|  |
| --- |
| IALA Guideline |

11??

Technical Characteristics and Guidance on the use of Racons

Edition 1.0

Document date

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

|  |  |  |
| --- | --- | --- |
| Date | Page / Section Revised | Requirement for Revision |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

1 INTRODUCTION 5

2 Applications of Racons 5

2.1 General 5

2.1.1 Inland Waterways 5

2.1.2 Floating Aids 5

2.1.3 Frequency Bands 5

2.2 Specific applications 6

2.2.1 Long Range Navigation 6

2.2.2 Landfall 6

2.2.3 Inconspicuous Coastline Marking 6

2.2.4 Short Range Navigation 6

2.2.5 Leading Line 6

2.2.6 New Danger 6

2.2.7 Bridge Marking 6

2.2.8 Offshore structures 6

2.2.9 Routing Schemes 6

2.2.10 Turning Mark 6

2.3 Environment 6

2.3.1 Normal Environment 6

2.3.2 Sea Clutter Masking 7

2.3.3 Land and Pack Ice Masking 1 7

2.3.4 Target Masking in Congested Waterways 1 7

3 Characteristics 7

3.1 Effective Sensitivity and Effective Radiated Power 7

3.2 Sidelobe suppression 7

3.3 Energy Consumption 7

3.4 Update Rate 7

3.5 Coding 7

4 Racon Operating Range 8

4.1 Factors affecting nominal range 8

4.2 Environmental Factors 8

4.3 Multipath Fading 8

4.4 Expected Detection Ranges 8

5 DEFINITIONS 9

6 ACRONYMS 9

7 REFERENCES 9

List of Figures

Figure 1 Expected Racon detection ranges 9

# INTRODUCTION

Radar beacons (racons), when used with a ship’s radar, form a secondary aid 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 four parts

1. Guidance on the use of Racons.
2. Applications of Racons
3. Description of the characteristics of Racons.
4. Guidance on operating ranges.

# GUIDANCE ON THE USE OF RACONS

This guidance has been developed to assist Aids to Navigation Authorities considering 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.

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

# APPLICATIONS OF RACONS

## 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).

### 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.

### 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.

### 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.

## Specific applications

A number of specific applications of Racons are considered:

### Long Range Navigation

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

### 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.

### 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.

### Short Range Navigation

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

### 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.

### 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.

### 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, on 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.

### 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, May 1998).

### Routing Schemes

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

### Turning Mark

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

## Environment

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

### 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).

### 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.

### 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.

### Target Masking in Congested Waterways 1[[1]](#footnote-1)

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

# CHARACTERISTICS OF RACONS

This section describes Characteristics of Racons.

## 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.

## 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.

## 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.

## 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.

## 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.

# 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.

## 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. IALA Guideline 1010 on Racon Range Performance provides a more detailed and technical discussion on Racon range estimation.

## 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 NM.

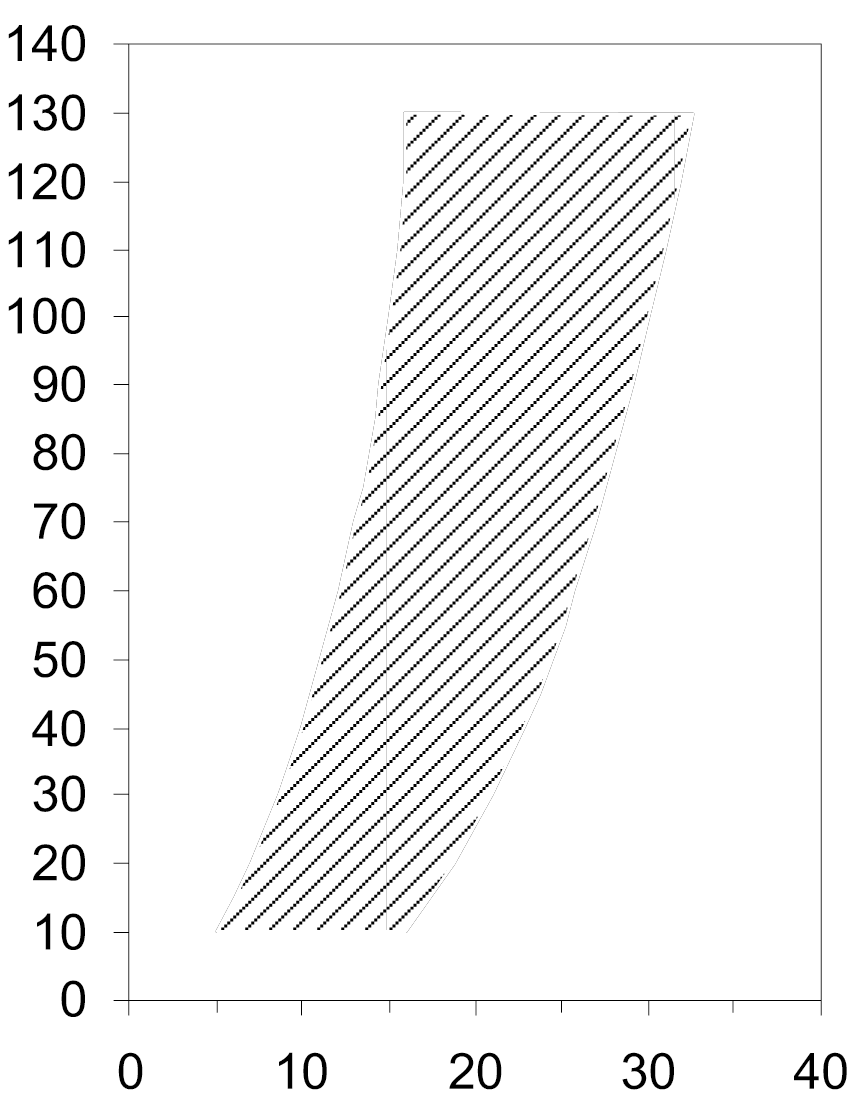
Temperature, humidity and precipitation can alter the performance factor of the atmosphere. The performance factor is difficult to measure and impossible to predict, and the factor’s wide range in value makes Racon range prediction difficult.

## 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.

## 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.



Racon height in metres

Expected Racon range in Nautical Miles

1. Expected Racon detection ranges

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 metres 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 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. Racon mounting height of greater than 40 metres would be expected to accomplish both goals.

# DEFINITIONS

*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.

# 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

# REFERENCES

1. Abcd
2. Efgh

1. Improved siting of racons and/or selection of an appropriate ON period/ OFF period ratio may provide solutions to these problems. [↑](#footnote-ref-1)