Tideland Signal Corp.

featuring Aids to Navigation Products

3.1 RACON

01	UPDATE	03.03.2008	CWQ
00	RELEASE	11.19.2007	CWQ
Rev	**Description**	**Date**	**By**

A. The Requirement

Marine radar is an important aid to the conduct of safe marine navigation, by day and by night and in all weathers. It is fitted in vessels ranging from small pleasure craft to the largest commercial cargo carriers. Radars provide a pictorial presentation of all objects that can reflect radar pulses within service range. These objects or responses are typically from other ships or hazards to safe navigation like land, navigation buoys or beacons. In a radar-equipped vessel, the mariner can assess the risk of collision with other vessels and instantly be aware of his/her geographical position, relative to an identified navigational hazard or landmark.

Marine radars operate in one of two frequency bands that are referred to by mariners in general as X and S band. X band radar is most common and found on most sea-going vessels and craft. S band radar is typically found in larger vessels. S band provides a longer radar range and is more effective in poor weather conditions.

Radar “contacts” are typically anonymous. Although land “contacts” may be recognizable by their shape and size, single contacts could be small islands or rocks, ships, fishing vessels, pleasure craft or buoys. The presence of many “contacts” on a radar display can make the picture [so] difficult to interpret and confusing from a navigational point of view. A Radar Beacon (Racon), however, identifying the radar response of any object where it is fitted, particularly at a point of navigational significance, resolves a great deal of potential confusion, and contributes much to the safety of navigation.

B. Definition

A racon is an electronic receiver/transmitter device, that responds to radars operating in the marine bands, by transmitting a series of response pulses. These appear on interrogating radar displays, as a distinctive, Morse-coded trace, radiating from the position of the racon.

C. Types

There are two types of racon in service, currently.

Slow Sweep Racons.

The older of the two, Slow Sweep Racons or Slow Sweepers, as they are called, are obsolete. They operate in X-band only and their receivers "sweep" through the X –band frequencies listening for interrogating radars. When an interrogation is detected, there is just time for a response in 3 to 5 antenna rotations, producing a long dash ("T") trace on an interrogating radar display, before the receiver sweeps on along the frequency band, only returning to that particular frequency 60 to 90 seconds later. The data rate of such racons is too slow. Moreover, with so many S band radars at sea, IALA has recommended that racons should be capable of responding to both X and S band radar.

Frequency-Agile Racons.

Frequency-agile Racons, on the other hand, can respond to any interrogating marine band radar within reception range, on a pulse-to-pulse basis, providing an identifying coded trace on the interrogating radar's display, as above.

D. Applications

Racons are used in numerous applications to identify navigation marks, by day or by night, regardless of visibility conditions.

Marking Landfall

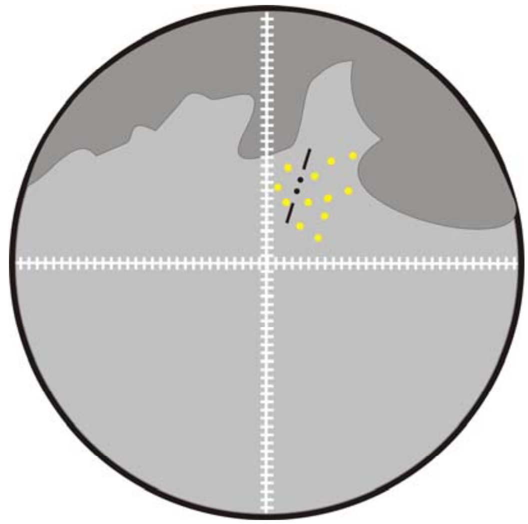
Racons, marking landfalls, ensure that the process of approaching a coast from the open sea is easy and safe, both by night and by day, for the many vessels fitted with radar – allowing those with sophisticated electronic position-fixing equipment, to corroborate their position, and enabling those not so well equipped, to fix their position.

