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Shipbuilding — Marine radar reflectors

Construction navale — Réflecteurs radars de marine

Reference number
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Foreword

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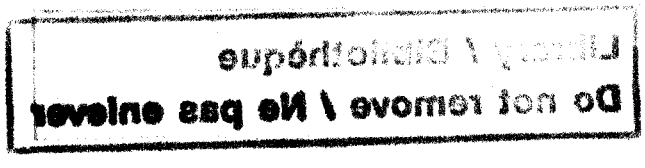
Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8729 was prepared by Technical Committee ISO/TC 8, *Shipbuilding and marine structures.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.



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Shipbuilding — Marine radar reflectors

1 Scope and field of application

This International Standard specifies the minimum requirements for a radar reflector intended to enhance returns from small vessels as required by IMO Resolution A.384(X).

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

2 References

IMO Resolution A.384(X) (adopted on 14 November 1977), *Performance standards for radar reflectors.*

IMO Resolution A.477(XII) (adopted on 19 November 1981), *Performance standards for radar equipment.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 radar reflector : Any passive device which is designed to enhance returns from small radar targets.

3.2 echoing area : 4π 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 receiver affects the effective echoing area of the reflector.

In case of free space propagation, the echoing area σ can be measured by the following equation :

$$S = \frac{P \times G^2 \times \lambda^2 \times \sigma}{(4\pi)^3 \times R^4}$$

where

S is the received power;

P is the transmitting peak power;

G is the antenna gain;

λ is the wave length;

R is the distance between radar and target.

3.3 azimuthal polar diagram : Polar diagram relating the echoing area of the reflector to the azimuthal angle about its vertical axis.

3.4 Luneberg reflector : Reflector, making use of a number of concentric spheres of varying refractive index, capable of focusing incident energy onto a reflecting surface. The energy is reradiated along the incident path. (See annex A.)

3.5 corner reflector : Reflector, consisting of three flat conducting surfaces intersecting mutually at right angles, which reflects the greater part of the incident waves parallel to their direction of incidence. (See annex B.)

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 conditions of sea states, vibration, humidity and change of temperature likely to be experienced in the marine environment as specified in 6.2 and 6.3. Use of ferrous metals should be avoided.

4.2 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

The radar reflector shall comply with the following minimum requirements for all frequencies between 9 320 MHz and 9 500 MHz.

5.1 Reflecting pattern in horizontal plane

5.1.1 The maximum echoing area of the radar reflector shall be at least 10 m^2.

5.1.2 Its azimuthal polar diagrams shall be such that its response over a total angle of 240° is not less than −6 dB with respect to the maximum echoing area. The response shall not remain below this level over any single angle of more than 10°.

NOTE — Typical azimuthal polar diagrams of two types of marine radar reflector are shown in annexes A and B.

5.1.3 These requirements shall be assessed by reference to related azimuthal polar diagrams about the reflector's vertical axis and tilted from the vertical at angles not exceeding ± 3°.

5.2 Reflecting pattern in vertical plane

The performance of the reflector, up to at least ± 15° from the horizontal shall be such that its response at any inclination remains above − 12 dB with respect to its maximum echoing area over a total angle of at least 240°.

6 Type tests and inspection

6.1 Order of tests and inspections

Mandatory tests and inspections shall normally be performed in the following order :

— visual inspection of the structure and the materials (see 6.2.1);

— performance test (see 6.2.2);

— vibration test (see 6.2.3);

— mechanical strength test (see 6.2.4).

In addition, the following optional tests may be carried out at the discretion of the testing authority :

— dry heat test (see 6.3.1);

— humidity test (see 6.3.2);

— low temperature test (see 6.3.3);

— corrosion test (see 6.3.4);

— rain test (see 6.3.5).

After each test, a visual inspection shall be carried out to verify the physical durability of the reflector.

On completion of these tests, a general performance test shall be carried out to verify conformity with the performance requirements.

6.2 Mandatory tests

6.2.1 Visual inspection

A visual inspection shall be carried out to confirm that the construction and finish of the reflector are satisfactory.

6.2.2 Performance test

The performance test shall be carried out in a chamber or on a test site where the background noise level has been reduced to the equivalent echoing area of 0,01 m^2 or less at frequencies between 9 320 MHz and 9 500 MHz. The test shall consist of measurement of polar patterns of the reflector within the volume defined in 5.1 and 5.2.

