INTERNATIONAL STANDARD

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First edition
1998-10

Maritime navigation and radiocommunication equipment and systems – Radar –

Part 2: Shipborne radar for high-speed craft (HSC) – Methods of testing and required test results

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For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams.*

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR –

Part 2: Shipborne radar for high-speed craft (HSC) – Methods of testing and required test results

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60936-2 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems. The IEC 60936 series, of which this is part 2, replaces IEC 60936 published in 1988, in order to reflect the new requirements of the International Maritime Organisation (IMO). This part of the series contains some of the specific requirements.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/193/FDIS	80/210/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annexes A, B, C, D and E form an integral part of this standard.

A bilingual version of this standard may be published at a later date.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR –

Part 2: Shipborne radar for high-speed craft (HSC) – Methods of testing and required test results

1 Scope

This International Standard specifies the minimum operational and performance requirements, methods of testing and required test results as required by IMO resolution A.820 and Chapter X of the high-speed craft (HSC) code. It complies with the requirements of 13.13 of the HSC code and incorporates applicable parts of 13.5 of the HSC code on radar installations. In addition it takes account of IMO resolution A.694 and is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement in this standard takes precedence.

The HSC scenarios, as defined in annex D, apply to equipment intended for use on high-speed craft and to equipment which is tested to IEC 60872-1 and IEC 60872-2 and also intended for use on high-speed craft.

All texts of this standard, whose wording is identical to that in IMO resolution A.820 are printed in *italics* and the resolution and paragraph numbers are indicated in brackets.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60936. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60936 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60872-1:1998, *Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 1: Automatic radar plotting aids (ARPA) – Methods of testing and required test results*

IEC 60872-2, —, *Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 2: Automatic tracking aids (ATA) – Methods of testing and required test results* [1)]

IEC 60872-3, —, *Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 3: Electronic plotting aids (EPA) – Methods of testing and required test results* [1)]

IEC 60936-1, —, *Maritime navigation and radiocommunication equipment and systems – Radar – Part 1: Shipborne radar – Methods of testing and required test results* [1)]

IEC 60945:1996, *Maritime navigation and radiocommunication equipment and systems – General requirements, methods of testing and required test results*

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1) To be published.

IEC 61162:—, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

IEC 61174:1998, *Maritime navigation and radiocommunication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance standards, methods of testing and required test results*

ISO 9000, *Quality management and quality assurance standards*

IMO A.694:1991, *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system and for electronic navigational aids*

IMO A.820:1995, *Performance standards for navigational radar equipment for high speed craft*

IMO A.823:1995, *Performance standards for automatic radar plotting aids (ARPAs)*

IMO MSC.64 (67):1996, *Annex 4 – Performance standards for radar equipment*

IMO MSC.36 (63):1994, *International code of safety for high-speed craft (HSC)*

IMO MSC SN/Circular 197, *Operation of marine radar for search and rescue radar transponder (SART) detection*

IMO:1992, *Convention for Safety of Life at Sea (SOLAS), as amended*

ITU:1997, *Radio regulations*

IHO S-52:1994, *Specifications for chart content and display aspects of ECDIS*

3 Performance requirements

The radio frequency of operation of the equipment and its characteristics shall at all times be within the limits defined in the ITU Radio regulations. In particular, compliance with those limits is defined in IEC 60936-1.

3.1 (A.820/1) Introduction

3.1.1 (A.820/1.1) *The radar equipment is intended for installation in craft with the following characteristics:*

.1 *A maximum speed of* up to *70 knots;*

.2 *A maximum rate of turn* up to *20°/s; and*

.3 *normally operate between latitudes 70° N and 70° S.*

3.1.2 (A.820/1.2) *In addition to the general requirements contained in resolution A.694*:1991 *the radar equipment* shall *comply with the following minimum performance requirements.*

3.2 (A.820/2) General

The radar equipment shall *provide an indication, in relation to the craft, of the position of other surface craft and obstructions and of buoys, shorelines and navigational marks in a manner which will assist in navigation and in avoiding collision.*

3.2.1 Equipment shall be installed in such a manner that it is capable of meeting its recommended performance standards.

3.2.2 The operator manual for the radar shall include precautions in the use of the radar under certain combinations of conditions with regard to not performing to specification i.e. picture smearing and target tracking loss when at high speed close to targets.

3.2.3 Quality assurance

The radar shall be designed, produced and documented by companies complying with the ISO 9000 series standards, as applicable.

3.3 (A.820/3) Range performance

The operational requirement, where the radar antenna is mounted 7,5 m above sea level, is that the equipment shall *give a clear indication of surface objects such as a navigational buoy*, with a radar reflector height of 3,5 m, *having an effective echoing area of approximately 10 m^2 at 2,5 nautical miles in the absence of clutter.*

3.4 (A.820/4) Minimum range

The surface objects specified in 3.3 shall *be clearly displayed from a minimum range of 35 m up to a range of one nautical mile, without changing the setting of controls other than the range selector.*

The minimum range is the shortest distance at which, using a mandatory range scale of not more than 1,5 nautical miles, a stationary target ahead is still presented separately from the point representing the antenna position.

3.5 (A.820/5) Display

3.5.1 (A.820/5.1) *The equipment* shall *without external magnification provide a multi-colour daylight display with an effective radar picture diameter of not less than 250 mm.*

3.5.1.1 Target echoes shall be displayed by means of the same basic colours and the echo strength shall not be displayed in different colours.

3.5.1.2 Additional information may be shown in different colours.

3.5.2 (A.820/5.2) *Day and night colours* shall *be provided. It* shall *be possible to adjust brightness.*

3.5.2.1 The radar picture and information shall be readable under all ambient light conditions. If a light shield is necessary to facilitate operation of the display in high ambient levels, then means shall be provided for its ready attachment and removal.

3.5.3 (A.820/5.3) *The equipment* shall *provide the following set of range scales of display:*

0,25; 0,5; 0,75; 1,5; 3; 6; 12; 24 nautical miles.

3.5.4 (A.820/5.4) *Additional range scales may be provided.* These additional range scales shall be either smaller than 0,25 nautical miles or greater than 24 nautical miles.

3.5.5 (A.820/5.5) *The range scale displayed and, when in use, the distance between range rings* shall *be clearly indicated*.

3.5.6 (A.820/5.6) *Off-centre facilities* shall *be provided of* up to *at least a minimum of 50 % and not more than 75 % of range scale in use.*

3.5.7 The origin of the range scale (radar video) shall start at own ship, be linear and shall not be delayed.

3.5.8 (64 (67)/Annex 4/3.3.5) *Within the effective display radar video area, the display* shall *only contain information which pertains to the use of the radar display for navigation or collision avoidance and which has to be displayed there because of its association with a target (e.g. target identifiers, vectors) or because of some other direct relationship with the radar display.*

3.5.9 The frequency band in use shall be indicated to the operator as X-BAND or S-BAND as applicable.

3.6 (A.820/6) Range measurement

3.6.1 (A.820/6.1) *Fixed electronic range rings* equally spaced from the origin shall *be provided for range measurements as follows:*

.1 on the range scales of 0,25, 0,5 and 0,75 nautical miles at least two range rings; and

.2 on all other range scales six range rings shall *be provided.*

Any number of range rings are allowed on the voluntary additional range scales. When off-centred facilities are used, additional rings shall be provided at the same range intervals as on the mandatory range scales (see 3.5.3).

3.6.2 (A.820/6.2) *A variable electronic range marker* (VRM) shall *be provided with a numeric readout of range.*

It shall be possible to position a range marker, on any range scale, at any range, within 5 s of operation. The readout shall not display other data. For ranges of less than 1 nautical mile, there shall be only one zero before the decimal point. Additional variable range markers meeting the same requirements may be provided, in which case, read-outs shall be provided.

3.6.3 (A.820/6.3) *The fixed range rings and the variable range marker* shall *enable the range of an object to be measured with an error not exceeding 1 % of the maximum range of the scale in use, or 30 m, whichever is the greater.*

The accuracy of range rings and range marker shall be maintained when the display is off-centred.

3.6.4 (A.820/6.4) *It* shall *be possible to vary the brilliance of the fixed range rings and the variable* range *marker and to remove them* independently and *completely from the display*.

3.6.5 The thickness of the fixed range rings shall not be greater than the maximum permissible thickness of the heading line.

3.7 (A.820/7) Heading indicator (heading line)

3.7.1 (A.820/7.1) *The heading of the craft* shall *be indicated by a* continuous *line on the display with a maximum error not greater than ±1°. The thickness of the display heading* shall *not be greater than 0,5° measured at maximum range at the edge of the screen*, when the display is centred. The heading line shall extend from the own ship's position to the edge of the display. A bearing scale shall be provided to give an indication of the heading in all display modes. It shall have an accuracy of ±1° when centred. The radar picture shall be within this scale.

3.7.2 (A.820/7.2) *Provision* shall *be made to switch off the heading indicator* (heading line) *by a device which cannot be left in the "heading marker off"* (heading line off) *position.*

3.7.3 A heading marker shall be displayed on the bearing scale by a mark.

3.8 (A.820/8) Bearing measurement

3.8.1 (A.820/8.1) *Provision* shall *be made to obtain quickly the bearing of any object whose echo appears on the display.* An electronic bearing line (EBL) shall be positioned and give a numeric readout within 5 s.

3.8.2 (A.820/8.2) *The means provided for obtaining bearing* shall *enable the bearing of a target whose echo appears at the edge of the display to be measured with* a radar system, excluding sensor errors, *accuracy of ±1° or better.*

3.8.3 The EBL shall be displayed on the screen in such a way that it is clearly distinguishable from the heading indicator. It shall not be thicker than the heading indicator.

3.8.4 It shall be possible to vary the brilliance of the EBL. This variation may be separate or combined with the intensity of other markers. It shall be possible to remove the EBL completely from the screen.

3.8.5 The rotation of the EBL shall be possible in both directions continuously or in steps of not more than 0,2°.

3.8.6 The numeric readout of the bearing of the EBL shall be displayed with at least 4 digits including one after the decimal point. The EBL readout shall not be used to display any other data. There shall be a positive identification of whether the bearing indicated is a relative or true bearing.

3.8.7 A bearing scale around the edge of the display shall be provided. Linear or non-linear bearing scales may be provided.

3.8.8 The bearing scale shall have division marks for at least each 5 degrees, with the 5 degree and 10 degree divisions clearly distinguishable from each other. Numbers shall clearly identify at least each 30 degree division.

3.8.9 It shall be possible to measure the bearing relative to the heading line and relative to North.

3.8.10 It shall be possible to move the position of the EBL origin away from the own ship to any desired point on the effective display area. By a fast simple operation it shall be possible to move the EBL origin back to own ship's position on the screen. On the EBL, it shall be possible to display a variable range marker.

3.8.11 Additional EBLs meeting the above requirements may be provided, in which case separate readout shall be provided. These may be centred on own ship or off-centred.

3.8.12 (A.820/8.3) *A minimum* of *two lines for parallel indexing* shall *be provided,* independent of, and clearly distinguishable from, an EBL, and they shall be clearly distinguishable from map lines. They shall be fully adjustable independently in both range and bearing with an accuracy defined in 3.6.3 and 3.8.2.

3.9 (A.820/9) Discrimination

3.9.1 (A.820/9.1) *The equipment* shall *be capable of displaying as separate indications on a range scale of* 1 nautical mile or less, that is, on the 0,75 nautical mile range scale, *in the absence of sea clutter, two 10 m^2 targets at a range of between 50 % and 100 % of the range scale in use, and on the same azimuth, separated by not more than 35 m in range.*

The discrimination shall be maintained when the display is off-centred.

3.9.2 (A.820/9.2) *The equipment* shall *be capable of displaying as separate indications two* stationary *(10 m^2) targets both situated at the same range between 50 % and 100 % of 1 mile range, on the 1,5 mile range scale and separated by not more than 2,5° for X band radars and 4° for S band radars.*

NOTE – 9 200 MHz to 9 500 MHz (X-Band) and 2 900 MHz to 3 100 MHz (S-Band).

3.9.3 Side-lobes

The picture quality shall not be adversely affected by side-lobes.

3.10 (A.820/10) Roll or pitch

The performance of the equipment shall *be such that when the ship is rolling and pitching up to ±10° the range performance requirements of* 3.3 and 3.4 *continue to be met.*

3.11 (A.820/11) Antenna scan

The scan shall *be clockwise, continuous and automatic through 360° of azimuth. The scan rate* shall *not be less than 40 revolutions per minute. The equipment* shall start and *operate satisfactorily in relative wind speeds of up to 100 knots.* Alternative methods of scanning are permitted provided that the performance is not inferior.

