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

IALA Recommendation e-NAV-146

On

Strategy for Maintaining Racon Service Capability

Edition 1

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10, rue des Gaudines
78100 Saint Germain en Laye, France
Telephone: +33 1 34 51 70 01 Fax: +33 1 34 51 82 05
e-mail: contact@iala-aism.org Internet: www.iala-aism.org

Document Revisions

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

Date	Page / Section Revised	Requirement for Revision

IALA Recommendation on

Strategy for Maintaining Racon Service Capability

(Recommendation e-NAV-145)

THE COUNCIL:

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

RECOGNISING that radar will continue to have an important role in hazard warning, spatial awareness and confirmation of position;

RECOGNISING ALSO that a Racon service assists in position determination by providing a readily identifiable radar target;

RECOGNISING FURTHER the anticipated continuing requirement for Racons in the e-Navigation era;

NOTING that IMO have approved new radar performance standards which from 1 July 2008 removed the requirement for S-Band radars to trigger Racons;

NOTING ALSO that New Technology (NT) S-Band radars offer benefits of improved radar detection performance utilising lower peak power than conventional radar;

NOTING FURTHER that S-Band NT radars are being offered by manufacturers and are being fitted on ships;

NOTING FURTHER that IMO continues to recognize the importance of Racons as an aid to navigation;

CONSIDERING that National Members and other appropriate Authorities wish to maintain their Racon service capability, and the benefits to navigation that accrue from these services;

ADOPTS the strategy in the Annex to this recommendation; and,

RECOMMENDS that National Members and other appropriate Authorities providing marine aids to navigation services follow the strategy as detailed in section 6 of the Annex.

Table of Contents

Index of Tables

Annex
Strategy for Maintaining Racon Service Capability

1 INTRODUCTION

This strategy deals with the anticipated developments in radar over the next decade (NT Radar), the consequences for existing Racon performance with a potential reduction in the Racon service capability, and the possible options for meeting this challenge. The strategy reflects discussions in IALA and consultation with other bodies such as CIRM. Any regulatory changes considered necessary will need to be coordinated through IALA and progressed in IMO, ITU and IEC, as appropriate.

2 PRESENT SITUATION

The advent of new technology (NT) radar, with low power, solid-state transmitters introduces uncertainty about the future of Racons.

In 2004, IMO MSC79 approved new radar performance standards in Resolution 192(79), which from 1 July 2008 removed the requirement for S-Band radars to trigger Racons. This was intended to facilitate the introduction of cost effective coherent processing techniques that would enable future radars to have an improved performance in sea and rain clutter. Potentially, it also allowed more stringent limits to be considered by ITU on spurious and out of band emissions of marine radars in order to improve the utilisation efficiency of the radar spectrum.

S-Band radar is normally the preferred choice by users when operating in adverse conditions, particularly in open waters, when the extra angular resolution of X-Band radar is not so important. S-Band is much less affected by precipitation clutter than X-Band. IMO saw that the potential performance improvements that could be obtained by using new technology (NT) would therefore be particularly beneficial at S-Band. The requirement to trigger Racons was dropped in order not to limit the possibilities of improving radar performance in clutter. However, IMO continues to recognize the importance of Racons as an aid to navigation, since they provide a means of identifying and locating navigation marks in poor visibility without reliance on GNSS or other electronic position fixing systems. For this reason the requirement at X-Band on Racon compatibility has not been altered.

Prior to IMO's decision, the Nautical Institute carried out a survey of bridge officers and established that there was a consensus on an approach that effectively trades S-Band Racon compatibility for improved radar detection in conditions of heavy clutter. New systems and services provide an ever-increasing array of options through which to optimise service levels and reduce risk and cost. At the same time, the need for co-ordination through IALA and key stakeholders such as IMO and CIRM has never been more important in the endeavour to ensure consistent levels of service provision on an international basis.

Recognising the benefits of improved radar detection performance resulting from NT radar, and the relatively small number of Racons compared with the number of radars installed worldwide, it may be necessary for service providers to consider changes if the Racon service is to be maintained.

