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Part 2: Active type

Navires et technologie maritime — Réflecteurs radars de marine —

Partie 2: Type actif

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8729-2 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

ISO 8729 consists of the following parts, under the general title *Ships and marine technology — Marine radar reflectors:*

— *Part 1: Passive type*

— *Part 2: Active type*

Ships and marine technology — Marine radar reflectors —

Part 2:
Active type

1 Scope

It is recognised that small vessels, often made of glass fibre reinforced plastic (GRP), can be poor reflectors of radar signals. In situations where radar is the prime observation tool used by ships at sea, the International Maritime Organisation considers that it is essential that small vessels, considered in this context to be those under 150 gross tonnage, be equipped with a radar reflector to enhance their radar return and thus improve their visibility to radar.

This International Standard specifies the minimum requirements for a radar reflector intended to enhance returns from small vessels as required by IMO Resolution MSC.164(78).

It provides the specification for the construction, performance, testing, inspection and installation of such radar reflectors.

NOTE Requirements that have been extracted from IMO Resolution MSC.164(78) *Revised performance standards for radar reflectors* are printed in italics.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17025, *General requirements for the competence of testing and calibration laboratories*

IEC 60945, *Marine navigation and radiocommunication equipment and systems — General requirements — Methods of testing and required test results*

ITU-R SM.329, *Unwanted emissions in the spurious domain*

ITU-R SM.1541, *Unwanted emissions in the out-of-band domain*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
radar reflector
device that is designed to enhance radar returns from vessels with small radar cross section

3.2
active radar reflector
device that receives, amplifies and retransmits a radar signal as a method of enhancing radar returns

NOTE An active radar reflector is often also known as a radar target enhancer (RTE).

3.3
radar cross section
RCS
equivalent echoing area which is 4 π times the ratio of the power per unit solid angle scattered in a specified direction to the power per unit area in a plane wave incident on the scatterer from a specified direction

NOTE It is dependent on the radar operating frequency and the three-dimensional orientation of the reflector. Polarization of the transmitter and the received wave affects the effective radar cross section of the reflector.

3.4
azimuthal polar diagram
polar diagram providing the RCS of the reflector with respect to its azimuthal angle

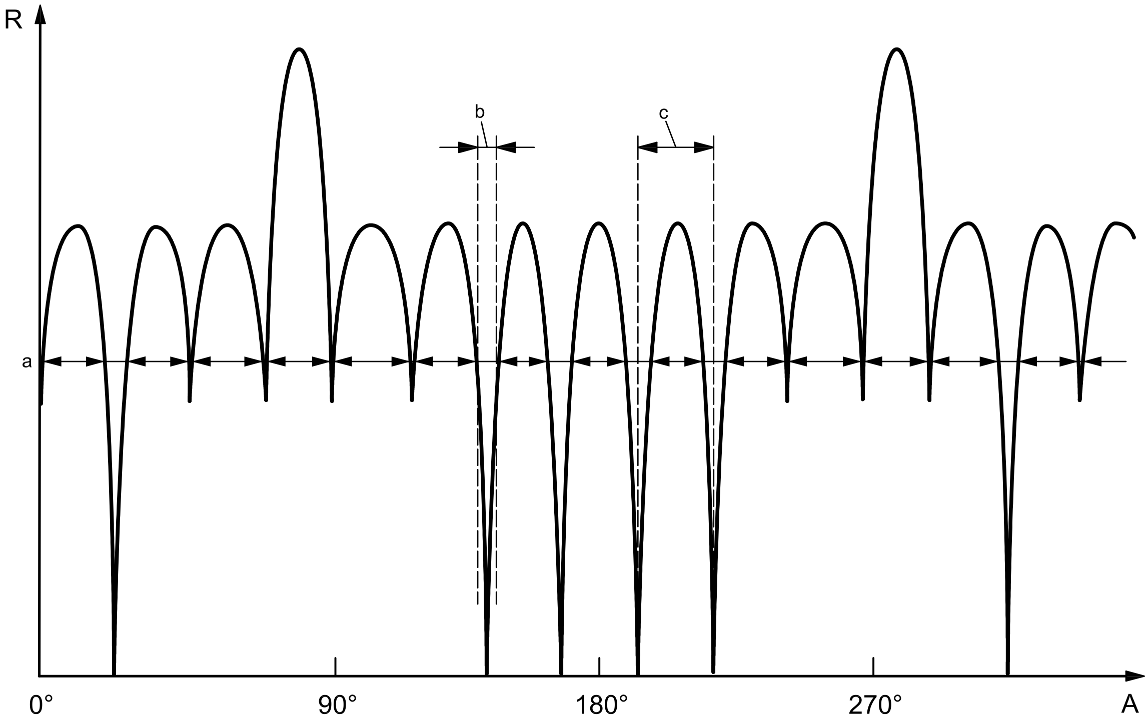
NOTE These diagrams can be produced for any angle of heel.

