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IMCO

OPERATIONAL GUIDANCE ON THE USE OF RADAR BEACONS AND TRANSPONDERS

1. At its twentieth session (5-9 September 1977) the Sub-Committee on Safety of Navigation completed a study on radar beacons and transponders which is included in its Report to the Maritime Safety Committee (NAV XX/10, Annex V).

2. At the request of the Sub-Committee, the attached text is brought to the attention of all Member Governments for advance information and use as appropriate. The Sub-Committee's Report will be considered for approval by the Maritime Safety Committee at its thirty-eighth session (April 1978).

3. On the basis of the Report and comments received from Member Governments, recommendations on operational standards for radar beacons and transponders will be prepared by the Organization.

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ANNEX V

NAVIGATIONAL AIDS AND EQUIPMENT

DRAFT REPORT ON RADAR BEACONS AND TRANSPONDERS

I. INTRODUCTION

1. The application of radar beacons as an aid to marine navigation, and ship-borne applications of transponders have been under study by IMCO and elsewhere for some years. In the course of the IMCO study, the present and planned uses of radar beacons and transponders by Member States have been surveyed through a questionnaire. Annex I presents a Table drawn up from consideration of the replies to this questionnaire. This study has led to observations and conclusions which, generally, support the development of a system of radar beacons and transponders for use in the interest of marine safety. Annex II presents a more detailed discussion of the prospective operational uses and advantages of radar beacons and transponders. General observations and conclusions are presented in the following paragraphs.

II. RADAR BEACONS AND TRANSPONDERS

2. The terms "radar beacon" (RACON) and "transponder", as used in this document, are understood to have the following meanings:

(a) radar beacon (RACON) - in the maritime radionavigation service means a receiver-transmitter device which, when triggered by a surface search radar, automatically returns a distinctive signal which can appear on the display of the triggering radar, providing range, bearing and identification information. The use of the terms "radar beacon" and "RACON" should be reserved exclusively to those radar transponders which are mounted on fixed structures, or on floating platforms anchored at fixed locations, to serve as an aid to navigation. Whether used alone, or mounted on another aid to navigation (such as a visible mark) the RACON itself is considered a separate aid to navigation. Annexes III and IV contain operational standards for swept and fixed frequency radar beacons, respectively;

(b) transponder - in the maritime radionavigation service means a receiver-transmitter device which transmits automatically when it receives the proper interrogation, or when a transmission is initiated by a local command. The transmission may include a coded identification signal and/or data. The response may be displayed on

a radar PPI, or on a display separate from any radar, or both, depending upon the application and content of the signal. Annex V contains some notes on transponders.

III. GENERAL OBSERVATIONS

3. The use of radar beacons as an aid to marine navigation can improve the accuracy of navigation and thus offers a significant improvement in maritime safety through the reduction of groundings and other accidents which may be caused by navigational error.

4. Transponders offer a capability for the exchange of information between ships, and between a ship and shore. The use of transponders could therefore offer a potential for reducing collisions and other accidents which may be caused by inadequate knowledge of the identity, manoeuvring characteristics, position, intended or actual movement of ships.

5. The proliferation and uncontrolled use of radar beacon and transponder devices generally could lead to an unacceptable increase in responses presented on a ship's radar display, degrading the usefulness of the navigational radar display, and causing confusion among multiple beacon and transponder responses.

6. Larger numbers of transponders might be supported by the use of selective interrogation, as well as by the specification of technical parameters to be met by these devices.

7. Realization of most of the future benefits of radar beacons and the use of some types of transponders requires modification or replacement of shipboard radars to provide radar equipment with the necessary beacon or transponders modes. The uncontrolled proliferation of radar beacons and transponders could produce incompatibilities among devices developed for different uses, or could necessitate a succession of modifications to shipboard radars to accommodate progressive developments of radar beacons and transponders.

8. The most value will be gained from these devices when navigational information derived from their responses is presented in a simple and straightforward form.

IV. CONCLUSIONS

9. The improvements in navigational information which these devices offer to the safety of navigation clearly support the development of radar beacons and transponders. It is essential, however, to have international agreement on the systems to be used, for the following reasons:

(a) to avoid any significant degradation of the navigational radar display;

(b) to ensure that the responses of individual radar beacons and transponders are unambiguous;

(c) to limit the use of radar beacons and transponders to those situations where an operational need has been established;

(d) to provide the technical basis for the design of new radars, and an effective modification to existing radars, to make them compatible with the progressive development of radar beacons and transponders.

