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Ships and marine technology — Marine radar reflectors —

Part 1: **Passive type**

Navires et technologie maritime — Réflecteurs radars de marine —

Partie 1: Réflecteurs de type passif

Reference number
ISO 8729-1:2010(E)

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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 8729-1 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

This first edition of ISO 8729-1 cancels and replaces ISO 8729:1997, which has been technically revised.

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*

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Ships and marine technology — Marine radar reflectors —

Part 1:
Passive type

1 Scope

It is recognized that small vessels, often made of glass 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 Organization (IMO) 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 to 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.

There are two types of radar reflector: passive and active. Passive reflectors are mechanical, whereas active reflectors have an electronic element. This part of ISO 8729 concerns passive 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 8729-2:2009, *Ships and marine technology — Marine radar reflectors — Part 2: Active type*

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

IMO Resolution MSC. 164(78), *Revised performance standards for radar reflectors*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8729-2 and the following apply.

3.1
passive radar reflector
radar reflector which does not consist of any electrical devices that receive, amplify and return a radar signal as a method of enhancing radar returns

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3.2
azimuthal polar diagram
polar diagram providing the radar cross section (RCS) of the reflector with respect to its azimuthal angle

NOTE These diagrams can be produced for specified angle of heel. Examples of typical plots for a Luneburg reflector and for a corner reflector are given in Figures B.1 and B.2 respectively.

3.3
Luneburg reflector
reflector, making use of a number of concentric spheres of varying refractive index, capable of focusing incident energy onto a reflecting surface

3.4
corner reflector
reflector, consisting of flat conducting surfaces intersecting mutually at right angles, that reflects the greater part of the incident waves parallel to their direction of incidence

4 Construction

4.1 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 and capable of withstanding the environmental conditions specified in 5.3.

Ferrous metals should not be used.

4.2 Enclosed size of the reflector for small-craft

The volume of the reflector for small-craft should not exceed 0,05 m^3.

If this volume exceeds 0,05 m^3, the following text should be noted in the manual:

“This reflector exceeds the recommended volume limit for small-craft.”

4.3 Colour

The radar reflector intended for installation on board vessels shall not be coloured black. It should be of a highly-visible colour.

5 Performance requirements

5.1 General requirements

The radar reflector shall comply with the following minimum requirements for the frequency range of X-Band (9,300 GHz to 9,500 GHz), and S-Band (2,900 GHz to 3,100 GHz).

5.2 Reflecting pattern in horizontal plane

5.2.1 *The radar reflector* shall *have a Stated Performance Level of at least 7,5 m^2 at X-Band and 0,5 m^2 at S-band. The SPL* shall *be maintained over a total angle of at least 280°.*

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The response shall, at the assessed level for each polar plot:

— not have any nulls greater 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 passive radar reflector at X-band are given in Figures B.1 and B.2.

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 Environmental requirements

The radar reflector shall comply with all requirements for

— dry heat,

— low temperature,

— vibration,

— rain and spray,

— solar radiation,

— corrosion, and

— compass safe distance

specified in IEC 60945.

6 Inspection and type tests

6.1 Visual 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 handling of the reflector.

6.2 Test site

Tests will normally be carried out at test sites accepted by the type test authority for these tests. 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.

6.3 Environmental tests

6.3.1 Methods of test

The reflector shall meet the requirements of IEC 60945 for exposed equipment for the environmental conditions given in 5.3.

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6.3.2 Required results

IEC 60945 requires performance tests or checks to be carried out during the test programme. A performance test needs specialized equipment used in a free-field environment for qualitative results. Therefore, the "performance check" shall consist of a visual examination during the tests for any damage visible to normal eyesight, and the "performance test" shall consist of the full reflective performance test specified in 6.4.1 which shall be conducted on the sample reflector after conducting the environmental tests specified in 6.3.1.

6.4 Performance tests

6.4.1 Test methods

The reflective performance tests shall be conducted in a free-field environment or a fully anechoic chamber where the background noise level has been reduced to the equivalent of 0,01 m^2 at frequencies between 2,900 GHz and 3,100 GHz and 9,300 GHz and 9,500 GHz.