6.2.3 Vibration test

The radar reflector shall be mounted on a vibration table in a manner which is recommended by the manufacturer for operational use. The reflector shall be vibrated at all frequencies between

a) 5 Hz and 12,5 Hz with an excursion of ± 1,6 mm;

b) 12,5 Hz and 25 Hz with an excursion of ± 0,38 mm;

c) 25 Hz and 50 Hz with an excursion of ± 0,1 mm;

taking at least 15 min to cover each frequency range. As an alternative to b) and c), the table shall be vibrated at all frequencies between 12,5 Hz and 50 Hz at a constant maximum acceleration of 10 m/s^2 taking at least 30 min to cover the full frequency range.

This procedure shall be carried out in each of three mutually perpendicular directions of the radar reflector.

If vibration responses are observed on the radar reflector, the amplification of any such response shall not exceed a factor of 3.

6.2.4 Mechanical strength test

The reflector shall be mounted in the recommended way and moved under sea water at a relative velocity of 1,3 m/s in both directions in each of three mutually perpendicular planes consecutively.

The reflector, mounted in the recommended way, shall also be subjected to a jet of water delivered at a rate of 1 kW for a period of not less than 10 s on five separate occasions on each face.

6.3 Optional tests

6.3.1 Dry heat test

The reflector shall be placed in a chamber at normal room temperature. Then the temperature shall be raised to and maintained at 70 ± 3 °C for a minimum period of 10 h.

6.3.2 Humidity test

The reflector shall be placed in a chamber at normal room temperature and humidity which, over a period of 3 ± 0,5 h, shall be steadily heated to 40 ± 3 °C and shall also be brought to a relative humidity of 93 $^{+2}_{0}$ %, during this period.

These conditions shall be maintained for a minimum period of 10 h. With the reflector still in the chamber, the chamber shall then be brought to normal room temperature and humidity in not less than 1 h.

6.3.3 Low temperature test

The reflector shall be placed in a chamber at normal room temperature. Then the temperature shall be reduced to and maintained at − 25 ± 3 °C for a minimum period of 10 h.

6.3.4 Corrosion test

The reflector shall be placed in a chamber fitted with apparatus such as a spray gun capable of spraying in the form of a fine mist a salt solution to the following formula :

— sodium chloride	26,5 g
— magnesium chloride	2,4 g
— magnesium sulfate	3,3 g
— calcium chloride	1,1 g
— potassium chloride	0,73 g
— sodium bicarbonate	0,20 g
— sodium bromide	0,28 g

in distilled water to make up 1 l of solution.

The quantity of each salt shall be subjected to a tolerance of ± 10 % by mass. The spraying apparatus shall be such that the products of corrosion cannot mix with the salt solution contained in the spray reservoir.

The equipment shall be sprayed simultaneously on all its external surfaces with the salt solution for a period of 1 h.

The spraying shall be carried out 4 times during a period of 7 days, with the storage conditions between spraying being 40 ± 2 °C and 60 % to 80 % relative humidity.

6.3.5 Rain test

The reflector shall be placed in a chamber fitted with eight shower heads, the discharge ends of which shall consist of flat non-corrodible plates 0,16 cm thick, having a total of 36 holes each of 0,1 cm diameter evenly spaced on concentric circles as follows :

— 16 holes on a circle of 5,1 cm diameter,

— 8 holes on a circle of 3,8 cm diameter,

— 8 holes on a circle of 2,5 cm diameter,

— 4 holes on a circle of 1,3 cm diameter.

The shower heads shall be arranged at a distance of 50 to 80 cm from the reflector in such a manner that spray from four of the shower heads is directed downwards at an angle of 45° on each of the uppermost portions of the reflector.

Spray from the other four shower heads shall be directed horizontally at the centre of each area of the four sides of the reflector.

Fresh water at normal room temperature at a static pressure of 310 to 380 kPa shall be sprayed on to the reflector from the eight shower heads.

The reflector shall be subjected to this test for a period of 1 h, while being continuously rotated between 12 and 20 r/min about a vertical axis passing through the centre of the reflector.

