex Part 2 – contains guidance on the use of racons.

Annex Part 3 – describes the characteristics of racons.

Annex Part 4 – gives guidance on operating ranges.

Annex Part 5 – provides a glossary of terms.

A.1. PART 1 – TECHNICAL PARAMETERS FOR A GENERAL PURPOSE MARITIME RADAR BEACON (RACON)

Table 1 Technical Parameters For A General Purpose Maritime Radar Beacon (Racon) (From ITU-R M.824-2 Annex 1)

Item		Specifications
1 Antenna	Polarization	In the 9 GHz band, suitable for responding to radars using horizontal polarization. In the 3 GHz band, suitable for responding to radars using horizontal polarization and to radars using vertical polarization.
2 Receiver	1 Frequency band	9 300 - 9 500 MHz and/ or 2 900 - 3 100 MHz. (9 300 – 9 320 from 01 January 2001).
	2 Blocking period	100 µs after end of response.
	3 Primary radar pulse length	0.05 µs.
3 Transmitter	Frequency	Transmission should occur either: • on the frequency of the interrogating signal with a frequency tolerance of ± 3.5 MHz for interrogating pulses with a duration of less than 0.2 µs, or, with a frequency tolerance of ± 1.5 MHz for pulses with a duration equal to or more than 0.2 µs, or • by a series of sweeps covering the entire frequency band of the receiver in which the signal was received. Where the transmission consists of a series of sweeps, the form of the sweep shall be sawtooth and should have a slew rate of between 60 s and 120 s per 200 MHz.
4 Response	1 Delay after receipt of interrogation	Normally not more than 0.7 µs.
	2 Form of identification	Identification coding should normally be in the form of a Morse letter. The identification coding used should be as described in appropriate navigational publications. The identification coding should comprise the full length of the radar beacon response and, where a Morse letter is used, the response should be divided with a ratio of one dash equal to three dots and one dot equal to one space. The coding should normally commence with a dash.
	3 Duration	The duration of the response should be approximately 20% of the maximum range requirement of the particular radar beacon, or should not exceed five miles, whichever is the lower value. In certain cases, the duration of the response may be adjusted to suit the operational requirements for the particular radar beacon (see Note 1).

Note 1: Characteristics for antenna aperture and gain, receiver sensitivity, transmitter power, racon response duration, racon ON period/ OFF period, and side-lobe suppression should be determined by Authorities.

Note 2: Swept frequency racons are obsolescent and are not recommended for new installations.

Note 3: Power output is not specified. Please see section A.2 for information on racon signal strength.

A.2. PART 2 – GUIDANCE ON THE USE OF RACONS

A.2.1. GENERAL

This guidance has been developed to assist Authorities considering the provision of racons or the replacement of existing devices and to amplify the technical requirements as set out in Table 1. For a more detailed description of Racons, see section A.3 General Considerations

1. Racons should conform to Table 1 (above).
2. Racons operating on both 9 GHz and 3 GHz bands should normally be provided.
3. 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.
4. Racons should be fitted with side-lobe suppression.
5. Coding of racons should be in accordance with international recommendations (Ref. IMO Resolution A.615(15)).
6. 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 according to local laws. However, it should be noted that a racon's effective radiated power is quite low and that safe installations usually do not require any special effort.

A.2.2. APPLICATIONS OF RACONS

A.2.2.1. 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 (Table 1, Note 1) can usually be adjusted for individual racons. The siting of a racon must take into account the required range performance (see section 4).

A.2.2.1.1. Inland Waterways

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

A.2.2.1.2. Floating Aids

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 beam-width is required.

A.2.2.1.3. 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.

A.2.2.2. SPECIFIC APPLICATIONS

A number of specific applications of racons are considered:

A.2.2.2.1. Long Range Navigation

A racon can be used to identify a navigation mark at long range.

A.2.2.2.2. 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.

A.2.2.2.3. Inconspicuous Coastline Marking

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.

A.2.2.2.4. Short Range Navigation

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

A.2.2.2.5. Leading Line

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.

A.2.2.2.6. 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.

A.2.2.2.7. 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 Recommendation O-113, For the marking of fixed bridges 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.

A.2.2.2.8. 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 O-114, For the marking of offshore structures).

A.2.2.2.9. Routing Schemes

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

A.2.2.2.10. Turning Mark

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

A.2.2.3. ENVIRONMENT

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

A.2.2.3.1. 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).

A.2.2.3.2. Sea Clutter Masking [1]

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.

A.2.2.3.3. 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.

A.2.2.3.4. Target Masking in Congested Waterways [1]

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

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

A.3. PART 3 - CHARACTERISTICS

A.3.1. GENERAL

This section describes Characteristics of Racons.