To suppress unwanted indirect reflected echoes in blind arcs, sector blanking of the transmission may be used. The sector of blanking shall be clearly indicated on the display.

3.12 (A.820/12) Azimuth stabilization

3.12.1 (A.820/12.1) *Means* shall *be provided to enable the display to be stabilized in azimuth by an approved directional sensor. The equipment* shall be *provided with an approved directional sensor input to enable it to be stabilized in azimuth. The accuracy of alignment with the approved directional sensor transmission* shall *be within 0,5° with a rate of turn of 20°/s.*

3.12.2 (A.820/12.2) *The equipment* shall *operate satisfactorily in the unstabilized mode when the main approved directional sensor is inoperative.*

3.12.2.1 The equipment shall operate satisfactorily in the head-up unstabilized mode when the azimuth stabilization is inoperative.

3.12.2.2 The display shall revert to head-up mode after 1 min of stabilization remaining inoperative. An alarm shall be given within 5 s of this failure.

3.12.2.3 Any functional limitation shall be explained in the documentation.

3.12.3 The change over from one display mode to the other shall be possible within 5 s and shall achieve the required bearing accuracy.

3.13 (A.820/13) Performance monitor check

Means shall *be available, while the equipment is used operationally, to determine readily a significant drop in performance relative to calibration standard established at the time of installation, and* separate means shall be provided to check *that the equipment is correctly tuned in the absence of targets*. A significant drop in performance shall be an overall reduction of 10 dB or more.

3.14 (A.820/14) Anti-clutter devices

Suitable means shall *be provided for the suppression of unwanted echoes, i.e. from sea clutter, rain and other forms of precipitation, clouds and sandstorms. It* shall *be possible to adjust manually and continuously the anti-clutter controls*. Anti-clutter controls shall be inoperative in the fully anti-clockwise position. In addition, automatic anti-clutter controls may be provided; however, they must be capable of being switched off.

Adjustment of anti-clutter controls in small discrete steps shall be regarded as continuous adjustment. Additionally, adjustment by controls which operate by other than circular movement is acceptable on condition that:

.1 if they operate by linear movement they shall be inoperative in the fully left or down position; or

.2 if they operate by a pair of push buttons it shall be operation of the left or lower button which shall render the device inoperative.

An indication of the operative conditions of the anti-clutter controls shall be provided.

3.15 (A.820/15) Operation

3.15.1 (A.820/15.1) *The equipment* shall *be capable of being switched on and operated from the place at which the navigator normally operates the high speed craft.*

3.15.2 (A.820/15.2) *Operator controls* shall *be accessible and easy to identify* (see annex B) *and use.* The controls shall be identified in English by the relevant name or abbreviation given in annex B*. Where symbols are used* additionally *they* shall *comply with the recommendation of the Organization on symbols for control on marine navigational radar equipment.*

3.15.3 (A.820/15.3) *After switching from cold, the system* shall *be operational within 4 min.*

3.15.4 (A.820/15.4) *A standby condition* shall *be provided from which the equipment can be brought to an operational condition within 15 s.*

3.16 (A.820/16) Interference from external magnetic fields

After installation and adjustment on board, the bearing accuracy as prescribed in these performance standards shall *be maintained without further adjustment irrespective of the movement of the craft in the earth's magnetic field*. The effect of external magnetic fields shall be sufficiently restricted to ensure that performance is not affected. Effective means shall be provided for the operator to degauss, or equivalent technique, to reduce the observable effect of external magnetic fields.

3.17 (A.820/17) Display modes

3.17.1 (A.820/17.1) *The equipment* shall *be capable of operating both in relative and true motion.*

In true motion mode, when own ship reaches the offset limits, the display shall automatically reset to the offset limit on the reciprocal heading. Manual resetting shall be provided. In order to standardize the motion modes of operation the names TM, RM(T) and RM(R) are to be used (see B.4.9).

3.17.2 (A.820/17.2) *The radar origin* shall *be capable of being offset to at least 50 % and not more than 75 % of the radius of the display.*

3.17.3 (A.820/17.3) *Where sea or ground stabilization is provided, the accuracy and discrimination of the display* shall *be at least equivalent to that required by these performance standards.*

3.17.4 Speed and distance measuring equipment (SDME) providing the craft's speed through the water to the radar shall be capable of providing the speed in the fore and aft direction (in the ahead direction).

3.17.5 The ground-stabilized input shall be two-dimensional. It may be provided from the SDME where a two-dimensional SDME is fitted, from an electronic position-fixing system, or from radar tracked stationary targets. The speed accuracy shall be in accordance with the requirements of resolution A.824.

3.17.6 The type of input (3.17.5) and stabilization (3.17.3) in use shall be displayed.

3.17.7 It shall also be possible to input the craft's speed manually from 0 (zero) to 70 knots in steps of not more than 0,5 knots.

3.18 (A.820/18) Antenna system

3.18.1 (A.820/18.1) *The design of the antenna system* shall *enable it to be installed in such a manner that the operational efficiency of the radar system as a whole is not substantially impaired.*

3.18.2 (A.820/18.2) *The antenna system* shall *be so designed to withstand the forces expected to be experienced by such craft.*

3.19 (A.820/19) Operation with radar beacons and SARTs

3.19.1 (A.820/19.1) *All radars operating in the 3 cm band* shall *be capable of operating in a horizontally polarized mode.*

The radar shall be able to detect and display signals from radar beacons and 9 GHz (X-BAND) radars and shall also be able to detect and display signals from SART's.

3.19.2 (A.820.19.2) *It* shall *be possible to switch off those signal processing facilities which might prevent a radar beacon* or SART *from being shown on the radar display*.

3.19.3 The documentation provided by the manufacturer shall include instructions, based on IMO SN/Circular 197, that describe the optimum setting of the radar controls to observe a SART.

3.20 (A.820/20) Multiple radar installations

3.20.1 *Where it is required that two radar installations be carried, they* shall *be so installed that each radar can be operated individually and both can be operated independently*. There shall be an indication of the radar and frequency band selected.

3.20.2 When an emergency source of electrical power is provided in accordance with the appropriate requirements of Chapter II-1 of the IMO SOLAS Convention, both radars should be capable of being operated from this source.

3.20.3 Where two radars are fitted, inter-switching facilities may be provided to improve the flexibility and availability of the overall radar installation. They shall be so installed that failure of either radar would not cause the supply of electrical energy to the other radar to be interrupted or adversely affected.

3.21 (A.820/21) Interface

3.21.1 (A.820/21.1) *The radar system* shall *be capable of receiving information from equipment such as gyro-compass, speed and distance measurement equipment (SDME) and electronic position-fixing systems (EPFS) in accordance with international standards* (see IEC 61162).

The source of received information shall be capable of being displayed.

3.21.2 (A.820/21.2) *The radar* shall *provide an indication when any input from an external sensor is absent. The radar* shall *also repeat any alarms on status messages concerning the quality of the input data from its external sensors.*

3.21.3 If the radar system is capable of transmitting information to other equipment, it shall be in accordance with IEC 61162. As far as possible, such an output interface shall not degrade the radar performance by normal or abnormal behaviour of the interface nor of the signals on it.

3.21.4 If no suitable IEC 61162 interface is available, another appropriate interface may be used.

3.22 (A.820/22) Navigational information

The radar display shall *be capable of presenting in graphical form, positions and navigational track lines, e.g. way-points and tracks between way-points, in addition to the radar information*. Optionally, radar maps can be provided (see annex E). It shall be possible to adjust these points, lines and maps relative to a geographical reference. *The source of the graphical information* shall *be clearly indicated*. Electronic chart display and information system (ECDIS) system electronic navigational chart (SENC) information, if used, shall comply with IEC 60936-3 as appropriate.

3.23 (A.820/23) Target trails

Target trails shall be *displayed by the radar echoes of targets in the form of synthetic afterglow*. In relative motion *the trails may be either relative or true*. In true motion the trails shall be true. *The true trails may be sea or ground stabilized*. The trails shall be distinguishable from the targets and shall be capable of being switched off. The length of the trails may be user adjustable and be capable of being reset.

3.24 Plotting

3.24.1 (HSC Code/13.5.3) *At least one radar* shall *be equipped with facilities for plotting which are at least as effective as a reflector* (reflection) *plotter*.

At least as effective as a reflection plotter, means, as a minimum, the fitting of an automatic tracking aid (ATA) as defined in IEC 60872-2.

3.24.2 An ATA or ARPA, as applicable, shall be capable of meeting the performance requirements of the HSC scenario detailed in annex D.

3.24.3 Automatically applied “target identities” shall not be reused until, as a minimum, the number assigned equals the maximum number of tracked targets.

3.25 Safety precautions

3.25.1 Radiation from the antenna shall be possible only when the beam is scanning, except that override facilities may be provided for maintenance purposes. The maximum distances from the antenna at which radio frequency radiation levels of 100 W/m^2 and 10 W/m^2 can be expected shall be included in the equipment handbook.

3.25.2 Means shall be provided to prevent scanner rotation for maintenance and other purposes.

3.26 Failure warnings and status indicators

3.26.1 If there is any detectable reason why the information presented to the operator is invalid, adequate and clear warning shall be given to the operator. As a minimum, clear warnings shall be given to the operator of input failure of:

.1 azimuth;

.2 heading line;

.3 trigger;

.4 compass;

.5 SDME;

.6 electronic position-fixing system (EPFS) or invalid;

.7 radar video.

3.26.2 A fault which prevents the update of a radar picture shall clear the radar display area, and an appropriate alarm shall be given.

3.26.3 Picture freeze, screen data not refreshed, shall not occur when any of the inputs in 3.26.1 occur or when any other additional input to the radar system fails.

3.26.4 Alarms shall be displayed in the order of occurrence, the acknowledgement shall only acknowledge a single alarm.

3.26.5 Functions and data that depend on a failed sensor or signal shall be indicated or inhibited.

3.27 Standard names, abbreviations and symbols

The standard names, abbreviations and symbols for marine radars defined in annex B, where appropriate, shall be used.

3.28 Electronic plotting video symbols

Electronic plotting video symbols defined in annex C shall be used.

3.29 Ergonomics

3.29.1 (64 (67)/Annex 4/8.1) For the purposes of this standard *the following functions*, shall *be directly accessible and immediately effected* by dedicated controls or primary access in an associated menu. Alternative solutions which meet the functional requirements may be provided.

- *on/off switch*;
- standby;
- *monitor brilliance*;
- contrast [1)];
- *tuning (if manual)*;
- *range selection*;
- *anti-clutter rain*;
- *electronic bearing line*;
- *gain*;
- *presentation mode*;
- *anti-clutter sea*;
- *variable range marker*;
- *marker (cursor)*;
- acknowledge alarm [1)];
- vector true/relative [1)];
- pulse length [1)];
- *dimmer for panel illumination* (where applicable).

Inappropriate pulse lengths shall be either inhibited or clearly indicated.

3.29.2 (64 (67)/Annex 4/8.2) *The following functions*, shall *be continuously variable or in small, quasi-analogue steps:*

- *monitor brilliance*;
- *tuning (if manual)*;
- *anti-clutter rain*;
- *electronic bearing line*;
- *anti-clutter sea;*
- *variable range marker;*
- *marker (cursor);*
- *gain*.

3.29.3 (64 (67)/Annex 4/8.3) *The settings of the following functions,* shall *be readable in all light conditions:*

- *dimmer for panel illumination*;
- *gain*;
- *anti-clutter sea*;
- *monitor brilliance*;
- *tuning (if manual)*;
- *anti-clutter rain*.

The control of the dimmer and monitor brilliance may be located and adjusted by tactile means.

_____

1) Where provided.

3.29.4 (64 (67)/Annex 4/8.4) *For the following functions additional automatic adjustments may be provided. The use of the automatic mode* shall *be indicated to the operator and be capable of being switched off:*

– *monitor brilliance*; – *gain*;

– *anti-clutter rain*; – *anti-clutter sea*.

3.29.5 (64 (67)/Annex 4/8.5) *If discrete controls are available for the EBL and VRM they* shall *be situated on the left and right hand side respectively*.

3.29.6 A clear and logical arrangement of data fields shall be provided.

4 Methods of testing and required test results

This clause defines the type test methods and results required to ensure that equipment complies with the requirements of clause 3.