Position Fixing off Poorly Defined Coasts

Straight low-lying coastlines without distinctive shape make position fixing on radar very difficult. Marking points of navigational significance along such coasts with racons greatly improves the situation for mariners.

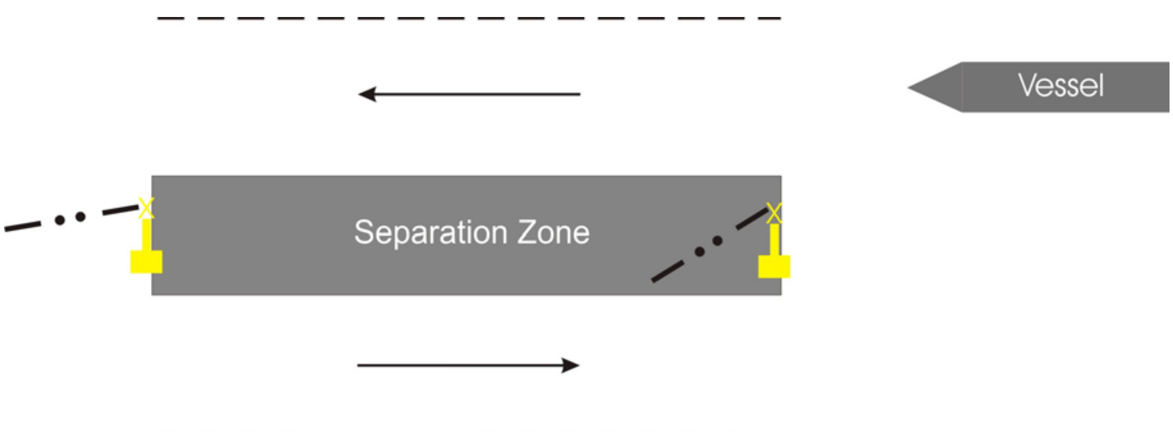
Marking Port Approaches and Confined Waters

On occasion, points of navigational significance (particularly those marking an entrance channel or turning points in confined waters) can be difficult to distinguish from other radar contacts. Small ships at anchor, slow moving fishing vessels, pleasure craft or pilot boats, other buoys, beacons or rocks, for example, may make a radar display very difficult to interpret. Marking points of navigational significance (fairway buoys in particular) with a racon clarifies the radar picture, making navigation in poor visibility and at night much easier and safer.



Marking Traffic Separation Schemes (TSS)

For ships negotiating a TSS, the nearest identifiable land can be at the extremes of radar range. In poor visibility and at night, it may be difficult to determine ship position, relative to the appropriate traffic lane by means of radar. Navigational safety in such cases can be much improved by positioning deep water floating navigation marks, each clearly identified with a racon, in the central (prohibited) separation zone, at both ends of the TSS.



Marking Temporary Hazards

Temporary obstructions, for example new wrecks, underwater drilling or salvage operations, pose a hazard to safe navigation, particularly in busy shipping areas. This hazard is reduced significantly by clearly identifying the stationary vessel or navigation mark in question by means of a racon emitting International Morse Code D.

Marking Bridges

When visibility is poor, a safe course under the open spans of a bridge may not be obvious on a radar display. IALA Recommendation 0-113 on the marking of fixed bridges over navigable waters includes advice that a racon marking the centre of safe passage instantly pinpoints the best point of passage for approaching vessels in all weather. The Recommendation also recognizes that some administrations may wish to mark the piers with racons, and advises that racons on piers that inbound vessel are to leave to starboard should respond with Morse code “T” and racons on piers that the same vessels are to leave to Port should respond with Morse code “B”.

Offshore Platform Marking

Offshore Platforms in busy shipping areas are vulnerable. A collision involving a platform poses a serious threat both to human life and marine ecology. Marking such platforms with a racon significantly reduces the risk to them. In areas where there are concentrations of offshore platforms or there is a newly installed platform whose charted position has not been fully promulgated, selective marking with racons can make an otherwise confused radar display much easier to interpret.

