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Agenda item [[2]](#footnote-2) 3.1

Technical Domain / Task Number 2 …WG3………………………

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Introduction to the Tests Information on Next Generation Racon

# 1. Summary

This document introduces the experiments on the next generation racon carried out by the China Maritime Safety Administration in the waters of the Minjiang River near the coast area of Fuzhou in 2021, and puts forward some ideas and suggestions related to the next generation racon.

## Purpose of the document

## The purpose of this document is to share information on the testing of next generation racon in China, also to discuss the possibility of updating the IALA relevant guidelines of about racon, so as to promote racon to adapt to the development trend of radar.

## Related documents（R-101）

# R0101 MARINE RADAR BEACONS (RACONS) (R-101)

# Background

2.1 Problems that may arise from the development of solid-state radars

In the 20th century, new solid-state radars were developed due to military needs. By the end of the 20th century, solid-state radar technology was introduced to navigation radars. Compared with traditional magnetron radar, solid-state radar has the advantages of strong anti-interference, anti-rain and fog ability, high resolution, maintenance-free, and low radiation etc.

At present, according to incomplete estimates, more than 3 million ships of various types are equipped with marine radars. Among them, solid-state radars are being used in large numbers by police forces, border security forces, coastal and maritime patrol personnel, search and rescue personnel etc. In addition, solid-state radars have also been installed on most yachts and other non-SOLAS ships. The S-band solid-state radar develops most rapidly because it is not restricted by IMO, especially on large cruise ships, ferries, luxury yachts, and ocean-going cargo ships.

Because of the much smaller peak power of the new solid-state radar signals, and a new signal processing method adopted, the current racon cannot be triggered by new solid-state radars. With the increase in the number of ships using solid-state radars, racon’s failure to respond to solid-state radars may bring hidden dangers to the current safety of ship navigation.

2.2 IMO Considerations for Solid State Radars

IMO has regulation about racon. It was published on Nov 19, 1987: **IMO Resolution A.615(15)**

Actually, ANNEX 2 of **Resolution A.615(15) says：**

（*Origin）*

*Operating frequencies*

*2.1 Radar beacons designed to operate on a wavelength of 3 cm should be*

*capable of being interrogated by any navigational radar equipment operating on*

*any frequency between 9,320 MHz and 9,500 MHz and respond within this*

*frequency band.*

*2.2 Radar beacons designed to operate on a wavelength of 10 cm should be*

*capable of being interrogated by any navigational radar equipment operating*

*on any frequency between 2,900 MHz and 3,100 MHz and respond within this*

*frequency band.*

In other words, IMO actually requires the racon to support all navigation radars, but in fact, the existing racon cannot respond to solid-state radars. However, due to the importance of racons to navigators over the past few decades, IMO eliminated the requirement of 3GHz (S-band) radars to trigger racon , while X-band radars still need to support racon （Resolution MSC.192(79) was adopted on Dec 2004).

# Discussion

* 1. Tests

China Maritime Safety Administration has carried out research and experiments on the availability of solid-state racons. The details are as follows:

* + 1. Test equipment

At present, solid-state radars on the market are mainly divided into two types: FM continuous wave small radars and pulse compression radars in terms of transmitting signals. The tested radars selected are two common solid-state radars on the market: 4G FM continuous wave radar and HALO-3 marine pulse compression solid-state radar.

- 4G FM CW Radar

The power of this radar is very low, with a peak signal power of only 165 mW. (The peak power of conventional magnetron radar is generally 4kw-25kw.).

- HALO-3 pulse compression radar

HALO-3 adopts the signal processing method of pulse compression, and the peak power of the signal is less than 25W.

3.1.2 Test vessel

*Figure 1: Test vessel*

Vessel Name: Haixun 16201

Vessel type: Buoy tender

The test ship was provided by the Fuzhou Navigation Dept. The solid-state radar antenna was placed at a height of about 2.5 meters. (Figure 1)

The Japanese FURUNO magnetron radar was originally installed on the ship, and the installation height was about 7.5 meters. (Figure 2)



*Figure 2：Shipborne Radar Figure 3：Racon*

3.1.3. Racon

The new type of racon was placed on the bank of the Minjiang River, about 3 meters above the water surface. (see Figure 3)