4.1 General conditions of measurement

All the general requirements of IEC 60945 shall be carried out before the tests to verify whether the equipment under test (EUT) meets these technical requirements. The equipment shall comply with those requirements of IEC 60945 appropriate to its category, i.e. protected (from the weather) or exposed (to the weather).

The manufacturer shall declare which equipment or units are protected or exposed. The manufacturer shall declare the preconditioning required before environmental checks.

For the purpose of this standard the following definitions apply:

Performance check: re-configuration of the EUT and checking by non-quantitative visual checks that the system is still operative.

Performance test: for radar EUT, is identical to the performance check for the purposes of IEC 60945.

By inspection – a visual check of the equipment or documentation.

Clear indication or visibility of test targets – being visible for 50 % of the antenna scans.

4.1.1 Test site

Tests will normally be carried out at test sites selected by the type test authority. The manufacturer shall, unless otherwise agreed, set up the equipment and ensure that it is operating normally before type testing commences.

4.1.2 Height of radar antenna

During all appropriate tests, the radar antenna shall be mounted at a height of about 7,5 m above the surface of the water.

4.1.3 Test targets

Unless otherwise specified the effective echoing area of test targets and the target distances and heights used to determine conformity with this standard shall be referred to a point source target presenting an effective echoing area of 10 m^2 at the relevant frequency at a height of 3,5 m and at a distance of 2,5 nautical miles by the method described in annex A.

4.1.4 Sea state

Range performance measurements shall be conducted using a test target in a calm sea (sea state 0 or 1).

4.1.5 Radio frequency

Where tests relating to the radio frequency are specified, these shall be carried out only at the nominal operating radio frequency of the equipment unless specified otherwise.

4.2 Power supply, cabling distances and technical information

The supply voltage applied to the equipment during the tests shall be the nominal voltage and a.c. supplies be at nominal frequency unless specified otherwise.

4.2.1 Sub-system separation

4.2.1.1 When an equipment with separate transmitter and antenna is tested in accordance with this standard, the transmitter/receiver shall be connected to the antenna by 20 m of feeder.

The display shall be connected to other units by at least 30 m of cable. Where an equipment, in which the transmitter and receiver are always installed within the antenna/pedestal combination, is type tested, the 20 m of antenna feeder shall be omitted. Where necessary the manufacturer shall supply the appropriate cable and antenna feeder.

4.2.1.2 The manufacturer or his representative may propose for consideration by the testing authority the maximum and minimum distances by which units of the equipment shall be separated in order to comply with the requirements of this standard.

4.2.2.1 Technical information

Adequate information shall be provided to enable the equipment to be properly set up, maintained and operated during the type testing.

4.2.2.2 (3.2) The installation section of the manufacturer's manual shall be examined to ensure that it contains adequate information to comply with this standard.

4.2.2.3 (3.2.2) By examination of the operator's manual.

4.2.3 (3.2.3) By examination of the certification issued to the manufacturer.

4.3 (3.3) Range performance

4.3.1 Method of measurement

A test target as specified in 4.1.3 and at a minimum distance of 2,5 nautical miles shall be used.

A known amount of attenuation may be used to attenuate the test target echo until it is visible on the display on 50 % of the antenna scans.

As far as is practicable coastlines and ships shall be observed during the tests.

4.3.2 Results required

The equipment shall give a clear indication of the test target.

Where attenuation is used, the amount applied to achieve display of the test target echo on 50 % of the antenna scans shall be recorded.

Where objects described in 3.3 are included in the test, they shall be clearly indicated on the radar display.

4.4 (3.4) Minimum range

4.4.1 Method of measurement

The radar shall be adjusted within its specification in such a way that a test target at approximately 1 nautical mile is clearly visible. A second test target shall be moved to approach the radar antenna. The range at which the second test target ceases to be presented separately from the antenna position on the display shall be recorded.

Only the range selector and the sea control may be adjusted and, after adjustment, the targets shall be visible at the minimum range and at 1 nautical mile with the same setting of the sea control.

4.4.2 Results required

The minimum range shall be not greater than 35 m, measured horizontally.

4.5 (3.5) Display

4.5.1 Size

4.5.1.1 Method of measurement

The effective diameter of the display area shall be determined by linear measurement with a rigid ruler, and range scales and number of range rings provided on each scale shall be examined by visual inspection, while the equipment is operating.

4.5.1.2 Results required

The effective display diameter, range scale and range ring parameters shall conform with the requirements of 3.5.

4.5.2 Other requirements

4.5.2.1 Method of measurement

The requirements shall be checked by inspection during operation of the equipment.

4.5.2.2 Results required

The equipment shall comply with the requirements of 3.5.

4.6 (3.6) Range measurement

4.6.1 Method of measurement

The accuracy of the range rings and variable range marker shall be measured using test targets or other means as appropriate.

4.6.2 Results required

A range measurement shall be capable of being taken within 5 s of switching on a VRM and shall comply with the requirements of 3.6. A range measurement shall be capable of being taken within 5 s of switching on the VRM and shall be within ± 0,1 nautical miles or ± 2 % of range scale in use, whichever is the greater.

4.7 (3.7) Heading indicator (heading line)

4.7.1 Method of measurement

The requirements for the heading indication shall be checked by inspection. The thickness of the heading line shall be measured at the edge of the display.

4.7.2 Results required

The heading indication shall comply with the requirements of 3.7.

4.8 (3.8) Bearing measurement

4.8.1 Method of measurement

The overall accuracy of bearings taken on the radar equipment shall be measured by comparing the actual bearings of identifiable point targets with bearings obtained using the radar equipment.

The comparison shall be made at sample bearings distributed over 360°.

The distance of each target from the radar antenna shall be between 80 % and 100 % of the range scale in use.

The measurement may be made by either:

a) using a single point target positioned at known bearings relative to the radar antenna pedestal, or
b) taking the radar bearing of point targets at known bearings around the radar antenna pedestal, or
c) using 2 point targets of angular separation of approximately 45° with respect to the radar antenna. The apparent variation in angular separation of the two targets due to rotation of the radar antenna pedestal shall be measured.

All means provided by the radar equipment for taking bearings shall be checked.

Conformity with other requirements of 3.8 shall be checked as appropriate by visual inspection.

4.8.2 Results required

A bearing shall be taken within 5 s of switching on an EBL and the maximum bearing error shall not exceed ±1°.

4.8.3 (3.8.12) Parallel index lines

4.8.3.1 Method of measurement

The presence and operation of parallel index lines shall be checked by inspection.

4.8.3.2 Results required

The parallel index lines shall comply with the requirements of 3.8.12.

4.9 (3.9) Discrimination

4.9.1 (3.9.1) Range discrimination

4.9.1.1 Method of measurement

The radar shall be set to a range scale of 0,75 nautical miles. Two test targets of equal radar cross-section shall be placed on the same bearing with respect to the radar antenna, at a distance of between 50 % and 100 % of the range scale in use, and separated from each other by a distance of not more than 35 m. The rain control and the effective pulse length of the radar shall be set to their minimum values. The sea and gain controls shall be adjusted to show each of the two targets on the display for at least eight out of 10 antenna scans.

4.9.1.2 (3.5.6) Repeat the test with the display off-centred.

4.9.1.3 Results required

The test targets shall be displayed separately on the radar display.

4.9.2 (3.9.2) Bearing discrimination

4.9.2.1 Method of measurement

The radar shall be set to the range scale of 1,5 nautical miles. Two test targets of equal radar cross-section shall be placed at the same distance from, and separated in bearing with respect to, the radar antenna. The measurement shall be made at display inter-cardinal points ± 5°, i.e. 40° to 50°, 130° to 140°, etc. The distance shall be between 0,5 nautical mile and 1 nautical mile range.

The anti-clutter rain control shall be set to its minimum value. The anti-clutter sea and gain controls shall be adjusted to show each of the two targets on the display for at least eight out of 10 antenna scans.

The angular separation between the two targets shall be decreased until they cease to be displayed separately.

4.9.2.2 Results required

The angular separation at which the targets cease to be displayed separately shall not exceed 2,5° for the 3 cm wavelength band and 4° for the 10 cm wavelength band.

4.9.3 (3.9.3) Antenna side-lobes

4.9.3.1 Definitions

1. Antenna horizontal radiation pattern. The antenna horizontal radiation pattern is a graph to show the relative response of the antenna plotted against angular displacement in the horizontal plane.
2. Side-lobe. Any positive excursion from the monotonically decreasing main beam pattern of more than 2 dB.

4.9.3.2 Method of measurement

The horizontal radiation pattern of the radar antenna shall be measured either in the far field region or in a region that can be referenced to it. This shall be carried out at the nominal operating radio frequency of the equipment and also at the upper and lower limits of the radio frequency tolerance declared by the manufacturer.

4.9.3.3 Results required

The far field horizontal radiation pattern shall conform to the following table 1, the figures relating to one-way propagation only.

Table 1 – Effective side-lobes

Position relative to maximum of main beam degrees	**Maximum power relative to maximum of main beam** dB
within ±10	–23
outside ±10	–30

4.9.4 Compliance for alternative methods of meeting the above requirements may be demonstrated by measurements of antenna radiation pattern and submission of processing methods for achieving the required results.

4.10 (3.10) Roll and pitch

This shall be determined by measurement of the antenna vertical radiation pattern together with the results of range performance tests of 4.3.

Alternatively, compliance with the requirements of 3.10 may be demonstrated by tilting the antenna first in the fore/aft axis and then in the port/starboard axis and verifying the test target in 4.1.3 is still detected.

4.10.1 Definition

The antenna vertical radiation pattern is a graph to show the relative response of the antenna plotted against angular displacement in the vertical plane.

4.10.2 Method of measurement

The vertical radiation pattern (one way) of the radar antenna shall be measured either in the far field region or in a region which can be referenced to it. This shall be carried out at the nominal operating radio frequency of the equipment and also at the upper and lower limits of the radio frequency tolerance declared by the manufacturer.

4.10.3 Results required

Where excess performance of the equipment with respect to the requirements of 3.3 has been determined by the application of attenuation or any other method (e.g. by increasing the range of the test target) in the tests of 4.3.1, the antenna vertical radiation pattern shall be such that any reduction between the response at horizontal and the response in any other direction within ±10° of the horizontal, shall be not more than the measured excess performance.

Where attenuation is applied in only the receive path or the transmit path in the test of 4.3.1, the attenuation figure recorded in 4.3.2 shall be halved. Alternatively, if the test target used in the tests of 4.3.1 gives a clear indication at a distance of not less than 2,8 nautical miles, (see annex A) the far field radiation pattern shall be not more than 3 dB down, in any direction within ±10° of the horizontal.

4.11 (3.11) Antenna scan

4.11.1 Method of measurement

The antenna/pedestal combination shall be placed in a wind tunnel capable of producing an air stream of up to 100 knots. The antenna motor shall be provided with a power source at its nominal voltage and frequency.

Where appropriate, only the antenna/pedestal combination shall be used in this test. The rate of scan of the antenna shall be measured for all rotation speeds declared by the manufacturer.

4.11.2 Results required

4.11.2.1 The antenna shall start and run satisfactorily in relative speeds of up to 100 knots.

4.11.2.2 The antenna scan shall be continuous and clockwise when viewed from above and automatic through 360° in azimuth, and shall be not less than 40 rpm for all radar range scales.

4.11.2.3 If a sector blanking facility is provided, blank sector or sectors shall be checked to confirm that they are clearly indicated on the display.

4.12 (3.12) Azimuth stabilization

4.12.1 Method of measurement

4.12.1.1 The output from a compass, or compass simulator, shall be applied to the radar. The heading shall be applied in a clockwise direction and shall increase from 0°/s to 20°/s in approximately 3 s.

The rotation rate of 20°/s shall be applied for at least 60 s and shall be stopped after an appearance of the heading line. At the next appearance of the heading line the error in alignment in degrees shall be recorded.

The measurement shall be repeated by applying the heading change in an anti-clockwise direction.

4.12.1.2 The requirements of 3.12.2 and 3.12.3 shall be checked.

4.12.2 Results required

4.12.2.1 The alignment error shall not exceed 0,5°.

4.12.2.2 Changeover from one presentation mode to another (e.g. north-up to head-up) shall be possible with an accuracy of 0,5° within 5 s. The equipment shall continue to operate satisfactorily in the unstabilized mode when the compass input is inoperative. The documentation shall be checked for the inclusion of functional limitations.

4.13 (3.13) Performance monitor check

4.13.1 Method of measurement

The overall radar performance shall be reduced by 10 dB using a method appropriate to the equipment under test. The overall performance is defined as the ratio between effective radiated power and the minimum detectable signal in decibels.