Typically, a fully anechoic microwave test chamber would be used for carrying out these tests.

Before use, the reflector test range shall be calibrated using a precision sphere of known RCS.

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 duration for which 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.

6.4.2 Required results

The radar reflector shall have a minimum SPL of 7,5 m^2 at X-band and 0,5 m^2 at S-band.

6.5 Mechanical strength test

6.5.1 Test methods

Mount the reflector in the recommended manner for underwater testing and move underwater at a relative velocity of 1,3 m/s in both directions for each of three mutually perpendicular planes in sequence.

6.5.2 Required results

After the test, inspect visually to confirm the absence of mechanical performance issues or external damage.

7 Installation

7.1 Method

The radar reflector shall be installed in accordance with a method recommended by the manufacturer.

Fixing arrangements shall *be provided so that the reflector can be fitted* in its correct orientation *either on a rigid mount or suspended in rigging.*

Manufacturers shall ensure that the method of mounting is adequately described in the manual.

Manufacturers shall ensure that the fixing arrangements of the reflector correspond with those described in the manual and are sufficient to mount the reflector in the orientations specified therein.

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7.2 Positioning check

The radar reflector shall be installed in the optimum position for the avoidance of shadow sectors.

Manufacturers shall ensure that the manual describes shadow sectors and gives methods for their avoidance.

7.3 Mounting height check

Manufacturers shall ensure that the manual includes information clarifying the importance of the installation height, i.e. that a minimum installation height of 4 m above sea level (ASL) can satisfy the IMO requirements, in respect to detection, provided that the reflector complies with 6.4.1.

For smaller heights, larger reflectors in accordance with Annex A are recommended.

7.4 Mass check

For small-craft, the maximum mass *for mounting at 4 m* shall *be 5 kg.*

Reflectors designed for mounting at a greater height shall *be of the* mass *calculated as equivalent to, or less than 5 kg.*

Determine the mass of the reflector and confirm that it is suitable for installation at or above the minimum installation height.

If the height/mass value exceeds 4 m/5 kg, the following warning statement shall be clearly made in the manual:

“This reflector exceeds the height/mass equivalent 4 m/5 kg and may not be suitable for small boats and yachts. It is, however, the owner's responsibility to ensure that he or she does not adversely affect the stability of his or her vessel to an unacceptable degree.”

The reflector should weigh as little as practical in order to minimize its effect on the stability of small-craft.

7.5 Size check

The *physical sizes* of the reflector for the small-craft shall *be minimized and* it shall *not exceed 0,05 m^3*.

Check and confirm the physical size of the reflector (enclosed room).

If the size of the reflector exceeds 0,05 m^3, the following statement shall be clearly made in the manual:

“This reflector exceeds the recommended size limit for small-craft.”

8 Manual

The manufacturer shall provide a manual or equivalent documentation whose contents shall include:

— a general description of the reflector and any associated items;

— the reflector's dimensions and mass;

— a description of preferred methods of mounting and orientation;

— the measured compass safe distance (CSD) from the vessel's magnetic compass or a statement that the reflector should be mounted at least 5 m from the compass;

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— statements with regard to mass and mounting height that fulfil the requirements of 7.3 and 7.4;

— methods for avoiding shadow sectors;

— the minimum ASL height required to achieve the SPL.

9 Marking

One or more labels shall be affixed to each reflector, on a surface that does not significantly affect the radar reflector's performance, indicating:

— the name of the manufacturer;

— the identification mark or type number;

— the year of manufacture;

— the minimum reflector mounting height;

— the mass of the reflector;

— the compass safe distance;

— one of the following statements, as applicable

  — “For use up to ± 10 degree heel”, or

  — “For use up to ± 20 degree heel”;

— the SPL;

— any approval marking (for example EU “wheelmark” or other approval mark), as appropriate.

The reflector shall be clearly and permanently marked with any preferred or recommended orientation.