3.5
null
pronounced fall-off of RCS in the azimuthal polar diagram

3.6
stated performance level
SPL
performance level calculated from measurement data sets (i.e. azimuthal polar diagrams) taken during technical measurements of reflective performance

NOTE 1 SPL is the RCS value at which a null is 10° wide (see Figure 1). If there is more than one null with a width of at least 10°, then SPL is the lowest such value.

NOTE 2 If the azimuthal polar diagram does not show a null (as defined in 3.5) that is 10° wide, then the SPL is the RCS which is achieved over 280° of azimuth.



Key

A azimuth

R radar cross section

[a] Stated performance level.

[b] Null width ⩽ 10°.

[c] Spacing between nulls ⩾ 20°.

Figure 1 — Definition of stated performance level

3.7
self-oscillation
phenomenon whereby the receive and transmit antennas of an active reflector are unintentionally coupled, either inherently or by a reflecting surface closeby, so that feedback occurs between the two

NOTE Devices that are self-oscillating are also said to be unstable.

3.8
saturation
state whereby an active radar reflector is emitting the maximum power of which it is capable

NOTE 1 This power at which saturation occurs is known as the saturated power.

NOTE 2 The distance from the interrogating radar at which saturation occurs is a function of the power of the radar, the total gain of the reflector and the maximum power of the reflector.

4 Construction

4.1 General arrangement

The active radar reflector shall consist of a receive antenna (or antennas), an amplifier (or amplifiers) capable of operation across the X and S bands and a transmit antenna (or antennas). Typically there may also be an associated control box whose function is to switch the device on and off and to indicate to the user that the device is working.

4.2 Structure and materials

The materials used for the radar reflector shall be of sufficient strength and quality as to make the reflector capable of maintaining reflection performance under the conditions of stress due to sea states, vibration, humidity and change of temperature likely to be experienced in the marine environment. Use of ferrous metals should be avoided.

4.3 Enclosed size of the reflector

The volume of the reflector should not exceed 0,05 m^3.

4.4 Mass of the reflector

The reflector should weigh as little as practical in order to minimise its effect on the stability of small vessels.

5 Performance

5.1 Functionality

The active radar reflector shall receive a radar pulse, amplify it and retransmit it. The output shall only be an amplified version of the received pulse, without any form of processing except limiting.

5.2 Reflecting pattern

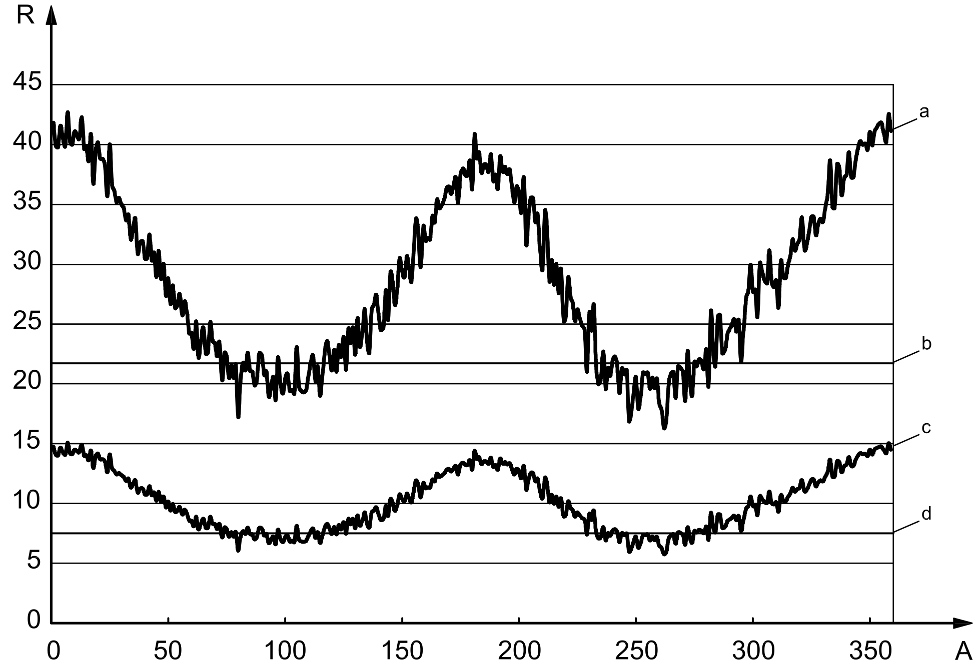
5.2.1 T*he radar reflector* shall *have a stated performance level of at least 7,5* m^2 *at* X *band (9,300* GHz *to 9,500* GHz*) and 0,5* m^2 *at* S *band (2,900* GHz *to 3,100* GHz*). The SPL* shall *be maintained over a total angle of at least 280°.*