4.13.2 Results required

It shall be possible to identify an overall reduction in performance of 10 dB and more.

4.13.3 Confirm by inspection that there is a means to check that the equipment is correctly tuned in the absence of targets.

4.14 (3.14) Anti-clutter devices

4.14.1 Method of measurement

The requirements for anti-clutter devices shall be checked by inspection during operation of the equipment. If an automatic anti-clutter option is provided, the equipment shall be tested in both manual and automatic modes.

4.14.2 Results required

The equipment shall comply with the requirements of 3.14. The documentation shall be checked to show that adequate explanation of the controls is included for description of the operative conditions of the anti-clutter controls.

4.15 (3.15) Operation

4.15.1 Method of measurement

The requirements of 3.15 shall be checked by inspection, and use shall be made of each external control function during testing of the equipment.

4.15.2 Results required

The equipment shall comply with the stated requirements.

4.16 (3.16) Interference from external magnetic fields

4.16.1 Method of measurement

The requirements of 3.16 shall be checked, as far as practicable, by visual inspection and during operation of the equipment.

4.16.2 Results required

The equipment shall comply with the requirements of 3.16 and the bearing accuracy of the equipment, as prescribed in the requirements of 3.8.1, shall be maintained without further adjustment irrespective of the movement of the equipment in the earth's magnetic field.

4.17 (3.17) Display modes

4.17.1 (3.17.1) By inspection.

4.17.2 (3.17.2) By inspection.

4.17.3 (3.17.3) **Method of measurement**

The motion of the trace origin at 45 knots shall be measured in true motion over a 10 min period with the display on the 12 nautical mile range scale.

4.17.3.1 Results required

The error in speed shall not exceed 5 %. The error in the motion of the trace origin, when compared with the compass input or the setting of a manual course control, shall not exceed 3°.

4.17.4 Confirm by inspection that the requirements of 3.17.4 to 3.17.7 are met.

4.18 (3.18) Antenna system

4.18.1 (3.18.1) The installation section of the manufacturer's manual shall be examined to ensure that it contains adequate information to comply with 3.18.

4.18.2 (3.18.2) **Ruggedness**

Two methods of measurement are acceptable, either by vibration or shock. The manufacturer shall state which method shall be used.

4.18.2.1 Vibration

The antenna shall be subjected to a sinusoidal vibration in the vertical plane at 5 Hz with an excursion of ±25 mm ±10 % (equivalent to 2,5 *g*) for a duration of 2 h.

4.18.2.2 Results required

A successful performance check shall be carried out at the end of the test period.

4.18.2.3 Shock

The test provides a method by which responses of components and equipment comparable with those likely to be experienced in practice in the operational environment can be produced in the test laboratory. The antenna is to be designed to withstand the test without external indications of damage or subsequent degradation in performance. A performance check is to be carried out before and after the test.

4.18.2.4 Method of measurement

The antenna shall be so mounted that the shock can be applied to the antenna mounting base to simulate an upward vertical impulsive force. The antenna shall be mechanically connected to the shock machine by its normal means of attachment. The procedure shall be carried out in normal laboratory environmental conditions. The severity of the test is specified by the peak acceleration, pulse shape and duration given in table 2.

Table 2 – Test severity – half-sine pulse

Peak acceleration m/s^2	**Duration of pulse** ms
100	25

The shock pulse shall be measured by an accelerometer placed at the antenna fixing point nearest to the centre of the table surface.

a) Carry out a performance check.

b) Switch off the power supply and apply three successive upward shocks of the required test severity and pulse shape.

c) Check for external indications of damage.

d) Carry out a second performance check.

4.18.2.5 Results required

There shall be no external indications of damage and there shall be no detectable degradation in performance.

4.19 (3.19) Operation with radar beacons and SARTs

The requirements of 3.19.1, where appropriate, and 3.19.2 and 3.19.3 shall be checked during operation of the equipment and the documentation checked by inspection for the inclusion of relevant instructions.

4.20 (3.20) Multiple radar installations

Where inter-switching facilities are provided they shall comply with the requirements of 3.20.

4.21 (3.21) Interface

4.21.1 Method of measurement

Simulate input signals on a suitable IEC 61162 interface.

4.21.2 Results required

Confirm that:

a) the readout (displayed data) matches the simulated values;

b) the status data is repeated;

c) when input signals are absent, there is an indication;

d) the source of received information is displayed.

4.21.3 (3.21.3) **Method of measurement**

Connect a receiver (listener) conforming to IEC 61162 to the EUT. Enable output transmissions from the radar.

4.21.4 Results required

A performance check shall be successful.

4.21.5 (3.21.4) If interface specifications other than those of IEC 61162 are offered, the manufacturer shall provide all the necessary information and equipment to allow such interfaces to be tested to the appropriate criteria.

4.22 (3.22) Navigational information

4.22.1 Method of measurement

Enter a minimum of three way-points visible on the current range scale.

4.22.2 Results required

Confirm that the way-points appear in the correct positions. Check that the source of graphical information is indicated.

Check, for compliance, the means of positioning of radar maps and conformity to annex E.

If ECDIS SENC information is used, show that the facility complies with the requirements of IEC 60936-3.

4.23 (3.23) Target trails

Check the functionality, for compliance, by inspection.

4.24 (3.24) Plotting

4.24.1 (3.24.1) If the radar is intended to be operated in conjunction with a plotting facility (i.e. ARPA or ATA), that facility shall be tested to show compliance with 3.24 and IEC 60872-1 or IEC 60872-2, as appropriate.

4.24.2 (3.24.2) Check that the EUT complies with the performance requirements of annex D.

4.25 (3.25) Safety precautions

4.25.1 Method of measurement

The radar equipment shall be set to operate in the condition that gives maximum mean radiated power from the antenna unit, having due regard to pulse duration and pulse repetition as may be determined by the range scale in use.

Stop the antenna scanning for the duration of this test while microwave power is being transmitted. A search for the power density levels stated in 3.25 shall be carried out in the vicinity of the antenna by means of a radio-frequency radiation monitoring instrument appropriate to the frequency range in use.

4.25.2 Results required

The maximum distance from the scanner of the antenna, within which a power density of 100 W/m^2 is exceeded shall be recorded. The maximum distance within which one tenth of this power density is measured shall also be recorded.

4.26 (3.26) Failure warnings and status indicators

4.26.1 Method of measurement

Inject the inputs given in 3.26.1. Simulate failures.

4.26.2 Results required

Check that the results comply with 3.26.2 and 3.26.3.

4.27 (3.27) Standard names, abbreviations and symbols

Check that the EUT complies with the requirements of 3.27.

4.28 (3.28) Electronic plotting video symbols

Check that the EUT complies with the requirements of 3.28.

4.29 Ergonomics

Examine the EUT for compliance with the requirements of 3.29.

4.30 (3.9.2) Antenna horizontal radiation pattern

The purpose is to investigate the quality of the antenna to ensure that picture quality is not impaired by side-lobes. The figures for the main beam give a method of comparing antennas.

4.30.1 Method of measurement

The horizontal radiation pattern of the radar antenna shall be measured either in the far field region or in a region which can be referenced to it. This shall be carried out at the nominal operating radio frequency of the equipment and also at the upper and lower limits of the radio frequency tolerance declared by the manufacturer.

4.30.2 Results required

The far field horizontal radiation pattern shall conform to table 3, the figures relating to one-way propagation only.

Table 3 – Main beam

Power relative to maximum of main beam dB	**Position relative to maximum of main beam (X-band)** degrees	**Position relative to maximum of main beam (S-band)** degrees
–3	within ±1	within ±1,8
–20	within ±2,5	within ±5

4.30.3 Compliance for alternative methods of meeting the above requirements may be demonstrated by measurements of the antenna radiation pattern and submission of processing methods for achieving the required results.

Annex A
(normative)

Method for relating the radar cross-section (echoing area) of one radar target with another – for the purpose of high-speed craft (HSC)

A.1 Effect of a change of target size

Where a target of radar cross-section or "echoing area" σ_1 is substituted for σ_2 in the same circumstances, the corresponding change in power from p_2 to p_1 received back at the radar is given by:

$$p_1/p_2 = \sigma_1/\sigma_2 \quad (1)$$

Hence $$10 \log (p_1/p_2) = 10 \log (\sigma_1/\sigma_2) \text{ dB} \quad (2)$$

Example 1: When a 30 m^2 radar reflector is substituted for 10 m^2, the change in power received back at the radar will be:

$$10 \log (30/10) = 4{,}8 \text{ dB}$$

A.2 Effect of a change of distance ("range")

Apart from other possible effects described in subsequent clauses, the relationship between power p_1 reflected back from a target at distance d_1, and power p_2 reflected back from the same target at distance d_2, is given by the inverse fourth power law as:

$$\frac{p_2}{p_1} = \frac{{d_1}^4}{{d_2}^4} \quad (3)$$

In decibels, equation (3) becomes: $$10 \log (p_2/p_1) = -40 \log (d_2/d_1) \text{ dB} \quad (4)$$

Example 2: A change of distance from 2 nautical miles to 3 nautical miles will give, apart from other possible changes described below, a power change of:

$$-40 \log (3/2) = -7{,}0 \text{ dB}$$

A.3 Effect of target height and radar height on discrete (non-distributed) targets ("lobing")

In calm to moderate sea states, a radar wave train that is reflected from the sea surface (with the angle of incidence equal to the angle of reflection) before striking the target will add vectorially with the wave train that travels directly to the target. This vectorial addition gives rise to a power enhancement *Y* seen at the radar. When *Y* is expressed in decibels it can vary between the limits +12 dB and $-\infty$ dB. This is of considerable importance when "discrete" or "point source" targets are used.

For the 3 cm band (9 410 MHz) and for the 10 cm band (3 050 MHz) values for the enhancement *Y* (in decibels) can be read from figures A.1 and A.2. The formulae on which the values in figures A.1 and A.2 are based are given in A.6.

Example 3:

Question: Referring to an X-band radar whose antenna height above the sea is 7,5 m, at what height above the sea must a physically small 10 m^2 target be mounted, at a distance of 2 nautical miles, in order to give a net effect of 10 m^2 at this distance?

Answer: This will be the condition where enhancement Y = 0 dB.

By inspection of the curve for 9 410 MHz in figure A.1, the minimum such height is 1,45 m.

A.4 Effects of frequency sensitivity

Certain types of target are frequency sensitive, as will be indicated in the formula relating the physical dimensions of the particular device to its radar cross-section. For a trihedral corner reflector the radar cross-section varies as the square of frequency.

For example, the performance of a trihedral corner reflector will be reduced by 9,9 dB at S-band compared with X-band. It must be borne in mind also that a change of operating frequency will affect in addition the considerations described in A.3 above.

A.5 Conclusion

Factors that affect the performance of given radar targets under normal propagation conditions are described above. This gives a theoretical method whereby one target may be compared with another, by simple addition of the various factors expressed in decibels.

Example 4:

Question: It is calculated from the dimensions of a particular corner reflector that its radar cross-section (echoing area) is 30 m^2 (in free space) at a frequency of 9 410 MHz (X-band). This reflector is mounted at a height of 3,5 m above sea level, at a distance of three nautical miles from a radar antenna mounted at a height of 7,5 m and operating at X-band.

How might the power returned to the radar from this reflector be expected to compare with that from a 10 m^2 target situated at 2 nautical miles from the radar at a height of 1,45 m (as used in example 3)?