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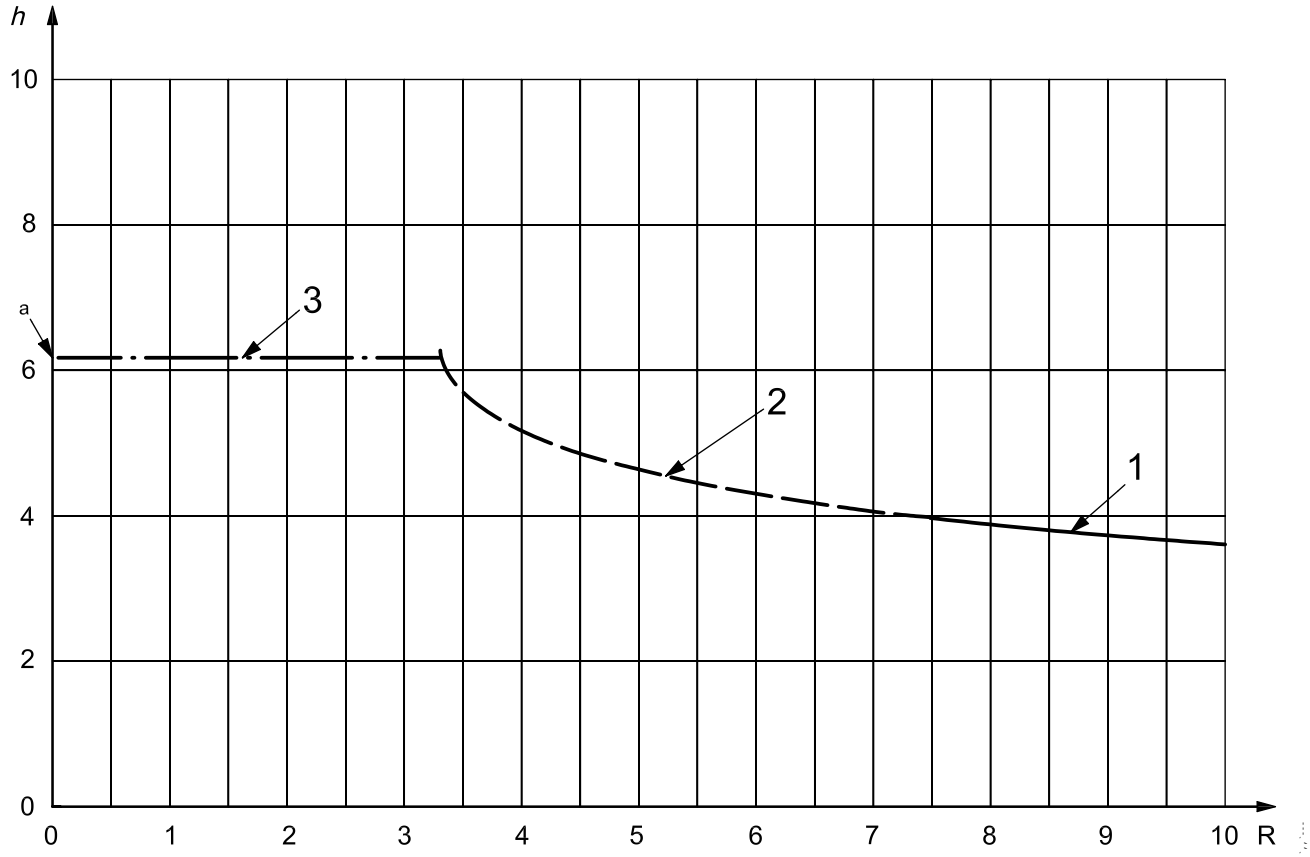
Annex A
(normative)

Mounting height of the reflectors



Key

h reflector ASL height, expressed in m

R RCS, expressed in m^2

1 IMO compliant radar reflector

2 not IMO compliant radar reflector due to limited size

3 size limit due to height pattern

[a] Raising the reflector above this height doesn't reduce the necessary RCS. A larger RCS is needed because of the height pattern.

Calculation condition

Frequency: 9,410 GHz

Height of radar antenna, h_a: 15 m

Height of target, h: 4 m

Distance of target: 5 nm

Transmission power: 10 kW

Antenna gain: 30 dBi

Target RCS, R: 7,5 m^2

The setting of the sensitivity of the receiver: –75 dBm

NOTE These values are based on IMO Resolution MSC. 192(79).