10. If studies show that the present development of fixed frequency radar beacons justifies their use for the identification of navigational marks used for general navigational purposes, they should be introduced in the following stages:

(a) international operational standards are prepared;

(b) international technical specifications are prepared;

(c) details of a beacon facility requirement are incorporated in the IMCO Performance Standards for a Navigational Radar;

(d) the requirement for a beacon facility is included in national specifications for navigational radar;

(e) the International Convention for the Safety of Life at Sea is amended to provide that all new radars installed on board ships be equipped with a beacon facility;

(f) fixed frequency radar beacons to identify navigational marks in addition to swept frequency devices are introduced.

Note: Some of these stages may be introduced concurrently.

ANNEX I

ENVISAGED OPERATIONAL USES OF RADAR BEACONS AND TRANSPONDERS

OPERATIONAL REQUIREMENTS	RADAR BEACONS 1/		TRANSPONDERS 3/	OTHER TECHNICAL METHODS	REMARKS
	FIXED FREQUENCY	SWEPT FREQUENCY			
I. Existing and near future					
(a) Ranging on and identification of positions on inconspicuous coastlines	Possible future use	In use			Display on PPI
(b) Identification of position on coastlines which permit good ranging but are featureless	Possible future use	In use			Display on PPI
(c) Identification of selected navigational marks both seaborne and landbased	Possible future use	In use			Display on PPI
(d) Landfall identification	Possible future use	In use			Display on PPI
(e) Improved detection of small radar targets	-			passive 2/ echo-enhancers	The response on the PPI should be limited in range and substantially coincide with the target. Passive methods such as radar reflectors are preferred for the present

(f) Establishing positions for hydrographic survey purposes			In use		
(g) Identification of certain classes of ships (ship-to-ship)			Possible		)
(h) Identification of ships for the purposes of shore surveillance			Possible	DF	)
(i) Identification and approach information to a specific point or into a channel or harbour		-	Possible	Leader cables, sonar	In an existing system, pilot takes aboard a portable display unit
(j) Indication of the existence of a temporary navigational hazard and marking new and uncharted dangers	-	In use			
(k) Identification of off-shore structures	Possible				)
II. Distant future					
(l) Search and Rescue operation			Possible	EPIRB	Subject to the views of the IMCO Sub-Committee on Life-Saving Appliances 4/)
(m) Identification of individual ships and data transfer			Possible	DF	Data contents to be developed

1/ Where only a bearing from a position is required this could be obtained by the use of a "Ramark", which is a radar beacon in the maritime radionavigation service which transmits continuously and provides a signal which appears on a radar display giving bearing information only.

2/ "Echo-enhancer" is a device to augment the radar return from a target.

3/ The term "Transponders" means transponders on ships and ashore.

4/ The Sub-Committee on Life-Saving Appliances considered this subject at its eleventh session and expressed the opinion that the study of the carriage of swept frequency radar beacons for use in survival craft or by survivors should be encouraged but that at this stage no provisions should be included in the revised Chapter III of the 1974 Safety Convention.

ANNEX II

OPERATIONAL USES AND ADVANTAGES OF RADAR BEACONS (RACONS) AND TRANSPONDERS

I. RADAR BEACONS (RACONS)

1. Radar beacons can be categorized in the following two main types by their transmission modes and other developments:

(a) Swept frequency radar beacon

(i) General operational characteristics: A radar beacon in the maritime service which is capable of transmitting a warning signal, automatically, to any radar-equipped ship in its vicinity:

(1) The beacon will be triggered automatically by the transmissions of any radar operating in the appropriate radar band.

(2) The return signal is to be displayed on the PPI of the triggering radar.

(ii) Operational Uses

(1)* Ranging on and identification of positions on inconspicuous coastlines.

(2)* Identification of position on coastlines which permit good ranging but are featureless.

(3)* Identification of selected navigational marks both seaborne and land-based.

(4)* Landfall identification.

(5) As a warning device to identify temporary navigational hazards and new and uncharted dangers.

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* If a fixed frequency radar beacon system is internationally agreed and introduced, swept frequency systems may, subject to review by IMCO, continue to be provided for these purposes at the discretion of the Navigation Authority concerned.