Answer: Considering the various relevant factors:

a) power change due to greater target size is 10 log (30/10)	=	+4,8 dB
b) power change due to greater distance is –40 log (3/2)	=	–7,0 dB
c) power change (enhancement) due to lobing at 3 nautical miles is seen by inspection of figure A.1 (9 410 MHz, target height 3,5 m) is	=	+6,0 dB
Adding the above three factors, the following answer is obtained		+3,8 dB

A.6 Formulae for figures A.1 and A.2

$$Y = 16 \sin^4 \frac{4\pi h_1 h_2 f}{2c\,D} \tag{5}$$

where

h_1 is the radar height
h_2 is the target height
} above the tangent plane to the earth at the reflection point.

f is the frequency of operation

c is the velocity of microwave propagation

D is the radar-to-target distance

NOTE – For horizontal polarisation only:

In the case of the curved earth, the heights h_1 and h_2 above the tangent have to be determined from the corresponding heights h_r and h_t of the radar and target respectively above the surface, by use of the approximate relationships (obtained from geometrical considerations):

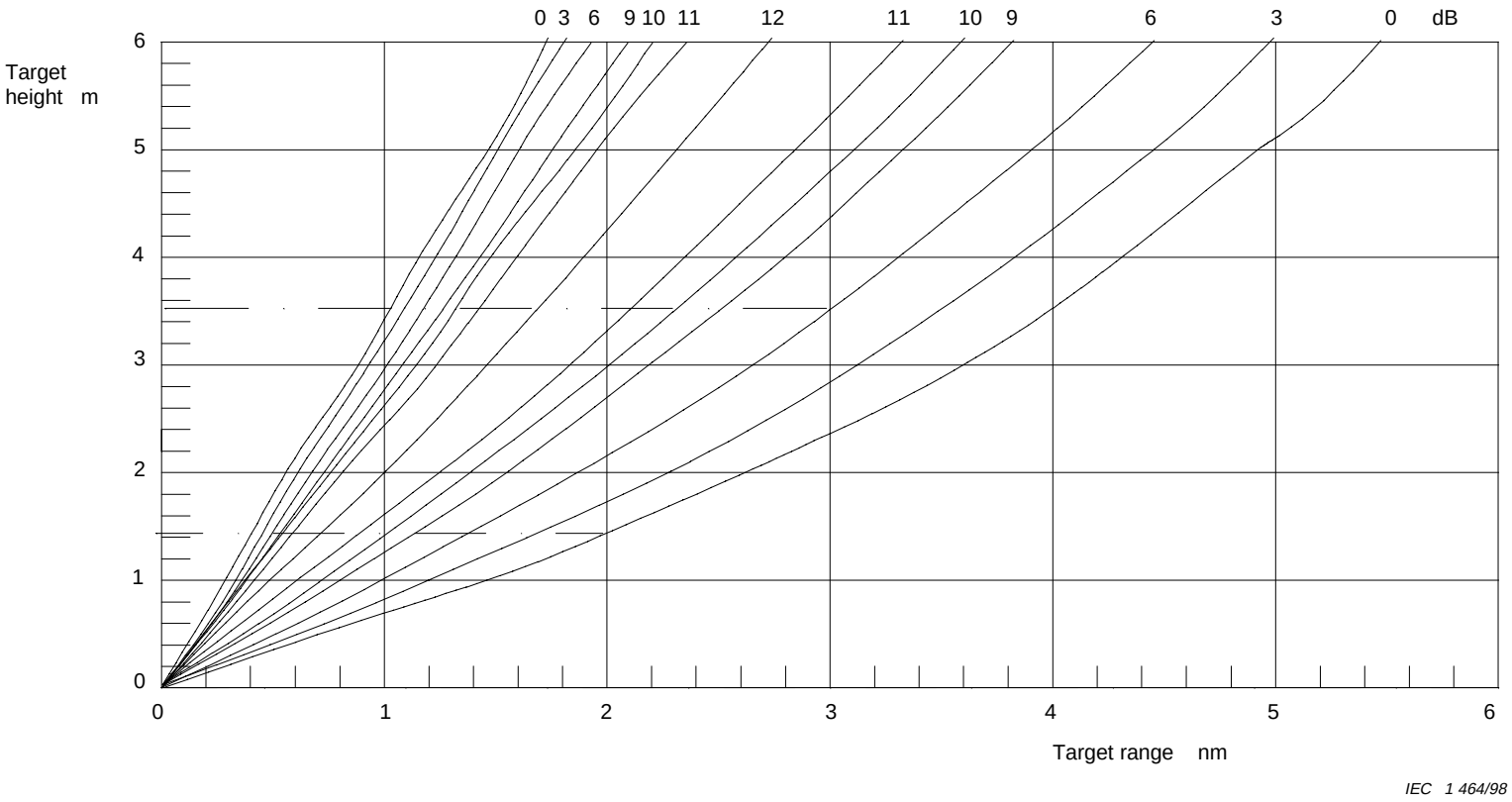
$$h_1 = h_r - \frac{(h_r\,D)^2}{d\,(h_r + h_t)^2} \tag{6}$$

and

$$h_2 = h_t - \frac{(h_r\,D)^2}{d\,(h_r + h_t)^2} \tag{7}$$

where d is the effective diameter of the "radio" earth (taken here as $6\,371 \times 4/3 \times 2 = 16\,990$ km)

The formulae do not take the influence of "beam divergence" during reflection at the curved earth into account, which will reduce the maximum enhancement and "fill in" the nulls, thus increasing the minimum values of Y above $-\infty$.



Antenna height = 7,5 m
Frequency = 9 410 MHz (3 cm band)

Figure A.1 – Enhancement by reflection (dB) over free space

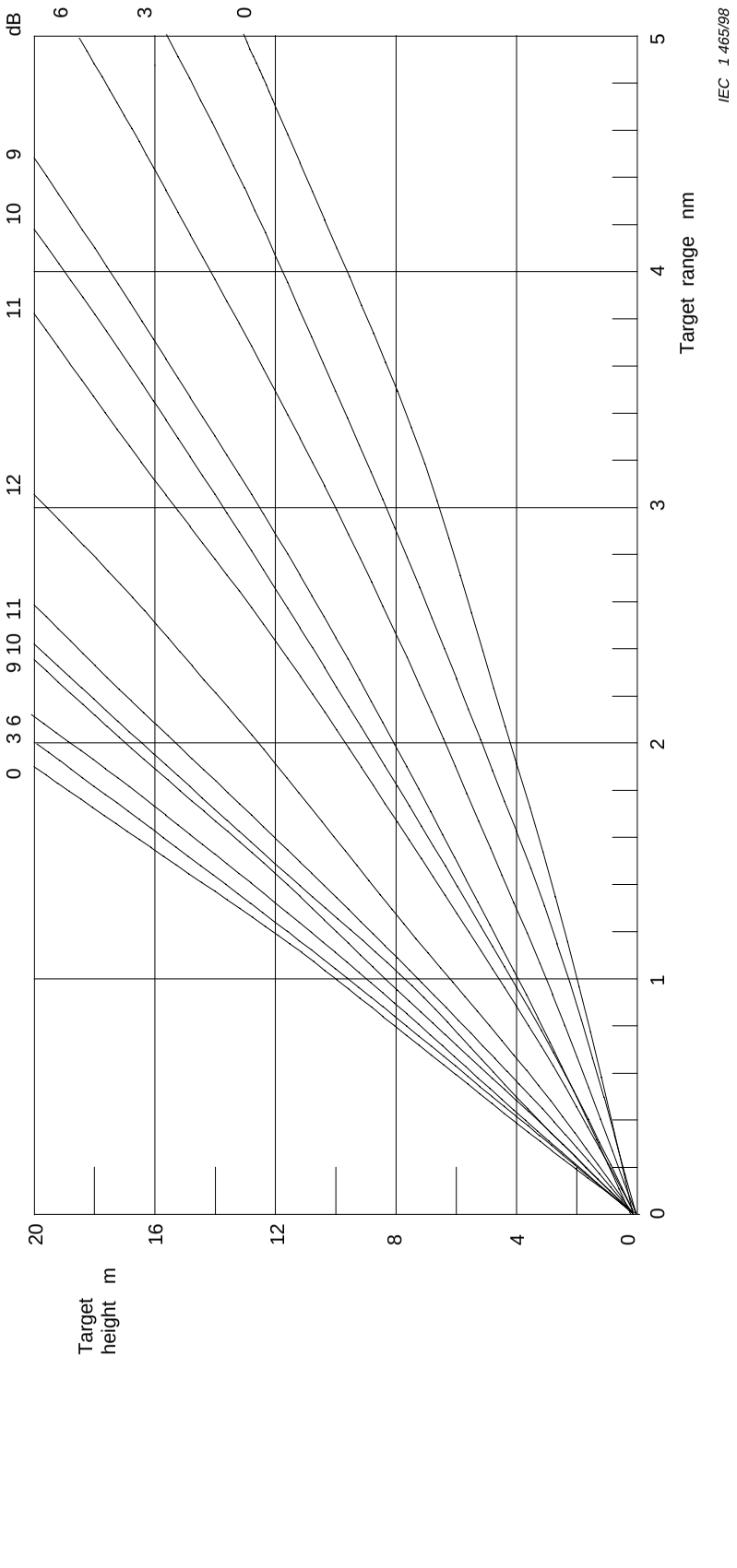


Figure A.2 – Enhancement by reflection (dB) over free space

Annex B
(normative)

Standard names, abbreviations and symbols for control functions on marine navigational radar equipment

B.1 List of controls

When any of the following controls are used, they shall be identified in English by the relevant name or abbreviation given in the following list. In addition they may be identified by standard symbols.

STANDARD NAMES	STANDARD ABBREVIATIONS	STANDARD SYMBOLS	DESCRIPTIONS
OFF	OFF	1	Off. e.g. radar or display
ON	ON	2	On. e.g. radar or display
STAND-BY	STBY	3	Standby
NORTH-UP	N UP	4	North stabilized display mode
HEAD-UP	H UP	5	Head-up unstabilized display mode
HEADING LINE OFF	HL OFF	6	Heading line on display to be switched off momentarily
RANGE	RANGE	7	Range scale in use. Plus (+) or minus (–) to indicate range up or down
SHORT PULSE	SP	8	Short pulse
LONG PULSE	LP	9	Long pulse
TUNE	TUNE	10	Tune
GAIN	GAIN	11	Gain of the receiver
RAIN	RAIN	12	Anti-clutter rain
SEA	SEA	13	Anti-clutter sea
PANEL ILLUMINATION	PANEL	14	Display panel brilliance
DISPLAY BRILLIANCE	BRILL	15	Brilliance of the picture on the display
RANGE RINGS	RR	16	Fixed range rings on the display
VARIABLE RANGE MARKER	VRM	17	Variable range marker on the display
ELECTRONIC BEARING LINE	EBL	18	Electronic bearing line on the display
PERFORMANCE MONITOR	PM	19	Performance monitor

B.2 Code of practice for symbols

The following code of practice shall be used when marking radar sets with optional symbols:

B.2.1 The maximum dimension of a symbol shall not be less than 9 mm.

B.2.2 The distance between the centres of two adjacent symbols shall be not less than 1,4 times the size of the larger symbol.

B.2.3 Switch function symbols shall be linked by a line. A linked line infers controlled action.

B.2.4 Variable control function symbols shall be linked by a line, preferably an arc. The direction of increase of the controlled function shall be indicated.

B.2.5 Symbols shall be presented with a high contrast against their background.

B.2.6 The various elements of a symbol shall have a fixed ratio one to another.

B.2.7 Multiple function of controls and switch positions may be indicated by a combined symbol.

B.2.8 Where concentric controls or switches are fitted, the outer of the symbols should refer to the larger diameter control.

B.3 Symbols

B.3.1 The symbols listed in this clause may be used for controls on marine navigational radar equipment

B.3.2 The circles shown around the following symbols are optional:

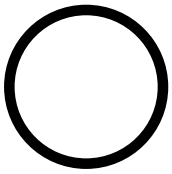
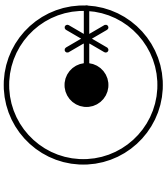
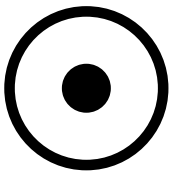
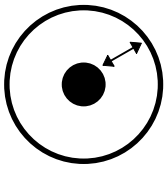
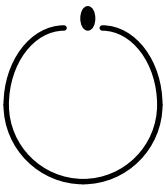
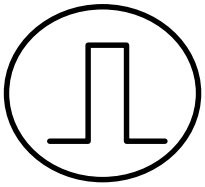
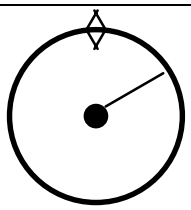
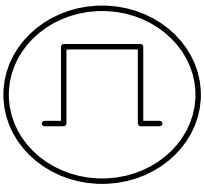
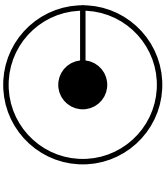
.1 Symbol 8: short pulse

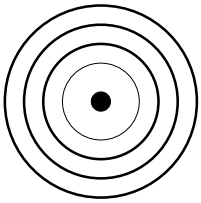
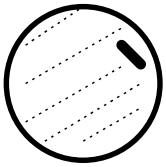
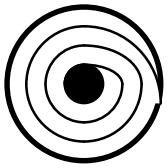
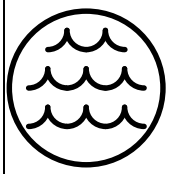
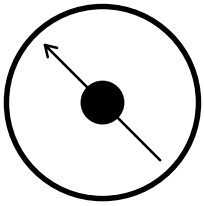
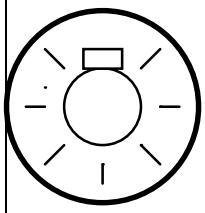
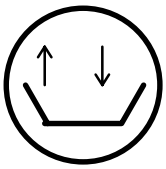
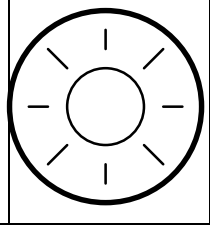
.2 Symbol 9: long pulse