Figure A.1 — Mounting height of the reflector (9,410 GHz, h_a = 15 m, –75 dBm at 5 nm)

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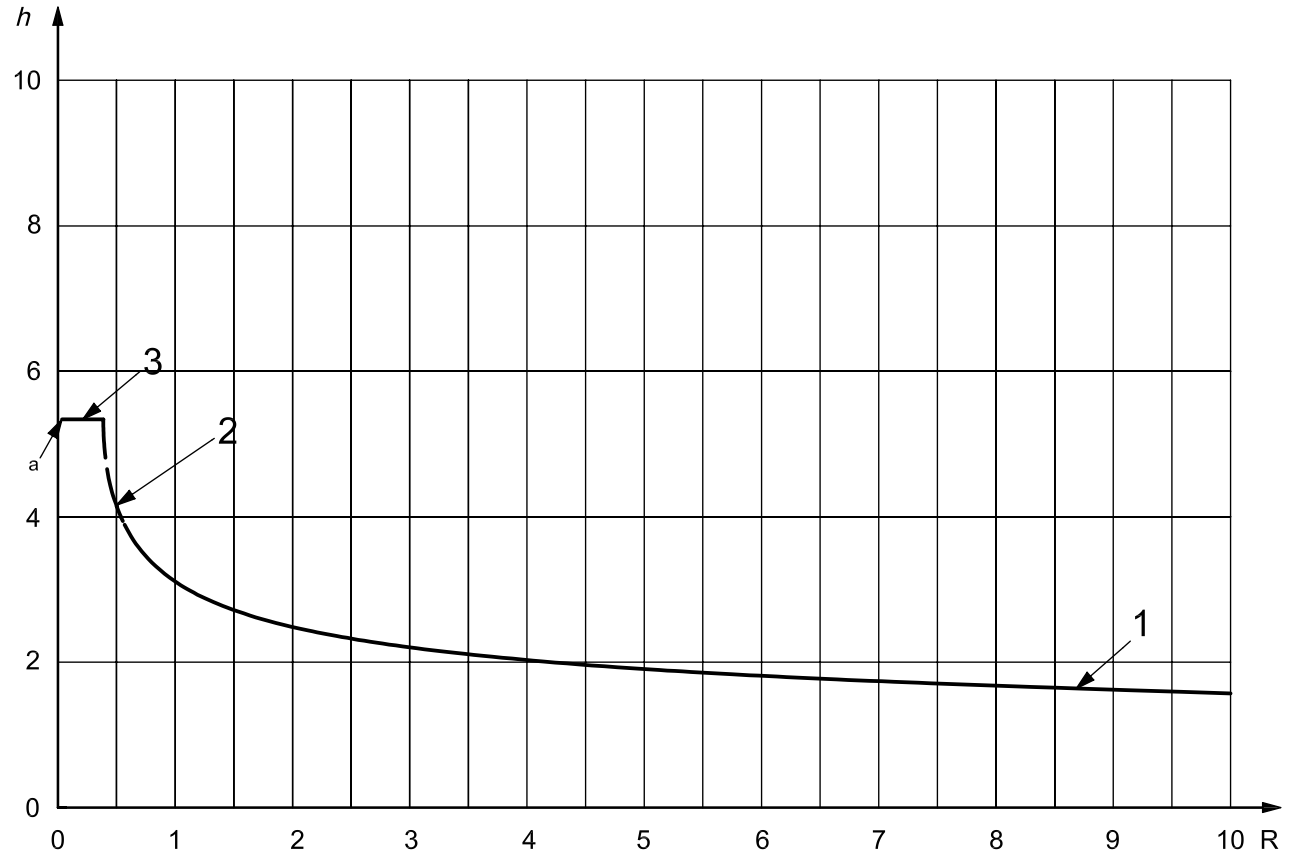

Key

h reflector ASL height, expressed in m

R RCS, expressed in m^2

1 IMO compliant radar reflector

2 not IMO compliant radar reflector due to limited size

3 size limit due to height pattern

a Raising the reflector above this height doesn't reduce the necessary RCS. A larger RCS is needed because of the height pattern.