3.1.4 Test location and time



*Figure 4： Test location*

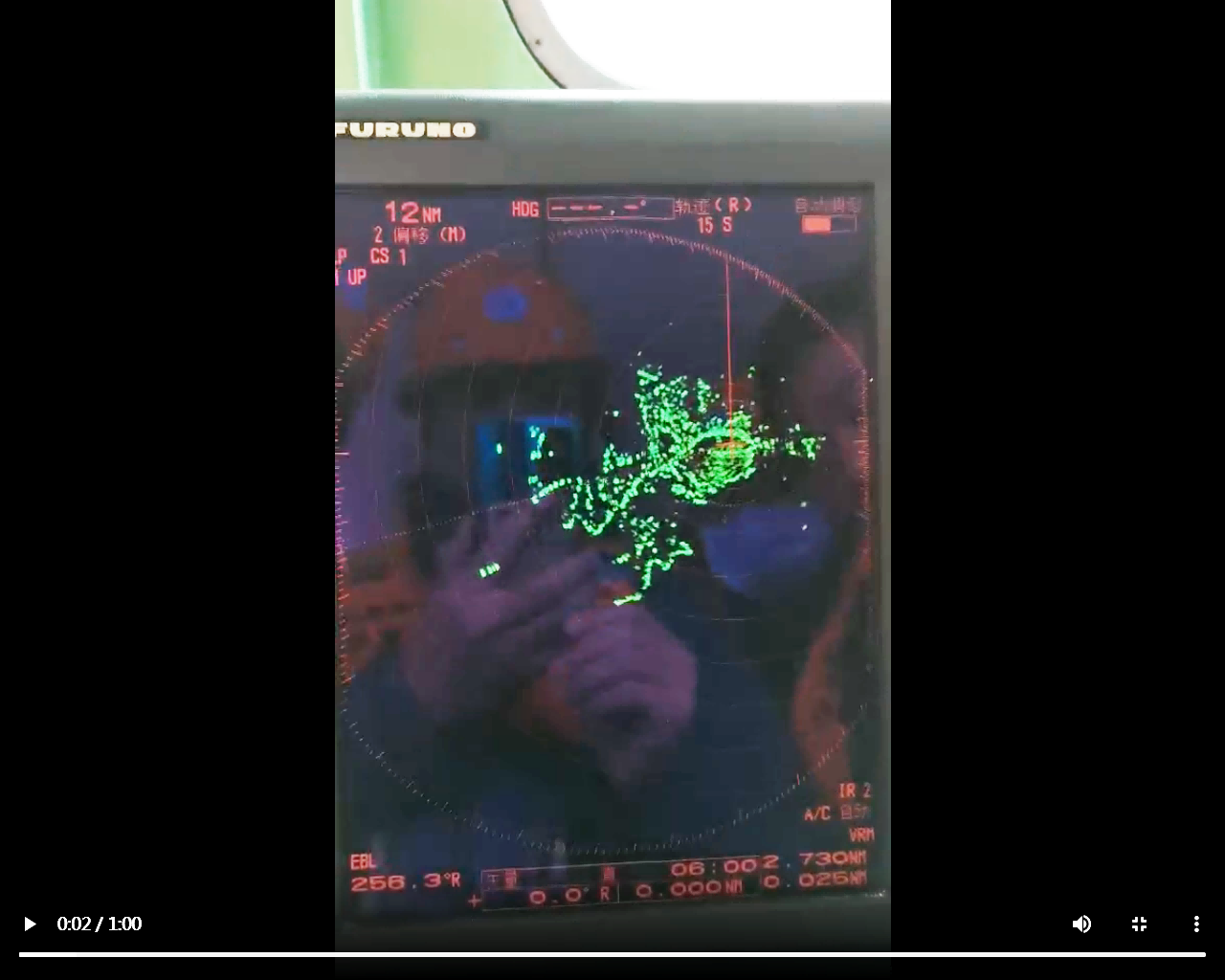
The test was launched on the Minjiang River in Fuzhou on March 2-3, 2021. The weather that day was cloudy.

Due to geographical limitation, the maximum distance tested was about 10 kilometers. The racon was placed on the river embankment at the starting point (Mawei), and the ship sailed along the Minjiang River to the upper right. (Figure 4)

3.2 Test results

3.2.1. Magnetron Radar test results

The onboard magnetron radar had very good results. The farthest tested distance was 10.09 km (5.5 nautical miles) due to the bend in the river. The radar screen display is shown in Figure 5. (In order to avoid signal coverage, the display distance was artificially extended by 12 kilometers.)



*Figure 5：Shipborne radar display*

3.2.2. Test Results of HALO-3 Pulse Compression Radar

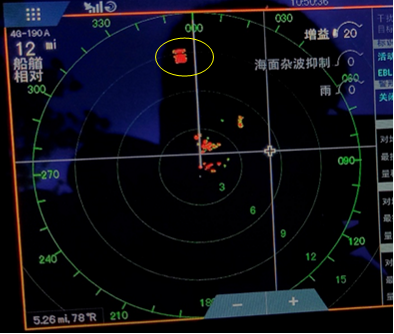
Pulse compression radar had also achieved very good results. The screen display is shown in Figure 6. The actual distance shown in the photo is 9.84 kilometers (also in order to avoid signal coverage, the displayed distance is artificially extended by 12 kilometers.)

Since the ship was moving all the time, the distances were slightly different due to the time difference between the two radar displays.

3.2.3. 4G FM CW radar test results

FM CW 4G also got a good display. Just because the signal strength of the FM continuous wave radar itself is very low, and its working distance is also short. Therefore, the maximum distance of the racon we tested was about 5 kilometers. The screen test display effect is shown in Figure 7. (Also in order to avoid signal coverage, the display distance was artificially extended by 12 kilometers.)

*Figure 6: Halo-3 Radar display*

*Figure 7: CW radar display*

**3.3. Test conclusions**

From the test results, the new type of racon can not only respond to the traditional magnetron radar, but also completely correspond to the new standard solid-state radar.

The response distance, the solid-state radar HALO-3 reaches more than 10 kilometers, which can already meet the work requirements. As for the magnetron radar, because its signal is very strong, the response range should be much more than 10 kilometers.

**3.4 Technical summary**

In view of the above-mentioned successful experiments, it is technically mature and feasible to upgrade the racon to adapt to the development of new radars. The relevant good practice could be used to update the IALA R-101 recommendation, for the reference of the navigational aids administration authorities of various countries.

**4. References**

[1] R0101 MARINE RADAR BEACONS (RACONS) (R-101)

[2] ITU-R M.824-4 (02/2013）

[3] IMO Resolution A.615(15)

**5.Committee Action**

The ENG committee is invited to note the information and to discuss the possibility of updating the recommendation that can be adapted to the next generation racon.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)