The response shall*, at the calculated SPL for each azimuthal polar diagram,*

— *not have any nulls wider than a single angle of 10°, and*

— *not have a distance between nulls of less than 20°. Nulls of less than 5° shall be ignored for this calculation.*

NOTE Typical azimuthal polar diagrams for an active radar reflector in X band at 0° and 10° elevation are given in Figure 2.



Key

A azimuth

R radar cross section, expressed in m²

a 0° elevation

b stated performance level for 21,7 m²

c 10° elevation

d stated performance level for 7,5 m²

The 0° elevation response shows a calculated SPL of 21,7 m³ for 280° azimuth coverage and the response at 10° elevation is calculated at 7,5 m³, which is just compliant with respect to the minimum SPL requirement. These two plots also illustrate the expected antenna gain reduction with elevation change.

Figure 2 — Examples of typical RTE azimuthal polar diagrams and their associated SPL

5.2.2 *For power-driven vessels and sailing vessels designed to operate with little heel (catamaran/trimaran), this performance* shall *be maintained through angles of (athwartships) heel 10° either side of vertical. For other vessels, the reflector* shall *maintain this performance over 20° either side of vertical.*

5.3 Time delay and stretching

The time delay and stretching of the output shall not exceed 10 % of the length of the received pulse or 10 ns, whichever is greater.

5.4 Polarisation

The active reflector shall respond to radar using horizontal polarisation in both X and S bands. For S band, the active reflector may use circular polarised antennas for receiving and transmitting.

5.5 Stability and self-oscillation

The active reflector shall be inherently stable and it shall not be possible for instability to be induced under any conditions. Stability shall be demonstrated by the tests specified in 7.3.4 and 7.3.5.

5.6 Maximum power

The maximum power of the active reflector shall not exceed 10 W.

5.7 Tolerance to a radar in close proximity

The reflector must be able to withstand a continuous pulse power density of 2 kW/m^2. This is equivalent to a 25 kW radar, 1 µs, with a 1,83 m antenna [1)] at a range of 30 m.

6 Environmental requirements

The active radar reflector shall meet the dry heat, damp heat, low temperature, solar radiation, vibration, rain and spray and corrosion requirements of IEC 60945 where they are applicable. If the design of the active radar reflector system is such that some parts are intended to be installed in an exposed position and others in a protected position, then the tests to which each part shall be subjected shall be those which apply to the intended position.

7 Inspection and type tests

7.1 Inspection

A visual inspection shall be carried out to confirm that the construction and finish of the reflector is such that the unit is safe to handle. For example, burrs should be removed and, if applicable, wires fixed so that injury cannot occur during the handling of the reflector.