7 Marking

A label shall be affixed to each reflector, on a surface that does not contribute significantly to radar reflector performance, indicating :

a) the manufacturer;

b) the mark or type number;

c) the year of manufacture;

d) the recommended mounting height of installation (see annex C);

e) the mass of the reflector;

f) the maximum echoing area of the reflector;

g) the compass safe distance, if applicable;

h) the recommended orientation of mounting.

8 Installation

8.1 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.

8.2 Positioning

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

8.3 Mounting height

The mounting height of a reflector shall be as defined in annex C.

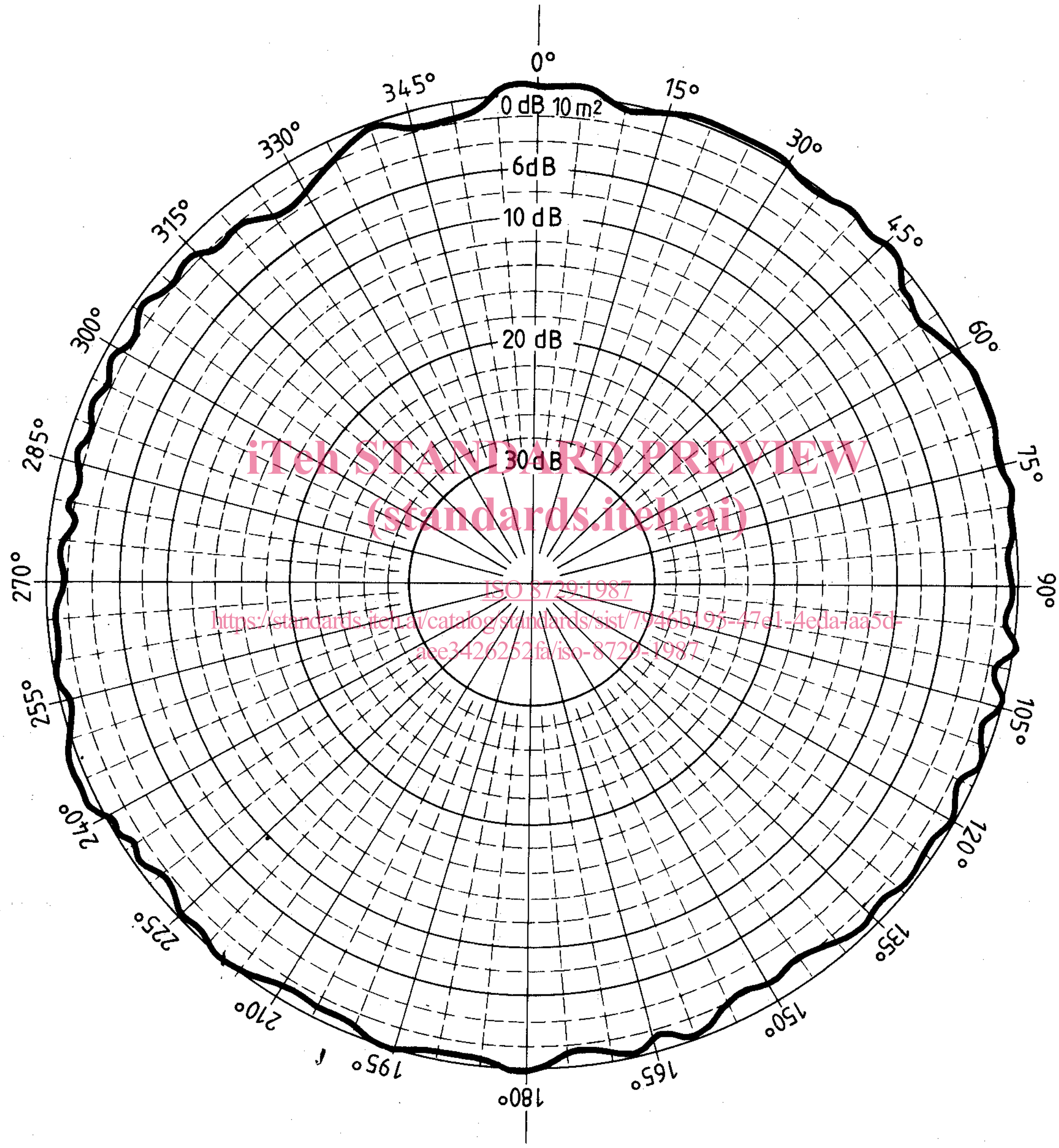
The radar reflector shall be installed as high as possible.