3 TECHNICAL BACKGROUND

It is likely that several S-Band NT radar solutions will emerge over the next few years and that these will rapidly be adopted by users and manufacturers. These may include solid state amplifiers, pulse compression, Travelling Wave Tube or Frequency Modulation Carrier Wave (FMCW). Target and clutter Doppler information may be used to enhance target visibility; in fact these techniques may also be used with magnetron radars. There are however, several benefits with the low peak powers resulting from pulse compression techniques, which enable solid-state

transmitters to be used. The required technology has become increasingly affordable because of the escalating market for mid-power microwave digital communication systems.

Solid-state transmitters also allow the easy use of frequency diversity techniques, giving a further significant boost to target detectability. They offer good benefits in improving the reliability of radar systems compared to magnetron based systems. Magnetrons have a limited in-service life (c10,000 hours) and require very high voltage power supplies that limit reliability.

Table 1 Comparison of characteristics of conventional and typical NT radars

Conventional Radar	**New Technology Radar**
non-coherent	coherent
pulsed	modulated pulse
high peak power (3-30 kW)	low peak power (10-500 W)
magnetrons	solid-state

Note that the interaction of FMCW radars and Racons requires a completely new approach to be developed. This has not been considered as part of this strategy paper.

4 THE ROLE OF RACONS

This Strategy is set in the following context:

- radar will continue to be the primary tool for collision avoidance for the foreseeable future;
- radar will continue to have an important role in hazard warning, spatial awareness and confirmation of position;
- anticipated continuing requirement for Racons in the e-Navigation era;
- the navigational requirement for Racons in the future is expected to be as set out in Appendix 1;
- there is a need to respond to the proliferation of other radar targets, such as wind farms;
- increasing congestion in some areas is making greater demands on AtoN;
- radars may be introduced over the next decade that will not trigger existing Racons, or will do so at significantly reduced range.

Mariners have access to a rapidly increasing amount of information, bringing with it a risk of information overload, which needs to be addressed under the Human-Machine Interface aspects of e-Navigation. This necessitates an ability to interpret and discriminate between individual aids to navigation in an environment with an increasing amount of radar clutter. There is a potential single point of failure with both the navigation and surveillance functions of bridge systems relying solely on GNSS. Radar aids to navigation are, and will remain, a key part of the approach to risk mitigation.

The removal of the requirement to trigger Racons does not necessarily mean that Racons will not work with NT Radars. They may work at a reduced, but acceptable range; NT Radars could be designed to trigger Racons, whilst retaining their other performance advantages; alternatively existing Racons could be modified to work with NT Radars or new Racons designed to do so. Calculations of performance with the first of the NT Radars indicate that existing Racons will perform, but with reduced range.

Trials have been carried out with an NT radar, which have indicated a serious reduction in range with most existing Racons (Refs 1 & 2). These trials have indicated the need for the development of this strategy.

NT radars are only being introduced at S-Band at present for SOLAS vessels, although there are X-Band NT radars available for non-SOLAS vessels. If X-Band NT radars are effective in improving small target detection in clutter it is likely that demand will grow for their application to SOLAS vessels. However, it is not currently anticipated that IMO will allow significant relaxation of the X-Band radar requirements to trigger and display Racons.

The important role of Racons is being challenged at S-Band and in the longer term at X-Band. As a result, the development of a suitable strategy for both S-Band and X-Band Racon services is considered vital.

5 OPTIONS FOR RACON SERVICES

5.1 Use Existing Racons

In principle, existing Racons can respond to pulsed NT radars, if certain constraints are placed on the radar design. However, these constraints may be unacceptable to radar manufacturers. The distance at which such radars can potentially trigger a Racon depends on the peak power of the pulse. Furthermore, an NT radar can be designed so that it would properly process and display the received pulse from the Racon, even though the Racon's response would not reflect the modulation on the radar transmitted pulse. This is a low cost and apparently low risk option for the Racon provider and it would be compatible with a large range of possible NT radar solutions, but only if they generate a Racon interrogation signal and have Racon detection algorithms within the radar's digital signal processing (DSP).

5.2 Improve Existing Racons

The second option is to examine the possibility of increasing the effectiveness of Racons with NT radars, by changes to the present Racon design characteristics e.g. receiver sensitivity. This might provide an acceptable way forward, assuming costs are acceptable - all existing Racons would have to be modified or replaced. Unchanged compatibility with existing conventional radars would also be essential.