Calculation condition

Frequency: 3,050 GHz	Transmission power: 30 kW
Height of radar antenna, h_a: 35 m	Antenna gain: 30 dBi
Height of target, h: 4 m	Target RCS, R: 0,5 m^2
Distance of target: 3,7 nm	The setting of the sensitivity of the receiver: −64 dBm

NOTE These values are based on IMO Resolution MSC. 192(79).

Figure A.2 — Mounting height of the reflector (3,050 GHz, $h_a = 35$ m, −64 dBm at 3,7 nm)

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Annex B
(informative)

Example diagrams

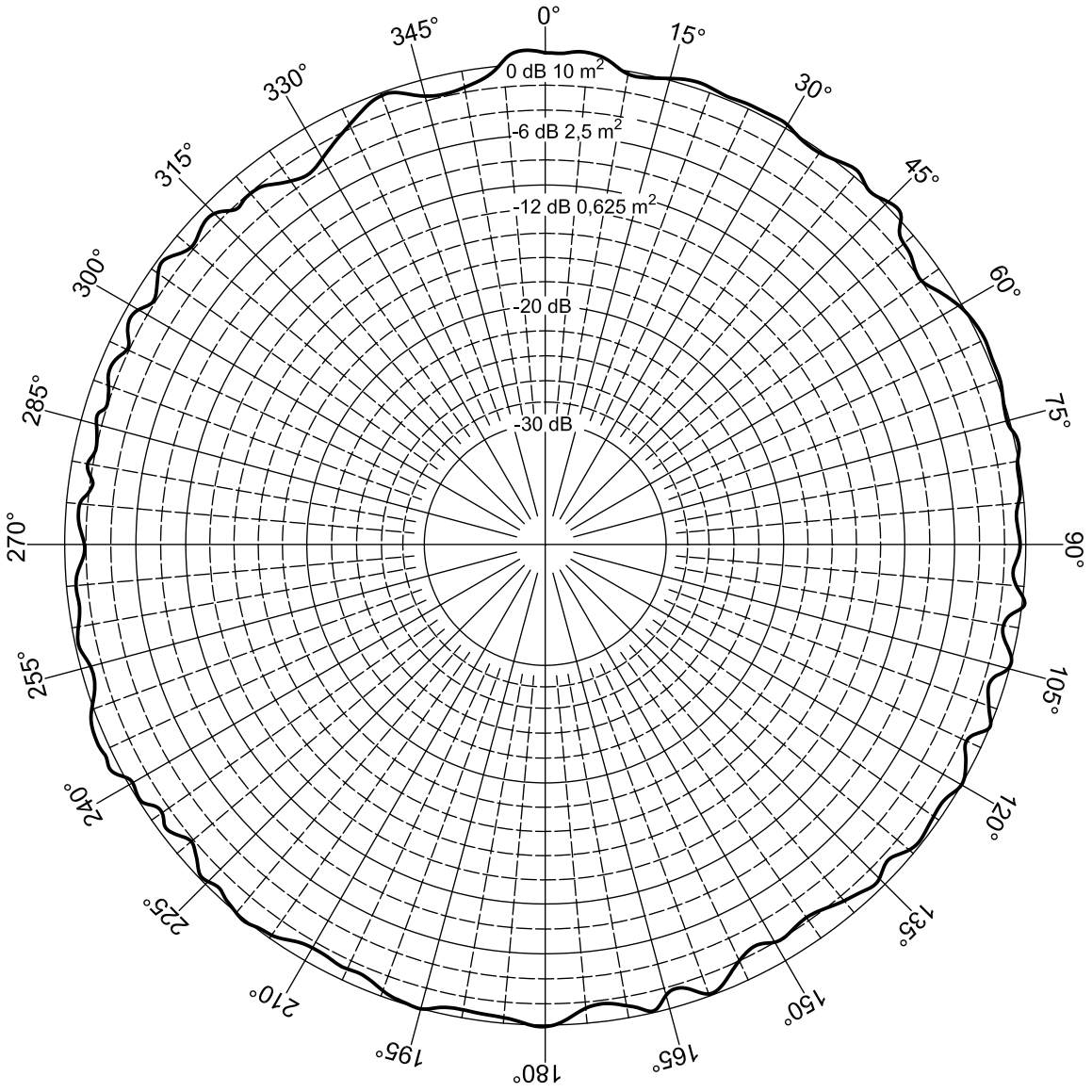

Figure B.1 — Example azimuthal polar diagram, produced by a Luneburg reflector in X-band

