e-NAV9 Input paper

Agenda item 8.7

Task Number 11

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The Committee is invited to consider this input from the General Lighthouse Authorities as a contribution to a possible IALA Strategy for racons.

Future Strategy for Racons

# Introduction

This strategy deals with the anticipated developments in radar over the next decade (NT Radar), the consequences for racons and the possible options for meeting these challenges. 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.

# 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 new 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.

# Technical Background

It is likely that a number of S-band NT radar solutions will emerge over the next few years. There is a good probability that these will rapidly become favoured both by users and manufacturers. As well as the use of target and clutter Doppler information to enhance target visibility, there are several other benefits. In particular, the low peak powers obtainable from pulse compression techniques 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.

**Comparison of characteristics of existing and NT radars**

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

# The Role of Racons

This Racon 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;
* there will be a continuing requirement for racons in the e-Navigation era;
* 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 will 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. 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 future systems relying solely on GNSS. The role of radar aids to navigation as part of the GLAs’ approach to risk mitigation will be a key element of future operational strategy.

The removal of the requirement to trigger racons does not necessarily mean that racons will not work with NT Radars. They may work, but 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 (Kelvin Hughes SharpEyeTM) indicate that existing racons will perform, but with reduced range.

Trials have now been carried out with the SharpEyeTM NT radar, which have indicated a serious reduction in range with most existing racons (Refs 3 & 4). These trials have provided firm guidance for future racon strategy.

NT radars are only being introduced at S Band at present, for SOLAS vessels, although there is an X Band NT radar available for non-SOLAS vessels. If they are effective in achieving their aim of improving small target detection in clutter it is likely that demand will grow for development of NT radars at X Band and their application to SOLAS vessels.

Therefore the important role of racons could be challenged in the medium term at S Band and in the longer term at X Band.

# Options for Racons

## 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 the 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).

## Modify Existing Racons

The second option is to examine the possibility of increasing the effectiveness of racons with future coherent radars, with various levels of changes to the present racon requirement specification. 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.

## Universal Radar Beacon

The third option is to consider the design of a racon that would be compatible with all types of coherent and non-coherent 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. Beacon power consumption would be a major consideration.

## 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.

## 5.5 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 is dependent on GPS and therefore does not provide redundancy of position-fixing; second, few vessels have onboard equipment that can display AIS AtoN. Until both these problems are resolved (by an alternative position sensor and by modernised display equipment) AIS will not provide an adequate replacement for racons.

# The Strategy

Trials carried out in March and December 2009 by the GLA (Refs.2 & 3) have shown the effectiveness of existing racons, including the latest design, with NT Radar. It can be concluded that there is a significant loss of performance, except with the most modern design. This indicates that the option of modified racons (5.2) should be pursued in the medium term, with the possibility of a Universal Radar Beacon (5.3) or non-radar alternatives (5.5) in the longer term.

# References

7.1 RPT-15-NW-08 Racon Plan 05, GLA R&RNAV 2010

7.2 RPT-06-MB-09 Racon Trials, GLA R&RNAV 2010

7.3 RPT-07-NW-10 Second Racon Trials, GLA R&RNAV 2010