This height is calculated to give detection at a range of five nautical miles by shipborne radar meeting the requirements of IMO Resolution A.477(XII).

Annex A

Typical horizontal pattern of a Luneberg reflector

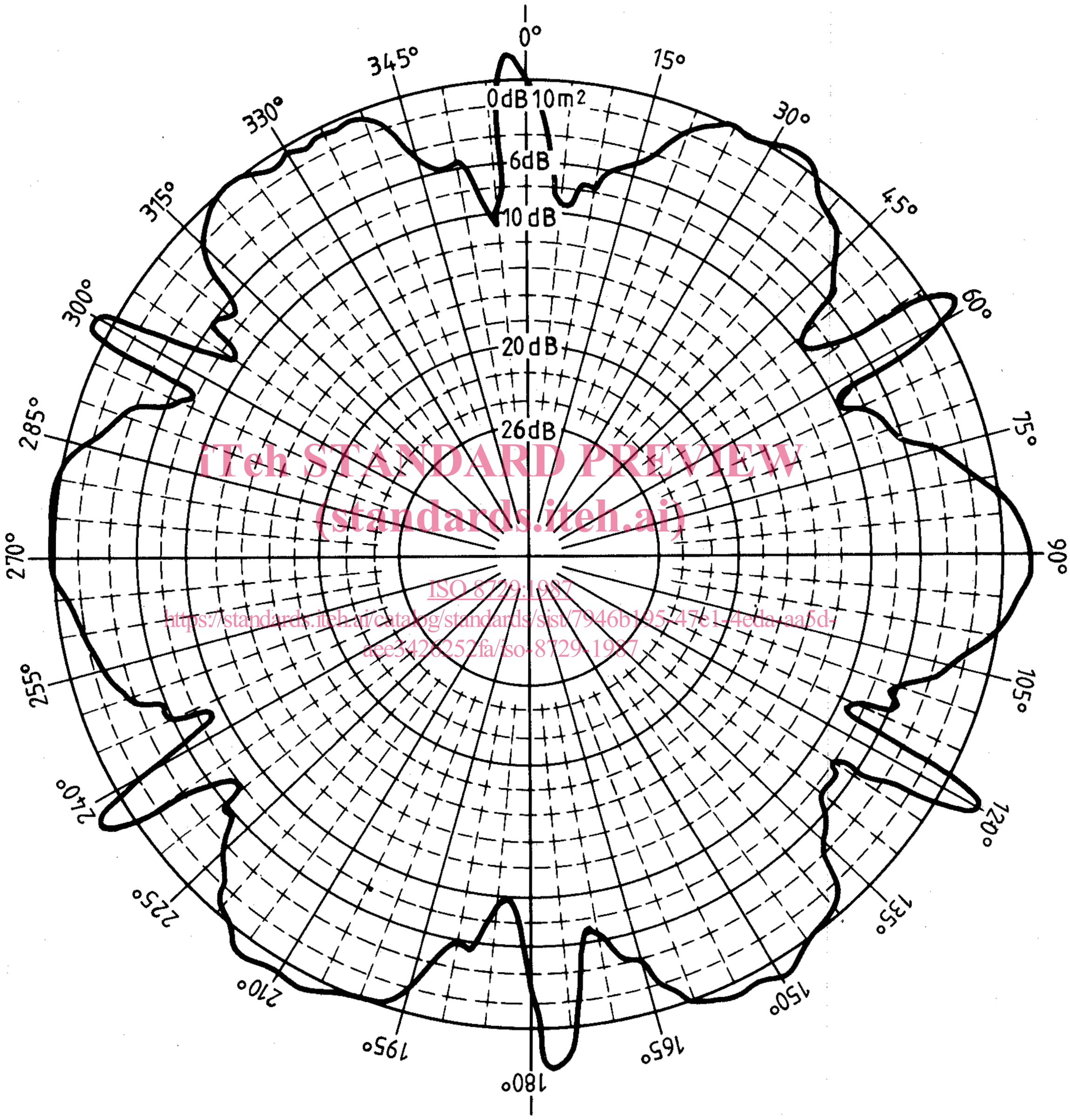
(This annex forms an integral part of the Standard.)