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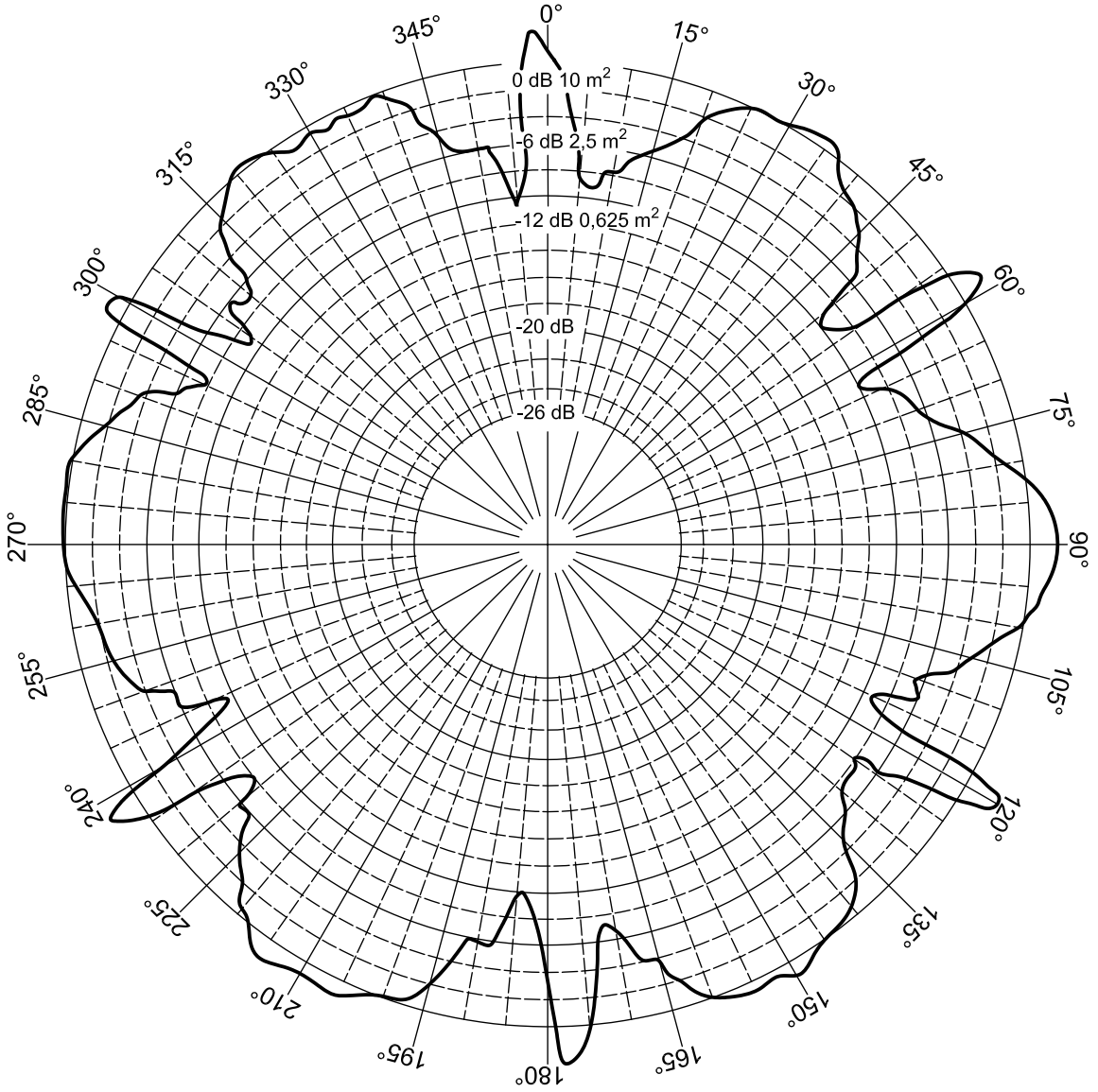