(iii) Operational benefits

(1) Provides a reference for identification and radiodetermination by means of radar.

(2) Provides a method of warning ships of the proximity of temporary hazards to navigation

(3) Supplements the radar surveillance of fixed and floating aids to navigation.

(b) Fixed frequency radar beacon

(i) General operational characteristics: A radar beacon in the marine radionavigation service which is capable of responding automatically to any radar-equipped ship in its vicinity, and which returns a signal on a fixed frequency which can be displayed on the PPI of a suitably configured radar.

(1) The beacon will be triggered automatically by the transmission of a radar operating in the appropriate radar band.

(2) The signal may be displayed continuously, either separately or superimposed on the radar picture, or may be switched off, at the option of the operator.

(ii) Operational uses

(1) Ranging on and identification of positions on inconspicuous coastlines.

(2) Identification of position on coastlines which permit good ranging but are featureless.

(3) Identification of selected navigational marks both seaborne and landbased.

(4) Landfall identification.

(5) Identification of off-shore structures.

(iii) Operational benefits (in addition to those defined for swept frequency radar beacons)

(1) Display of response is under the control of the operator.

(2) Clutter caused by rain, sea and land can be eliminated by independent display of the beacon response.

(3)* Beacon response can be available on each revolution of the radar antenna.

II. TRANSPONDERS

2. General operational characteristics: A transponder is a device, which, when properly interrogated, could provide for:

(a) ship radar target identification and echo enhancement with the proviso that such enhancer should not significantly exceed that which could be achieved by passive means on the radar PPI of an interrogating ship or shore station;

(b) radar target correlation with voice or other radio transmission for identification on the radar PPI of an interrogating ship or shore station;

(c) operator selectable presentation of transponder responses either superimposed on the normal PPI display, or free of clutter and other targets;

(d) transfer of information pertinent to collision/hazard avoidance, manoeuvre, manoeuvring characteristics, etc.

3. Operational uses

(a) Identification of certain classes of ships (ship-to-ship);

(b) identification of ships for the purposes of shore surveillance;

(c) search and rescue operations;

(d) identification of individual ships and data transfer;

(e) establishing positions for hydrographic purposes.

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* This may also be achieved with a fast sweeping radar beacon.

4. Operational benefits

(a) Could provide warning of the presence of designated classes of ships, and allow identification of a particular class, or a particular ship;

(b) could allow radar identification of ships making VHF radiotelephone transmission;

(c) could permit transfer of data pertaining to identify manoeuvring characteristics, position intended and actual movement of ships and thus improving capabilities for collision avoidance and ship traffic surveillance;

(d) selective interrogation would permit use without significant interference;

(e) could permit display and transfer of data without interference to the navigational radar display - yet could permit PPI display of selected data at the option of the operator.

7. Operating frequencies

(a) 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 9320 MHz and 9500 MHz and respond within the frequency band 9320 MHz to 9500 MHz.

(b) 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 2920 MHz and 3100 MHz and respond within the frequency band 2920 MHz to 3100 MHz.

8. Transmitter tuning characteristics

The tuning characteristics of the transmitter should be such that the beacon response can appear on a radar display in a recognizable form at least once every two minutes.

9. Operating range

The operating range should be compatible with the navigational requirements for the radar beacon at its location and should not normally exceed 30 nautical miles.

10. Response characteristics

(a) On receipt of an interrogating signal, the radar beacon should commence its response in such time that the gap on the radar display between the radar target and the beacon response does not normally exceed approximately 100 metres. In certain cases the operational use of beacons may allow this delay time to be increased. Under such circumstances the delay time should be as short as practicable and the details should be shown in appropriate navigational publications.

(b) The duration of the response should be approximately 20 per cent of the maximum range requirement of the particular beacon, or should not exceed 5 miles, whichever is the lower value.

(c) The leading edge of the response should be sufficiently sharp to permit satisfactory range determination. Where identification coding is used, the leading edges of any other dots and dashes in the response should be such that they may, if required, be substantially removed from a radar display with minimum degradation to the radar echoes.

7. Operating frequencies

(a) 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 9320 MHz and 9500 MHz and respond within the frequency band 9320 MHz to 9500 MHz.

(b) 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 2920 MHz and 3100 MHz and respond within the frequency band 2920 MHz to 3100 MHz.