.3 Symbol 14: panel illumination

.4 Symbol 19: performance monitor

B.3.3 Symbols for controls on marine navigational radar equipment

	Symbol	Name	Explanation		Symbol	Name	Explanation
1		OFF	To identify the "off" position of the control or switch	6		HEADING LINE OFF	To identify the "heading line" off position
2		ON	To identify the "radar on" position of the switch	7		RANGE	To identify the range selection switch
3		STAND-BY	To identify the "radar stand-by" position of the switch	8		SHORT PULSE	To identify the "short" pulse position of the pulse length selection control
4		NORTH-UP	To identify the "north-up" position of the mode of presentation switch	9		LONG PULSE	To identify the "long" pulse position of the pulse length selection control
5		SHIP'S HEAD-UP	To identify the "ship's head-up" position of the mode of presentation switch	10		TUNE	To identify the "tuning control"

	Symbol	Name	Explanation		Symbol	Name	Explanation
11		GAIN	To identify the “gain” control	16		RANGE RINGS	To identify the maximum position of the “range rings brilliance” control
12		RAIN	To identify the position of the “rain” control or switch	17		VARIABLE RANGE MARKER	To identify the “variable range marker” control
13		SEA	To identify the minimum position of the “anti-clutter sea” control	18		ELECTRO-NIC BEARING LINE	To identify the “electronic bearing line” control
14		PANEL ILLUMI-NATION	To identify the maximum position of the “scale illumination” control or switch	19		TRANSMIT /RECEIVE MONITOR	To identify the position of the performance monitor switch
15		DISPLAY BRILL-IANCE	To identify the maximum position of the “display brilliance” control				

B.4 Code of practice for standard names and abbreviations

English standard names and abbreviations listed in B.5 are not exhaustive.

B.4.1 Upper case and lower case letters may be used.

B.4.2 Full stops and hyphens shall not be used.

B.4.3 Standard abbreviations can be divided when used in menus, e.g. MAP, SYMBOL, LINE.

B.4.4 New names and abbreviations may be used for new functions provided they do not conflict with B.4.

B.4.5 Names and abbreviations marked with an * are for use in text areas and not in the radar picture area.

B.4.6 It is permissible to use a single first letter abbreviation when unambiguously used with a second abbreviation e.g., T.BRG, L.SPD.

B.4.7 Application

This list is intended to be used on new radar, high speed craft radar and electronic plotting equipment type approved after the revised IMO Resolution A.477 radar performance standard comes into force on 1 January 1999.

B.4.8 Descriptions

The descriptions are not a mandatory glossary, but are given for informative reasons.

B.4.9 Modes

In order to standardise the motion modes of operation the names True Motion, Relative Motion-True trails and Relative Motion-Relative trails, are to be used. The standard abbreviation for these modes shall be TM, RM(T) and RM(R).

B.5 Marine radar and high-speed craft radar

STANDARD NAMES	STANDARD ABBREVIATIONS	DESCRIPTIONS
ACKNOWLEDGE	ACK	Acknowledge or accept, e.g. Alarm
ADJUST	ADJ	Make changes
ALARM	ALM	Alarm
AUDIBLE	AUD	Audible, e.g. Alarms
AVAILABLE	AVAIL	Available, e.g. Function/sensor available
AUTOMATIC	AUTO	Automatic, e.g. Sea clutter
AZIMUTH	AZI	Azimuth, e.g. Azimuth error, Azimuth stabilized
BACKGROUND	BKGND	Background of display
BEARING	BRG	Bearing
BUILT-IN TEST EQUIPMENT	BITE	Built-in test equipment
CALIBRATE	CAL	Calibrate, e.g. radar, performance monitor and touch
CANCEL	CNCL	Cancel, e.g. A command or exit
CENTRE	CEN	Centre
*CHANGE	CHG	Change
CIRCULAR POLARISED	CP	Circular polarised, e.g. Antenna
CLEAR	CLR	Clear, e.g. remove data, video, synthetics currently entered
COMPASS	COMPASS	Compass, e.g. Compass error
CONTRAST	CONTR	Contrast on display
CORRECTION	CORR	Correction
COURSE	CSE	Course, e.g. Next course. New course
COURSE OVER THE GROUND	COG	Course made good over the ground, e.g. True
COURSE TO STEER	CTS	Course is the direction in which a vessel is steering or intended to be steered
COURSE-UP	C UP	Course-up stabilized display mode
CURSOR	CURS	A moveable reference used in reading bearings or a highlighted input point on the screen
DATA	DATA	Data
DATE	DATE	Date
DAY/NIGHT	DAY/NT	Day and night, e.g. Background, brilliance
DEAD RECKONING	DR	A position based on true course steered and speed through the water
DECREASE	DECR or –	Decreasing a value
DEGAUSS	DEGAUSS	Degauss the display
DEGREES	DEG or °	Degree. A measure of angle
DELETE	DEL	Delete
DISPLAY	DISP	Display, e.g. Radar screen

DISTANCE	DIST	Distance
DRIFT	DRIFT	Distance covered solely due to current, tidal stream and surface drift
ELECTRONIC BEARING LINE	EBL	Electronic bearing line on the display
ELECTRONIC RANGE AND BEARING LINE	ERBL	Electronic range and bearing line
ENHANCE	ENH	Enhance, e.g. Video
ENTER	ENT	Enter, e.g. Selected data
EQUIPMENT	EQUIP	Equipment
ERROR	ERR	Error, e.g. Operator, Alarm
ESTIMATED POSITION	EP	Estimated position. The position derived from DR, leeway and drift
EXTERNAL	EXT	External, e.g. Input, Alarm
GROUND STABILIZED	GND STAB	Ground stabilized mode
GROUND TRACK	GND TRK	Ground track
GYRO	GYRO	Gyro
HEADING	HDG	Heading. The direction in which the bows of a ship are pointing expressed as an angular displacement from north. From 000 to 360 clockwise
HEADING LINE	HL	Heading line
HOURS	HR	Hours
INCREASE	INCR or +	Increase a value
INFORMATION	INFO	Information
INITIALISATION	INIT	Initialisation, e.g. Starting a process or setting up parameters
INTERFERENCE REJECTOR	IR	Interference rejector, e.g. Rejection of other ship's radar interference (pulse to pulse correlator)
INTERSWITCH	ISW	Inter-switch function
INPUT	IN	Input
INPUT/ OUTPUT	I/O	Input/output
KNOTS	KT	Knots
*LABEL	LBL	Labels used to identify objects, e.g. To manually label a plot or target
LEEWAY	LWY	Leeway is the effect of wind in moving a vessel bodily to leeward at right angle to the course steered
LIMIT	LIM	Limit, e.g. The maximum or minimum range of a value
LOG	LOG	Log, e.g. Sensor for determining ship's speed
MAGNETIC	MAG	Magnetic
MAGNETIC VARIATION	MAG VAR	Magnetic variation
MANUAL	MAN	Manual, e.g. Acquisition, operation, and system input and "MAN SPD"
MARKER	MKR	Marker

MASTER	MSTR	Master, e.g. Display, Radar
MAXIMUM	MAX	Maximum (used before the value)
MEDIUM PULSE	MP	Medium pulse
MENU	MENU	Menu. A list of commands and/or options
MINIMUM	MIN	Minimum (used before the value or in association with MAX)
MINUTES	MIN	Minutes (used after the value)
MISSING	MISSING	Missing, e.g. HL missing
MUTE	MUTE	Mute or silence, e.g. Alarm
NAUTICAL MILE	NM	Nautical mile
NORMAL	NORM	Normal
OFFCENTRE	OFF CENT	Off centre, e.g. Off centre set or reset
OFFSET	OFFSET	Offset, e.g. Where EBL is offset from own ship
OUTPUT	OUT	Output
OWN SHIP	OS	Own ship
PARALLEL INDEX LINE	PI	Parallel index line, referenced to own ship
PERMANENT	PERM	Permanent, e.g. Permanent track
PERSONAL ACCESS CODE	PIN	Personal access code, e.g. For user settings
POSITION	POSN	Position
POWER	PWR	Power
PULSE LENGTH	PL	Pulse length
PULSES PER REVOLUTION	PPR	Number of pulses during the revolution of antenna
PULSE REPETITION FREQUENCY	PRF	Pulse repetition frequency
RADAR	RDR	Radar
RANGE	RNG	The range, e.g. of a Target. Not to be used for range scale
RECEIVER	RX	Receiver
RELATIVE	REL	Relative
RELATIVE BEARING	R BRG	Relative bearing; relative to ship's head
RELATIVE COURSE	R CSE	Relative course
RELATIVE MOTION	RM	Relative motion
RM (TRUE TRAILS)	RM (T)	Relative motion with true trails
RM (RELATIVE TRAILS)	RM (R)	Relative motion with relative trails
*SCAN TO SCAN	SC/SC	Scan to scan correlation. A number may be added to indicate the number of correlation scans
SECONDS	SEC	Time in seconds
SELECT	SEL	Select, e.g. Menu, Data, Target
SET	SET	The resultant direction towards which current, tidal stream and surface drift flow

SIMULATION	SIM	Simulation
SLAVE	SLAVE	Slave, e.g. Display
SPEED	SPD	Speed, e.g. In knots
*SPEED OVER THE GROUND	SOG	Speed made good over the ground, e.g. from GPS, ECHO REF., Dual axis LOG
SPEED THROUGH THE WATER	STW	Speed made good through the water, e.g. LOG (water track)
STABILIZED	STAB	Stabilized
SYNCHRONISATION PULSE	SYNC	Synchronisation
TARGET	TGT	Target, e.g. Any fixed or moving object, measured by radar
TIME TO GO	TTG	Time to go
TRAILS	TRAILS	Trails. Synthetic afterglow. True or relative. True trails may be sea or ground stabilized
TRANSCEIVER	TX/RX	Transceiver, e.g. X or S TX/RX, TX/RX 1 or 2, etc.
TRANSMITTER	TX	Transmitter
TRANSPONDER	TPR	Transponder
TRIGGER PULSE	TRIG	Trigger or timing pulse, e.g. Trigger error
TRUE	TRUE	True, e.g. True data, true heading
TRUE COURSE	T CSE	True course
TRUE BEARING	T BRG	True bearing. Relative to true north. Compass bearing corrected for compass error
TRUE MOTION	TM	True motion
TRUE SPEED	T SPD	True speed
UNINTERRUPTED POWER SUPPLY	UPS	Uninterrupted power supply
UNSTABILIZED	UNSTAB	Unstabilized
VIDEO	VID	Video
VISUAL DISPLAY UNIT	VDU	Visual display unit
VIDEO NORMAL	VID NORM	Video normal
*X-BAND	X	X-band (3 cm wavelength), e.g. Transceiver
*S-BAND	S	S-band (10 cm wavelength), e.g. Transceiver

B.6 ARPA, ATA and EPA

STANDARD NAMES	STANDARD ABBREVIATIONS	DESCRIPTIONS
ACQUIRE	ACQ	Acquisition. The process of selecting a target and initiating tracking or plotting
ACQUISITION ZONE	AZ	Acquisition zone. A zone where targets will be automatically acquired, e.g. Footprint-FAZ, Sector-SECT AZ and Inclusion zone-INC AZ
ANCHOR WATCH	ANCH	Anchor watch
AUTOMATIC RADAR PLOTTING AID	ARPA	Automatic radar plotting aid
AUTOMATIC TRACKING AID	ATA	Automatic tracking aid
BOW CROSSING RANGE	BCR	The range at which a target will cross own ship's bow
BOW CROSSING TIME	BCT	The time to BCR
CLOSEST POINT OF APPROACH	CPA	The closest point of approach, e.g. Limit (CPA LIM), Trial (CPA T)
DELAY	DELAY	Delay, e.g. Setting time to start of manoeuvre
ECHO REFERENCE	REF	Echo reference, e.g. A tracked target used as a reference for ground stabilization
ECHO REFERENCE SPEED	REF SOG	Speed derived from a stationary tracked target
ELECTRONIC PLOTTING AID	EPA	Electronic plotting aid
EXCLUSION ZONE	EZ	Exclusion zone. Zone within an acquisition zone where target will not be acquired automatically
FULL	FULL	Full, e.g. Guard zone, Acquisition zone, and tracking has no more capacity
GUARD ZONE	GZ	Guard zone. A zone where an alarm will be given when a target enters it
IDENTIFICATION	ID	Identification, e.g. Number of a target in racking or plotting
LABEL TARGET	LAB TGT	Label target, e.g. Display target ID on screen
LOST TARGET	LOST TGT	Lost target, e.g. No longer being tracked having been lost and does not have tracking ability
MANOEUVRE TIME	MVR TIME	Manoeuvre time, e.g. An alarm indicating manoeuvre should be carried out now
PAST POSITIONS	PAST POSN	Past positions, e.g. History dots
PREDICTED AREA OF DANGER	PAD	A graphic showing a PAD around a predicted close quarter situation area