5.3 Enhanced Racons

The Racon transmission waveform could be encoded with identity or positional information. This would enable enhanced radar positioning through the ability to correlate the radar response of a Racon with the known position of that Racon.

5.4 Universal Radar Beacon

The fourth option is to consider the design of a Racon that would be compatible with all types of conventional and NT radars. In principle, this is possible using main-stream advances in digital microwave techniques, digital RF memory and fast DSP. Although it stretches today's technology, it is likely that future advances will make this approach affordable. Its main advantage is that it is potentially compatible with all present and future radars. Racon power consumption would be a major consideration.

5.5 Secondary Radar

There is also the possibility of using non-primary radar techniques in order to determine a ship's relative position to one or more navigation marks. This can be readily performed with today's technology, using transponders in another band, but requires extra shipborne equipment, new standards and a Racon replacement programme. It would therefore be costly and politically very difficult to implement.

5.6 Non-radar technology

If the preceding options prove technically, politically or economically too difficult, then non-radar alternatives would have to be considered as a replacement for Racons. AIS is the obvious choice, although it has two major drawbacks: first, it may be dependent on GPS and therefore does not provide redundancy of position-fixing; second, a limited number of vessels have onboard equipment that can display AIS AtoN. Until both these problems are resolved (by an alternative position sensor and by the widespread adoption of modernised display equipment), AIS will not provide an adequate replacement for Racons.

6 THE STRATEGY

IALA members should present the case for retaining the existing Racon service capabilities in X-Band radar developments, are encouraged to provide S-Band Racon services optimised for conventional and NT radars.

Recognising the benefits of improved radar detection performance resulting from pulsed NT radar, an improved Racon (option 5.2) should be considered when planning a replacement or upgrade of equipment to maintain and enhance service capability.

IALA members are encouraged to support and consider the outcome of trials of enhanced Racon technology (option 5.3) and to explore the possibility of the Universal Radar Beacon (5.4) or non-radar alternatives (5.6) in the longer term.

IALA should encourage liaison with radar manufacturers to confirm that NT Radars have the capacity to trigger Racons at the proposed ranges, and work with Racon manufacturers to identify possible modification to improve triggering range.

7 REFERENCES

[1] RPT-06-MB-09 Racon Trials, GLA R&RNAV 2010

[2] RPT-07-NW-10 Second Racon Trials, GLA R&RNAV 2010

APPENDIX 1 PROPOSED NAVIGATIONAL REQUIREMENT FOR RACONS

1 BACKGROUND

Racons are an important element of the present and future AtoN mix.

IALA Recommendations / Guidelines and the NAVGUIDE set out the following typical uses of Racons:

- Inconspicuous coastlines;
- Ice conditions;
- Identification of AtoN at long range;
- Landfall identification;
- Traffic Separation Scheme / precautionary area;
- Hazard marking;
- Navigable spans under bridges;
- Leading lines;
- Short range Racon identification of a local feature (e.g. a harbour entrance);
- New Dangers (Morse D);
- Offshore structures;
- Turning Marks.

In the absence of any specific considerations IALA recommends that the availability of a Racon should be at least 99.6%, however many authorities treat all Racons as Category 1 AtoN with an availability target of 99.8%.

2 REQUIRED RACON RANGE

Racon range will depend on a number of factors including transmitter power, height of the Racon and height of radar. The Admiralty List of Radio Signals Volume 2 sets out the approximate ranges of Racons presently provided as well as some general information on Racon performance. At present Racon ranges are set out in two formats, in some cases a single range is given and in others a spread of ranges is given.

It is proposed that the navigational requirements for Racon range (regardless of radar type) should be a minimum of 5 nautical miles from a floating AtoN and 10 nautical miles from a fixed AtoN. These figures are based on a typical height of Racon of 5 metres for floating and 20 metres for fixed Racons and a radar height of 20 metres.

This performance level ignores the effect of fading due to multi-path interference, the impact of which will vary with the heights of antennas above sea level and with sea state.

3 RELATED DOCUMENTATION

IALA Guideline 1010 Racon range performance.

IALA Recommendation R-101 Maritime Radar Beacons (Racons).

IALA Recommendation O-113 for the marking of fixed bridges.

IALA NAVGUIDE.

IMO Resolution MSC.192(79) – Radar Performance Standards.

Admiralty List of Radio Signals Volume 2, UK Hydrographic Office.