Figure B.2 — Example azimuthal polar diagram, produced by a corner reflector in X-band

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Annex C
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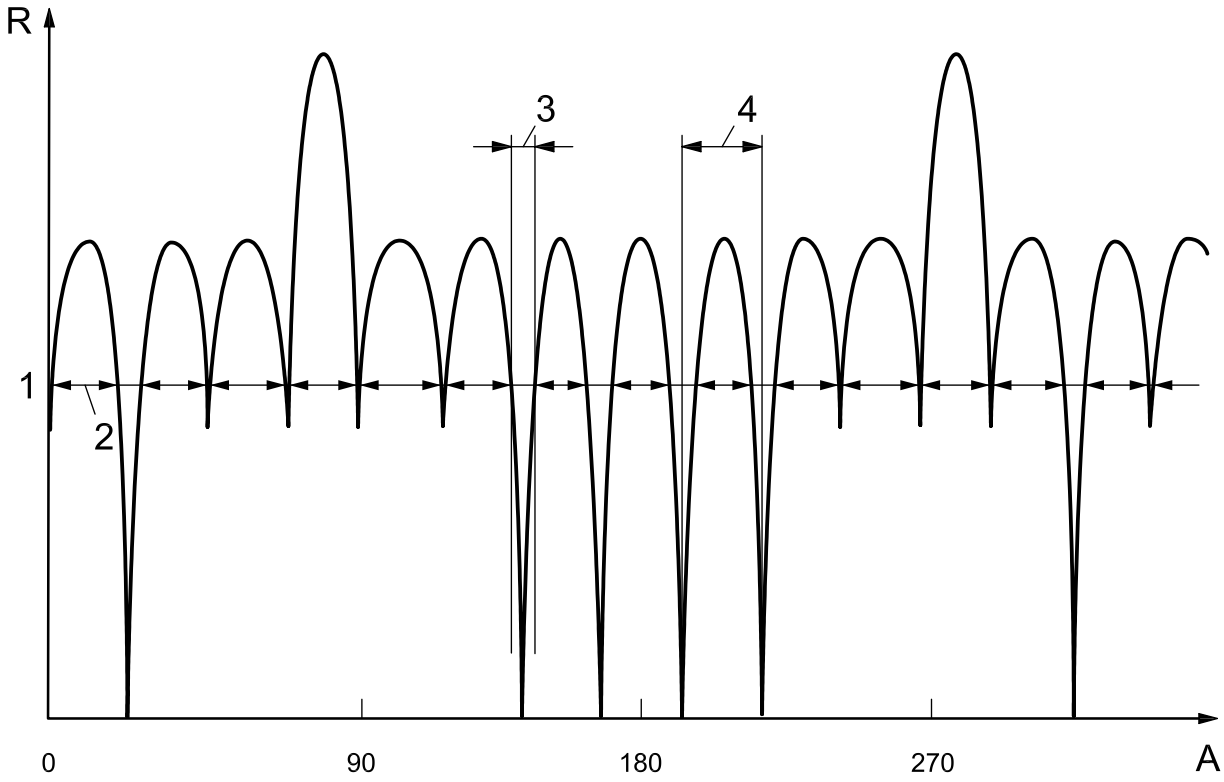
Stated performance level



Key

A azimuth, expressed in degrees

R RCS, expressed in m^2

1 SPL

2 $\Sigma \geqslant 280°$

3 null width $\leqslant 10°$

4 spacing between nulls $\geqslant 20°$

Figure C.1 — Characterization of radar reflector azimuth performance

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Annex D
(informative)

Equivalent requirements in this part of ISO 8729 and IMO Resolution MSC. 164(78)

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4.2 Enclosed size of the reflector for small-craft	
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8 Manual	
9 Marking	5.2 and 5.3

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