PREDICTED POINT OF COLLISION	PPC	A graphic showing where PPC intercept points lie with respect to own ship and other targets
RELATIVE VECTOR	R VECT	Relative vector
SYMBOLS OFF	SYM OFF	Symbols off, e.g. ARPA, ATA, EPA, NAV, ENC, etc.
TEST TARGET	TEST TGT	Test target for integrity checking of tracking
TIME TO CLOSEST POINT OF APPROACH	TCPA	Time to closest point of approach, e.g. Limit-TCPA LIM, Trial-TCPA T
TIME TO GO	TTG	Time to go
TRACKING	TRKG	Tracking. The computer process of observing the sequential changes in the position of a target in order to establish its motion
TRIAL MANOEUVRE	TRIAL	Trial manoeuvre. T is the ARPA symbol
TRUE VECTOR	T VECT	True vector
VECTOR	VECT	Vector, e.g. True or relative
VECTOR TIME	VECT TIME	Vector time, e.g. Length of vector measured in units of time

B.7 Geographics, mapping and navigation

STANDARD NAMES	STANDARD ABBREVIATION	DESCRIPTIONS
ANTENNA	ANT	Antenna, e.g. Radar or GPS
AUTOPILOT	AP	Auto-pilot. An automatic heading control aid to enable a vessel to maintain its heading in an intended direction
BEARING AND DISTANCE TO WAYPOINT	BWC	Bearing and distance to way-point (great circle)
BEARING AND DISTANCE TO WAYPOINT	BWR	Bearing and distance to way-point (rhumb line)
BEARING ORIGIN TO DESTINATION	BOD	Bearing origin to destination
BEARING WAYPOINT TO WAYPOINT	BWW	Bearing way-point to way-point
CO-ORDINATED UNIVERSAL TIME	UTC	Co-ordinated universal time
CROSS TRACK ERROR	XTE	Cross track error
CURVED HEADING LINE	CHL	Curved heading line for showing predicted track
DGPS	DGPS	Differential GPS. Local-L or Wide-W area system
DECCA	DEC	Decca navigator
DEPTH	DPTH	Depth, e.g. Depth alarm

DESTINATION	DEST	Destination
DISTANCE INTERVAL	DIST INT	Distance interval between tracked positions of targets
ECDIS	ECDIS	Electronic chart display and information system
ELECTRONIC NAVIGATIONAL CHART	ENC	The data base held on board the ship for use with ECDIS
ELECTRONIC POSITION-FIXING SYSTEM	EPFS	Electronic position-fixing systems, e.g. GPS, DECCA, LORAN-C
ESTIMATED TIME OF ARRIVAL	ETA	Estimated time of arrival
EVENT	EVENT	Event on radar or ECDIS
GLOBAL POSITIONING SYSTEM	GPS	GPS
GLONASS	GLO	GLONASS
GEOGRAPHICS	GEOG	Geographics. Maps and grid elements
GREAT CIRCLE	GC	Great Circle
GRID	GRID	Latitude and longitude grid, the lines of which approximate to a Mercator projection
HEADING CONTROL SYSTEM	HCS	Heading control system
INFRARED	INF RED	Infrared, e.g. sensor
INTEGRATED BRIDGE SYSTEM	IBS	Integrated bridge system
INTEGRATED NAVIGATION SYSTEM	INS	Integrated navigation system
INTEGRATED RADIO COMMUNICATION SYSTEM	IRCS	Integrated radio communication system
LATITUDE	LAT	Latitude
LATITUDE/LONGITUDE	L/L	Latitude/Longitude
LINE OF POSITION	LOP	Line of position
LONGITUDE	LON	Longitude
LORAN	LOR	Loran-C'
MAN OVERBOARD	MOB	Man overboard
MAP LINES	MAP LINES	Map lines. A navigational facility defining channels or traffic separation schemes which are ground stabilized
MAPS	MAP	Maps generated by the user
NAVIGATION	NAV	Navigation, e.g. “NAV SOG” from an EPFS
OFF TRACK	OFF TRK	Off track, e.g. Off track alarm
POSITION	POSN	Position, e.g. Mode select, Display
RADAR SYSTEM DATA	RSD	Radar system data
RADIUS	RAD	Radius turn, e.g. NEXT RAD
RATE OF TURN	ROT	Rate of turn

RHUMB LINE	RHL	Sailing on a constant course
ROUTE	RTE	Route. A planned course of travel, usually composed of more than one leg
SAFETY CONTOUR	SAF CON	Safety contour for depth, e.g. From ECDIS
SEQUENCE	SEQ	Sequence, e.g. Maps
SYSTEM ELECTRONIC NAVIGATIONAL CHART	SENC	System electronic navigational chart
TRACK	TRK	The path followed or to be followed from one position to another
TRACK CONTROL SYSTEM	TCS	Track control system
TRACK MADE GOOD	TMG	Track made good between the point of departure to a point of arrival
TRACK PILOT	TRK P	Track pilot
VOYAGE	VOY	Voyage, e.g. Voyage
WAYPOINT	WPT	Way-point. A reference point on the track
WAYPOINT CLOSURE VELOCITY	WCV	Way-point closure velocity
WHEEL OVER POINT	WOP	Wheel over point or line
WORLD GEODETIC SYSTEM	WGS	World geodetic system, e.g. WGS 84

Annex C
(normative)

Electronic plotting video symbols (EPVS)

C.1 General

C.1.1 IMO Resolutions A.823 for ARPA and MSC.64(67), annex 4 for marine radar and A.820 for high-speed craft radar require that certain indications and warnings be given on electronic plotting aids for anti-collision purposes.

Video symbols 1 to 14, illustrated in this annex, shall be used on ARPA to conform with the IMO mandatory requirements.

Video symbols 1, 3, 4, 5, 7, 8, 9, 11, 12 and 13 shall be used on ATA.

Video symbols 1, 4, 6, 8 and 12 shall be used on EPA. Symbol 7 may be used optionally where this facility is provided.

C.1.2 The size of the video symbols in the text assumes a 340 mm effective diameter display. Where the sizes of alpha-numerics are not specified, they shall be 6 mm high. For smaller diameter displays the size shall be proportionally smaller.

C.1.3 Other symbols may be used for other anti-collision functions provided they do not conflict with symbols 1 to 14 and navigational symbols for radar (annex E of the IEC 60936 series) and IHO chart symbols (IHO S-52). The use of these other anti-collision symbols shall be limited to ensure that they do not obscure the anti-collision requirements of the electronic plotting aids.

C.1.4 If two or more symbols simultaneously apply to a target, then the symbols may be displayed together provided that they are clearly distinguishable.

C.1.5 For the three warning/alarm symbols (symbols 7, 8 and 9) the following priorities shall be used:

C.1.5.1 An unacknowledged alarm (symbol 7 flashing) is always a higher priority than an acknowledged alarm (symbol 7 steady);

C.1.5.2 CPA/TCPA warning (symbol 8) has a higher priority than a target entering a guard zone (symbol 7);

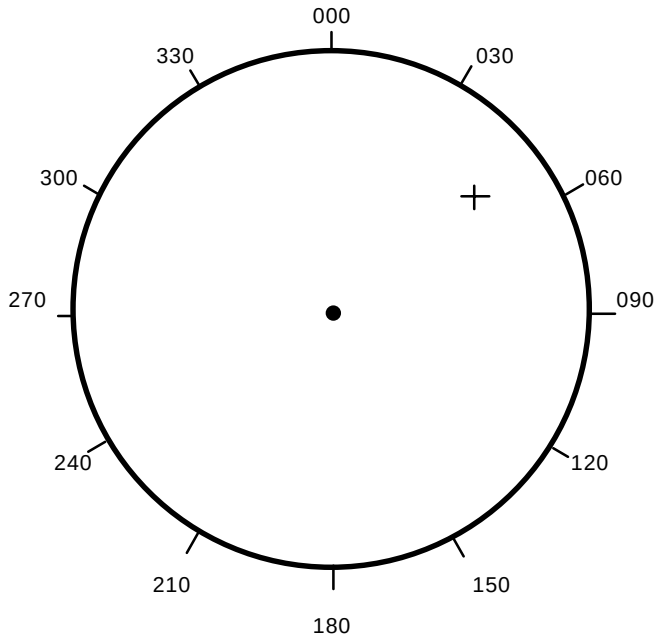
C.1.5.3 Guard zone warning (symbol 7) has a higher priority than a lost target warning (symbol 9).

C.2 Symbols

The following symbols are graphically presented within a representation of a radar plotting display, which includes a bearing scale graduated at nominal 30° intervals. In practice the bearing scale is divided into marks at least every 5° (see IEC 60936-1).

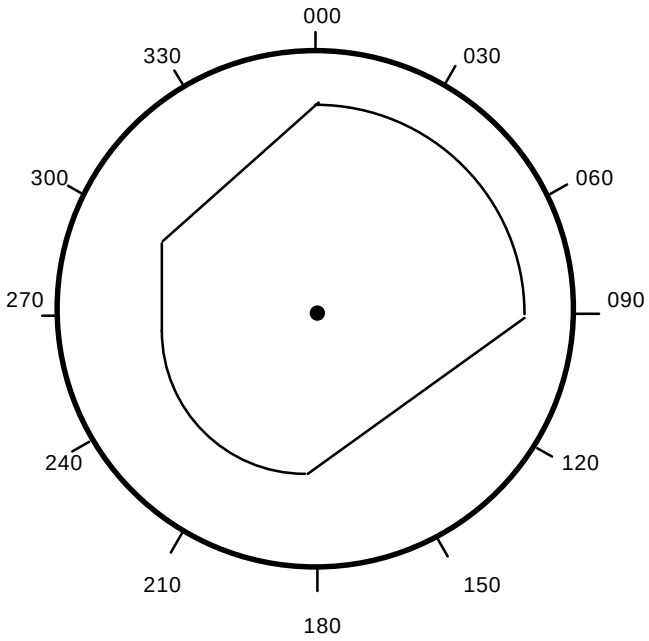
The diagrams that follow are intended to illustrate only the form of the symbols.

C.2.1 Symbol 1

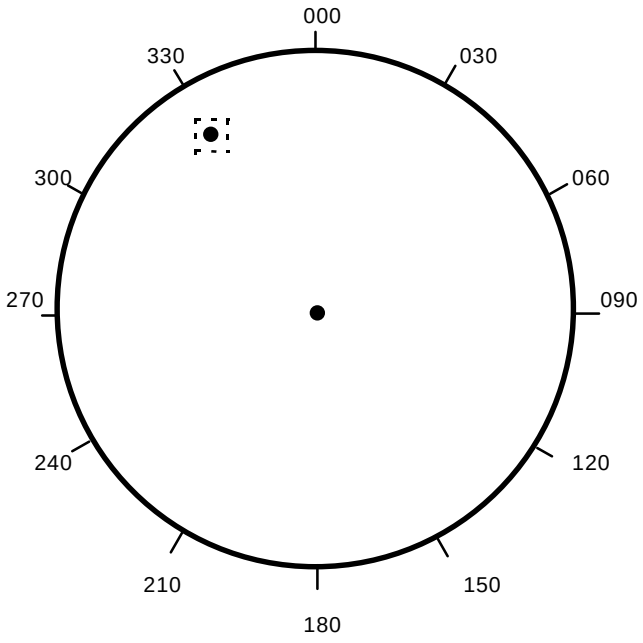
<table>
<tr><th>IMO/IEC references</th><th>EPVS symbol number</th><th>Detail</th><th>Description of symbol</th></tr>
<tr><td>3.2.1 of IMO A.823
3.3.2.1 of IEC 60872-1
3.3.2.1 of IEC 60872-2
3.3.5.1 of IEC 60872-3</td><td>1
ARPA
ATA
EPA</td><td>Manual acquisition and plotting.</td><td>A cross shall be used as the cursor for manual acquisition on an ARPA and ATA and for plotting on an EPA.</td></tr>
<tr><td colspan="3"> 
</td><td>NOTE 1 – The cross shall be at least 10 mm in height and 10 mm in width, to avoid confusion with other navigational and chart symbols, as well as for electronic chart display and information system (ECDIS) harmonization.