A.3.2. EFFECTIVE SENSITIVITY AND EFFECTIVE RADIATED POWER

The radar detection range of a racon can be increased or decreased by changing the effective sensitivity or effective radiated power of the racon. Higher effective radiated power of the racon can improve the probability of detection by a radar in clutter conditions. 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.

A.3.3. 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.

A.3.4. 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.

A.3.5. 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.

A.3.6. 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.

A.4. PART 4 – RACON OPERATING RANGE

A.4.1. GENERAL

The method recommended by the International Association of Lighthouse Authorities (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.

A.4.2. FACTORS AFFECTING NOMINAL RANGE

Apart from the effective power output of the radar, the most significant parameters affecting the nominal range are the heights of the racon and the radar scanner above sea level. The strength of the radar signal received at the racon is more critical than the return path and determines whether the racon will transmit a response.

The racon nominal ranges discussed in this section should be taken only as an approximate guide. The IALA document “Guidelines on Racon Range Performance” is a more detailed and technical discussion on racon range estimation.

A.4.2.1. Environmental 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 nautical miles.

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.

A.4.2.2. Multipath Fading

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.

A.4.3. EXPECTED DETECTION RANGES

Neglecting fading zones and using a “world-wide” average value for atmospheric propagation, Figure 1 shows expected detection ranges at various heights above sea level. Fading zones will occur at distances less than the expected detection range.

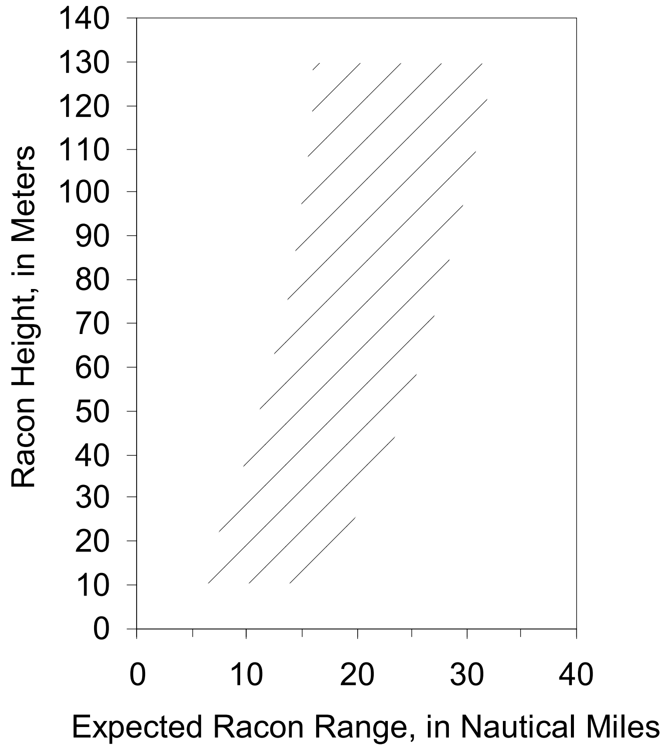

Figure 1 Expected racon detection ranges at various heights above sea level

The left edge of the shaded area represents the expected distance for a small vessel using a 4 kW 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 25 kW radar with its antenna mounted at 35 meters above sea level. Figure 1 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 miles to about 26 miles. The second use of the chart is for planning. For example, the goal is to service primarily large vessels at 25 miles and secondarily small vessels at 10 miles. Racon mounting height of greater than 40 metres would be expected to accomplish both goals.

A.5. PART 5 – GLOSSARY OF TERMS

Radar Beacon (Racon)

"A transmitter receiver device associated with a fixed navigational mark which when triggered by a radar, automatically returns a distinctive signal which can appear on the display of the triggering radar, providing range, bearing and identification information." (ITU Radio Regulation 4.40).

The terms 'radar beacon' and 'racon' should be reserved exclusively for this use. Racons may be devices mounted on fixed structures, or on floating aids anchored at fixed positions, for navigational purposes. Whether used alone or mounted on another aid to navigation (such as a visible mark) the racon itself is considered a separate aid to navigation. (IMO Resolution A.615 (15)).

Frequency-Agile Racon

A racon which replies at the frequency of the interrogating radar.

Swept Frequency Racon

A racon in which the transmitter is continuously swept over the particular radar band and responds when interrogated. The update rate is 60 to 150 seconds.

Update Rate

The rate at which the racon reappears on a radar display.

Side-Lobe Suppression

The means by which a racon is inhibited from transmitting in response to a signal from a side lobe of the antenna of an interrogating radar.