8. Transmitter tuning characteristics

The tuning characteristics of the transmitter should be such that the beacon response can appear on a radar display in a recognizable form at least once every two minutes.

9. Operating range

The operating range should be compatible with the navigational requirements for the radar beacon at its location and should not normally exceed 30 nautical miles.

10. Response characteristics

(a) On receipt of an interrogating signal, the radar beacon should commence its response in such time that the gap on the radar display between the radar target and the beacon response does not normally exceed approximately 100 metres. In certain cases the operational use of beacons may allow this delay time to be increased. Under such circumstances the delay time should be as short as practicable and the details should be shown in appropriate navigational publications.

(b) The duration of the response should be approximately 20 per cent of the maximum range requirement of the particular beacon, or should not exceed 5 miles, whichever is the lower value.

(c) The leading edge of the response should be sufficiently sharp to permit satisfactory range determination. Where identification coding is used, the leading edges of any other dots and dashes in the response should be such that they may, if required, be substantially removed from a radar display with minimum degradation to the radar echoes.

11. Identification coding

(a) In some applications coded response formats may be required.

(b) The form of identification coding when required should comprise the full length of the radar beacon response being divided into dashes and dots, with a ratio of 1 dash = 3 dots and 1 dot = 1 space.

The coding should normally commence with a dash and the design of beacons should permit the possible use of an additional three dots or dashes.

12. Construction

Radar beacons should be designed to operate continuously and with high reliability when permanently installed in a marine environment.

Note: Beacons which sweep the whole marine radar frequency band in less than 20 microseconds may not meet some of these operational requirements and others may be irrelevant.

ANNEX IV

DRAFT RECOMMENDATION ON OPERATIONAL STANDARDS FOR FIXED FREQUENCY RADAR BEACONS

1. Introduction

(a) Fixed frequency radar beacons intended to be used as given in Annex II, Part I(b) should conform to the following minimum operational standards.

(b) Fixed frequency radar beacons should be capable of being interrogated by a radar which conforms to the Recommendation contained in Resolution A.222(VII).

(c) The use of fixed frequency radar beacons must be authorized by a competent navigation authority.

2. Operating frequencies

(a) 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 9320 MHz and 9500 MHz and respond within the frequency band 9300 MHz to 9320 MHz.

(b) 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 2920 MHz and 3100 MHz and respond within the frequency band 2900 MHz to 2920 MHz.

3. Operating range

The operating range should be compatible with the navigational requirements for the radar beacon at its location and should not normally exceed 30 nautical miles.

4. Response characteristics

(a) On receipt of an interrogating signal, the radar beacon should commence its response in such time that the gap on the radar display between the radar target and the beacon response does not normally exceed approximately 100 metres.

(b) The duration of the response should be approximately 20 per cent of the maximum range requirement of the particular beacon, or should not exceed 5 miles, whichever is the lower value.

(c) The leading edge of the response should be sufficiently sharp to permit satisfactory range determination;

(d) When a beacon is required to respond to several interrogators, interruptions in responding to each particular interrogator should be kept to a minimum.

5. Identification coding

(a) The form of identification coding when required should comprise the full length of the radar beacon response being divided into dashes and dots, with a ratio of 1 dash = 3 dots and 1 dot = 1 space.

(b) The coding should normally commence with a dash and the design of beacons should permit the possible use of an additional three dots or dashes.

6. Construction

Radar beacons should be designed to operate continuously and with high reliability when permanently installed in a marine environment.

ANNEX V

DRAFT RECOMMENDATIONS ON OPERATIONAL STANDARDS FOR TRANSPONDERS

1. Studies by IMCO have indicated some operational applications for transponders and studies in CCIR are taking place on frequency and technical matters related to shipborne transponders.

2. The design of transponder systems should ensure that there is no significant degradation of fixed frequency radar beacons, and the response of a transponder should not be capable of being interpreted as being from a radar beacon of any type.

3. Where a transponder is to be used with a marine navigational radar any modifications necessary to the radar should not degrade its performance, be kept to a minimum, be simple and, where possible, be compatible with a fixed frequency radar beacon facility.

4. In-band transponders should not be used to enhance the detection of marine craft, except when specially authorized by Administrations for use in survival craft.

5. The long-term aim should be to develop transponder systems which are compatible with each other. Work has only recently started in this field and the preparation of international operational standards should be deferred pending the results of further study into the operational requirements.

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