Annex B

Typical horizontal pattern of a corner reflector group

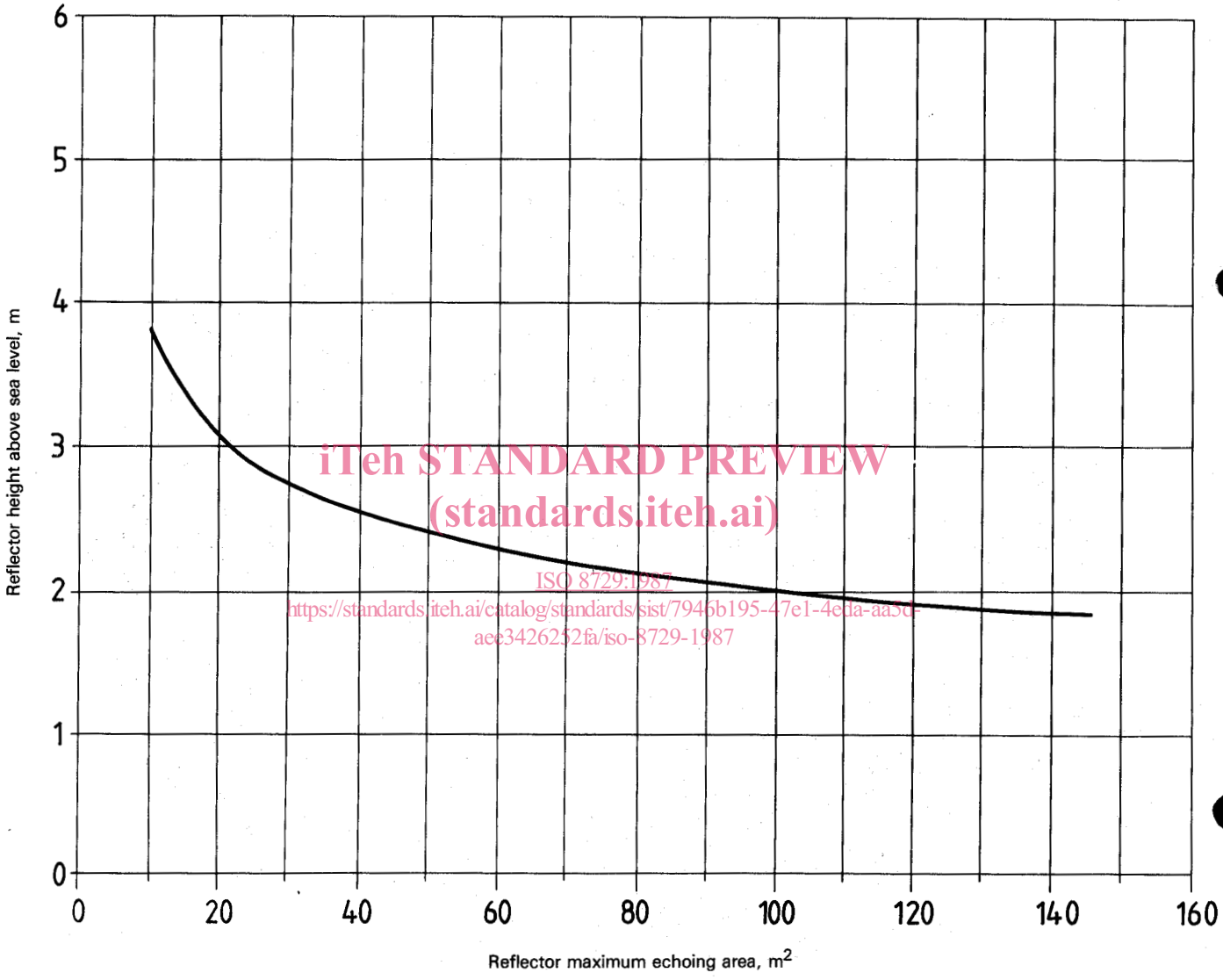
(This annex forms an integral part of the Standard.)



Annex C

Mounting height of the reflectors

(This annex forms an integral part of the Standard.)



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