Leading Lines

If racons can be installed 4 miles apart; in a leading line, an observer, viewing a radar display will detect an off-track deviation of more than 75 metres from a distance of 10 nm. At 5 nm from the front racon, an off-track deviation of more than 20 metres will be detected. Optimum results are obtained with the traces arranged so that they overlap when they are in line. Tideland’s headquarters office in Houston can provide detailed design advice.

E. Features

The essential features of a modern frequency-agile racon are:

Service

In the open sea, racons are required to respond to radars in both X and S bands. IALA also recommends that racons’ operating sequences include significant idle periods to give radar operators the opportunity to detect small radar contacts that might otherwise be masked by the trace, and identifies a minimum on time of 15 seconds and a minimum operating period of 60 seconds.

Range

Racon range depends upon a number of factors - radar power output, racon receiver sensitivity, antenna heights, environmental conditions, shape of the earth, for example – and ranges of over 30 nm are achievable within the geographical limitations imposed by the curvature of the earth.

Frequency Accuracy

To obtain its maximum range, a racon must respond with frequency accuracy that is within the frequency band of the interrogating radar, otherwise a portion of the signal will not be received. With many narrow band radars in marine service, IALA recommends (R-101r1) that the frequency matching accuracy of long pulse racon responses should be better than ± 1.5MHz with interrogating pulse width > 0.2 micro seconds. across all operational temperatures.

Side Lobe Suppression (SLS)

At short ranges, racons have to suppress radar side lobe interference. In a perfect world, marine radar would have a narrow, well-defined beam with energy radiating only in one direction. In reality, radar cannot avoid radiating small amounts of energy outside the main beam. Racons responding to side lobes would 'mask' the radar screen with multiple responses. Racons counter this problem with SLS; identifying and responding only to the main radar signal and not to side lobes.

To ensure all vessels receive a racon response, whether they are near to or far off from the racon position requires the use of 'Dual-Token SLS'. Racons equipped with dual-token SLS measure both the pulse width and frequency of interrogating radar pulses to identify side lobes by their amplitude, ensuring that they do not ignore the relatively weak interrogating radar pulses from ships on the longer range scales.

Proportional Scaling (Trace Visibility)

Proportional scaling is a racon feature that maintains a relatively constant racon image on the radar screen, regardless of the radar range scale. Without this feature, every time the scale of a radar display is changed to display a longer range, the racon trace (image) would be halved, progressively making it more difficult for the mariner to identify it as such. Racons that respond to interrogating radars with the same pulse width, however, delay this process when the radar changes pulse width, so that their traces are visible throughout service range.

Power Consumption

At racon equipped AtoN stations where mains power is not available, it may be essential to limit racon power consumption to between 1 and 2 W. This can be achieved in modern racons, within the designed power consumption, by selecting an appropriate operational sequence, and by increasing the idle time where radar traffic allows.

Environmental Protection

Whether installed on buoys or beacon, racons are inevitably installed where damp conditions prevail. Protection of the electronics of a modern racon from moisture ingress is achieved through the use of a pressurized housing. Using pressurized nitrogen counters condensation and guards against moisture being drawn in with changes in atmospheric pressure. In the worst case, racons may suffer immersion, if the buoy that they are marking capsizes. Protection down to 10 metres below sea level should be an essential requirement.

Code Letter

IALA Recommendation R-101r1 on Marine Radar Beacons (Racons) advises that the Morse-coded response should be divided with the ratio of one dash = three dots and one dot = one space. In addition, the coding should normally begin with a dash.

Morse code letters – but only those that begin with a dash identify frequency-Agile racons. This avoids the buoy or rock, on which they might be installed being mistaken for a Morse code dot on a radar display. Otherwise, for example, in the case of a buoy marked by a racon with code letter N, the response could be interpreted as code letter R.

Typical Codes used are;

B	— · · ·
C	— · — ·
D	— · ·
G	— — ·
K	— · —
M	— —
N	— ·
O	— — —
Q	— — · —
T	—
X	— · · —
Y	— · — —
Z	— — · ·