7.2 Testing

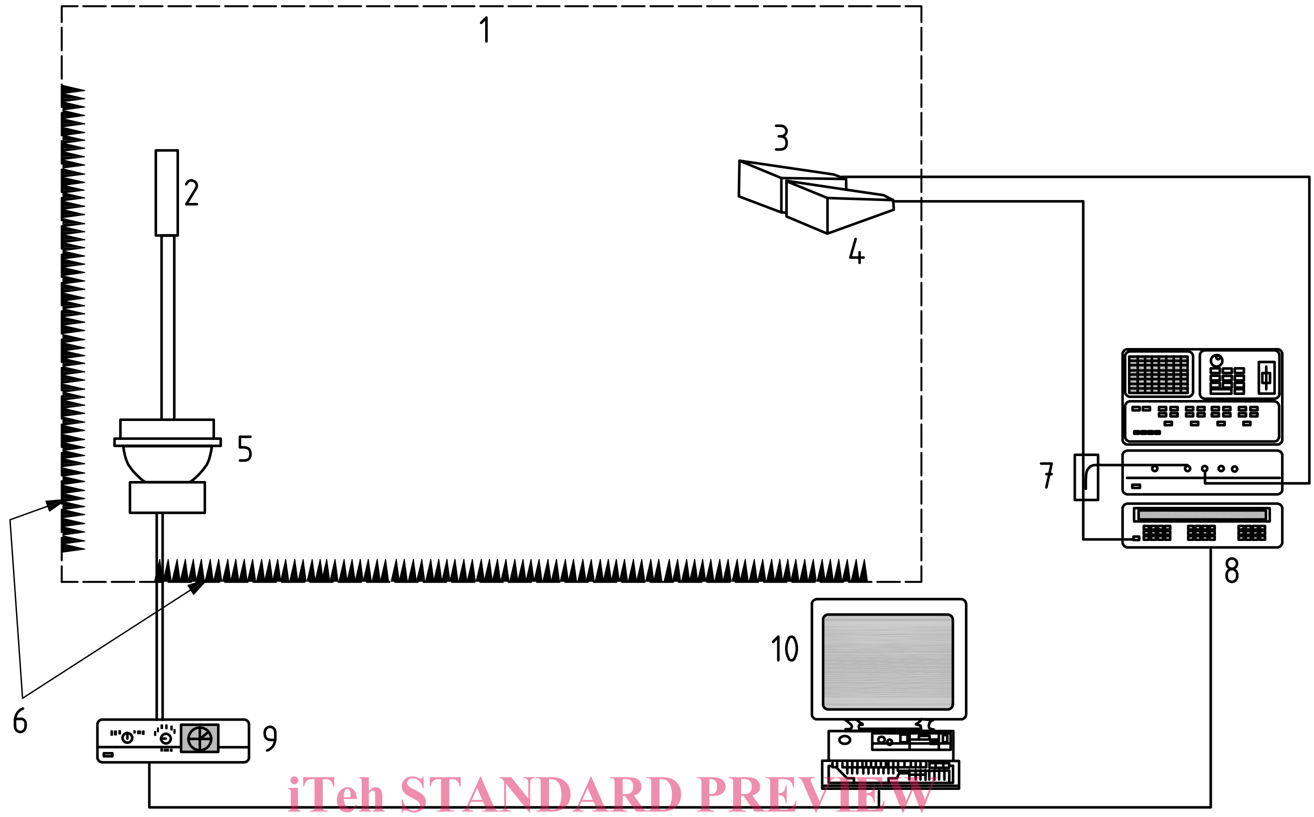
Tests will normally be carried out at test sites accepted by the type test authority for these tests. General requirements for the competence of testing and calibration laboratories are given in ISO 17025. The manufacturer shall, unless otherwise agreed, set up the equipment and ensure that it is installed in accordance with their installation requirements before type testing commences.

7.3 Performance tests

7.3.1 General

The reflective performance tests shall be conducted in a free-field environment where the background noise level has been reduced to the equivalent echoing area of 0,01 m^2 or less at frequencies between 2,900 GHz to 3,100 GHz and 9,300 GHz to 9,500 GHz. Typically, a fully anechoic microwave test chamber, specified for up to 10 GHz operation, would be used for the conduct of these tests. Before use, the reflector test range shall be calibrated using a precision sphere of known radar cross section. These tests may be carried out using a continuous wave (CW) or pulsed signal. CW signals are atypical of current magnetron radar but produce lower uncertainties in reflector testing. Due to the 100 % duty cycle of a non-fluctuating CW signal, the manufacturer should be consulted to ascertain the maximum time tests can be conducted and the duration of any rest period to allow for equipment under test (EUT) cooling. The tests should be carried out at both X band (9,410 GHz) and S band (3,050 GHz) with the same power density at the EUT turntable that was used for the chamber calibration. This power density should be at least 6 dB below the level required to saturate the EUT, unless otherwise stated in the test clause. For illustration, an instrumentation schematic is given in Figure 3.

1) 1,83 m ≈ 6 ft.



Key

1 fully anechoic chamber
2 equipment under test
3 receive antenna
4 transmit antenna
5 positioner (azimuth/elevation)
6 radar absorbent material
7 directional coupler
8 vector network analyser
9 position controller
10 PC

Figure 3 — Instrumentation schematic

7.3.2 SPL measurement

7.3.2.1 General

The test shall consist of a series of measurements to produce azimuthal polar diagrams of the reflector performance within the volume 360° azimuth and the required angle (±) of heel (see 5.2.2). Measurements shall be taken using a turntable capable of moving the EUT at intervals ⩽ 1° in azimuth and ⩽ 0,5° in elevation. The arrangement of the turntable shall give azimuth movement over elevation. Azimuthal polar diagrams shall be produced at 5° vertical intervals up to 10° or 20° depending on the designation of the EUT (see 5.2.2) both towards and away from the interrogating signal source. The turntable shall rotate at an angular speed to match instrumentation data capture rate, and measurement data should be recorded to a computer spreadsheet so that the SPL, which has a dynamic relationship with the 280° requirement and nulls, can be calculated for each plot.