NOTE 2 – The cursor is also used for other radar purposes.</td></tr>
</table>

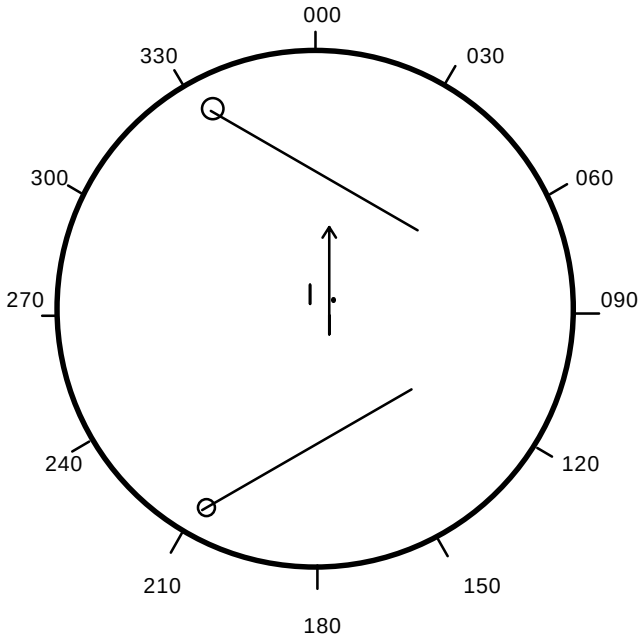
C.2.2 Symbol 2

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.2.1 of IMO A.823 3.3.2.1 of IEC 60872-1	**2** ARPA	**Area of auto acquisition.** *On any range scale where acquisition is suppressed over a certain area, the area of acquisition* shall *be indicated on the display.*	If facilities are provided for suppression of acquisition, continuous lines shall be used to define the limits outside of which auto acquisition is suppressed.
			NOTE 1 – In 3.2.1 of IMO A.823, no restriction is placed on the number and shapes of auto acquisition zones. NOTE 2 – The acquisition zone can also serve as a guard zone (see symbol 7).

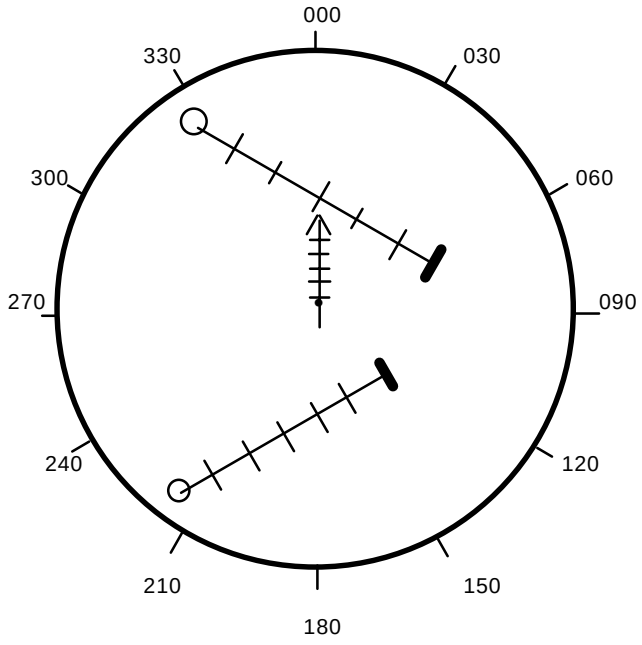
C.2.3 Symbol 3

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.3.2 of IMO A.823 3.3.3.1 of IEC 60872-1 3.3.3.1 of IEC 60872-2	**3** ARPA ATA	**Target being tracked during the initial stage.**	A broken square around the echo indicates the targets under acquisition and initial stage of tracking before steady-state tracking.
			

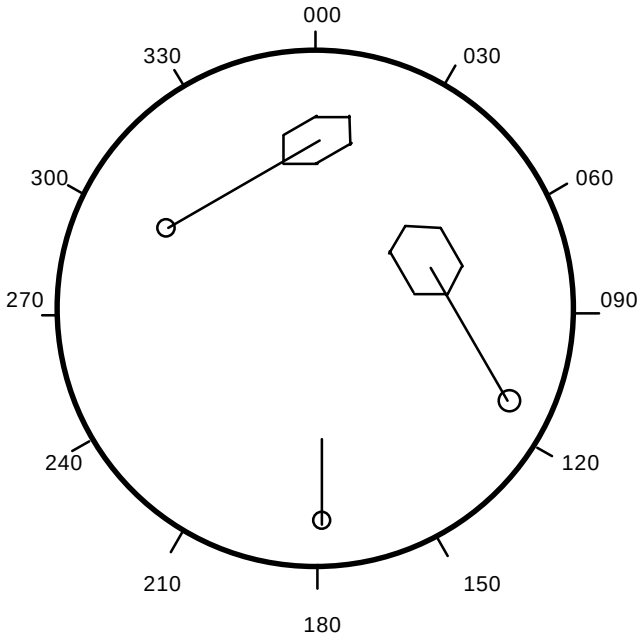
C.2.4 Symbol 4A

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823 3.3.4.6 of IEC 60872-1 3.3.4.6 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**4A** ARPA ATA EPA	**Course and speed vector. Target being tracked when tracking is in steady state.** *The course and speed information generated by the ARPA*/ATA/EPA *for acquired targets* shall *be displayed in a vector or graphic form.*	A vector indicating the target's predicted true or relative motion, which may have a fixed time scale or time-adjusted scale. The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter. The position of own ship shall always be indicated by a dot.
			NOTE – Optionally an open arrow or a double arrow may be added, if chosen by the user, to the end of own ship true vector. This is to indicate that all the vectors are sea stabilized to show course and speed through water (single arrow) or ground stabilized to show course and speed over the ground (double arrow) respectively.

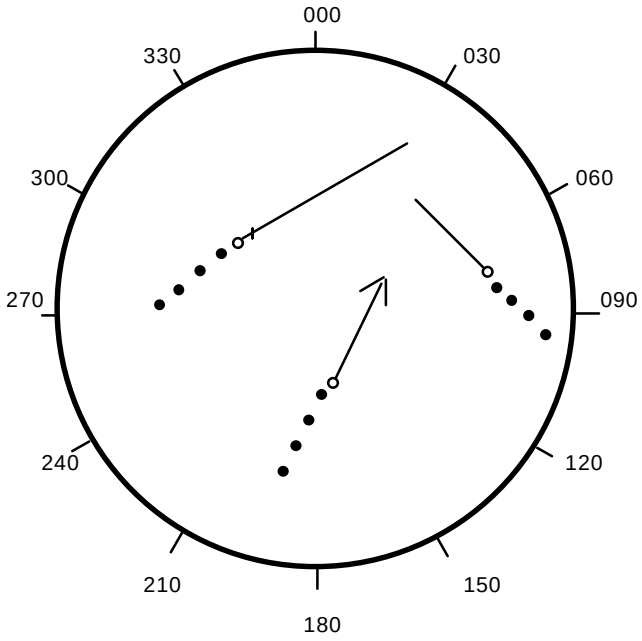
C.2.5 Symbol 4B

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823	**4B**	**Course and speed vector. Target being tracked when tracking is in steady state.**	A vector indicating the target's predicted true or relative motion, which may have a fixed time scale or time-adjusted scale.
3.3.4.6 of IEC 60872-1	ARPA	*The course and speed information generated by the ARPA*/ATA/EPA *for acquired targets* shall *be displayed in a vector or graphic form.*	The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter.
3.3.4.6 of IEC 60872-2	ATA		
3.3.5.1 of IEC 60872-3	EPA		
			NOTE 1 – Optionally an open arrow or a double arrow may be added, if chosen by the user, to the end of own ship true vector. This is to indicate that all vectors are sea stabilized to show course and speed through the water (single arrow) or ground stabilized to show course and speed over the ground (double arrow) respectively. NOTE 2 – Marks at 1 min intervals. Bold mark at 6 min intervals. Length represents user-selectable period applied to ALL vectors.

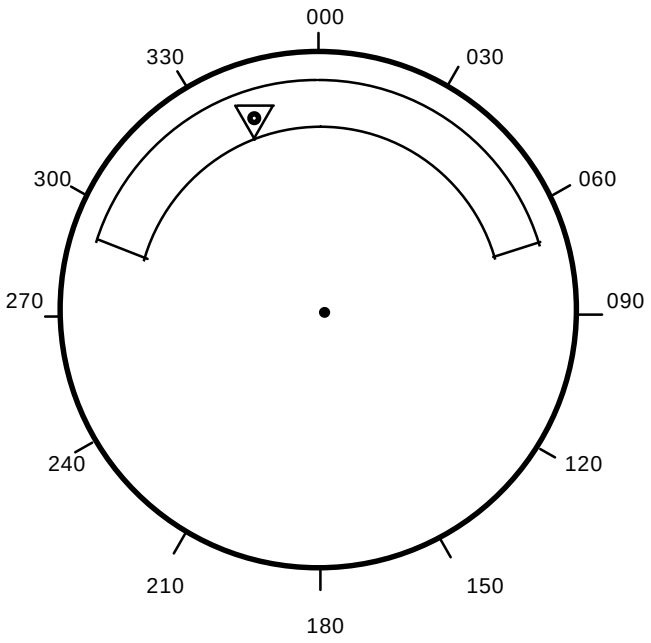
C.2.6 Symbol 5

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823	**5**	**Course and speed graphics. Target being tracked when tracking is in steady state.**	The graphics can take the form of a shape such as a hexagon (see example) or ellipse.
3.3.4.6 of IEC 60872-1	ARPA	*The course and speed information generated by the ARPA*/ATA *for acquired targets* shall *be displayed in a vector or graphic form.*	The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter.
3.3.4.6 of IEC 60872-2	ATA		
			NOTE 1 – The form of the graphics shall avoid shapes that are being used for other ARPA symbols. NOTE 2 – The meaning of the graphics shall be fully explained in the manufacturer's handbook, and shall specifically include how the graphics represent target speed.

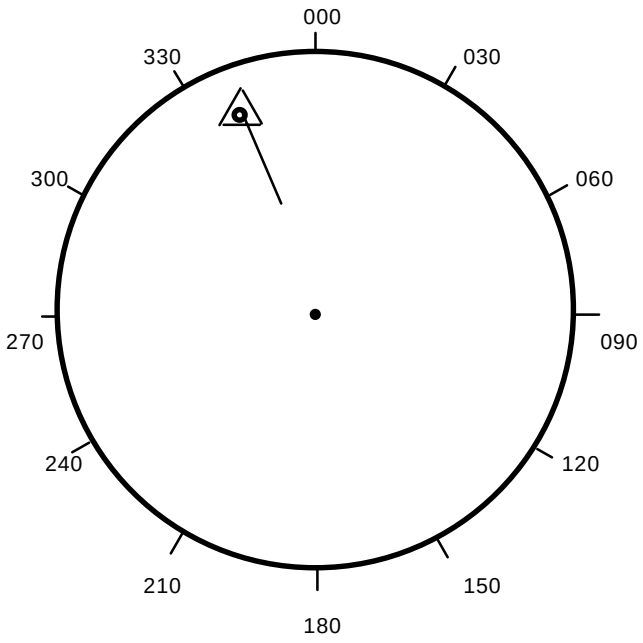
C.2.7 Symbol 6

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.3.5 of IMO A.823	**6**	**Past position of target on ARPA.**	At least four equally time-spaced past positions to be shown on request as dots on an ARPA.
3.3.3.8 of IEC 60872-1	ARPA	*The ARPA* shall *be able to display on request at least four equally time-spaced past positions of any targets being tracked over a period appropriate to the range scale in use.*	Plot positions shall be identified by an associated plot number adjacent to the initial plot and subsequently adjacent to the vector origin.
3.2.5 of IEC 60872-3	EPA	Plot position of targets on EPA.	On EPA, the past plot positions may not be equally time-spaced, and are not shown astern of own ship.
			NOTE – This diagram applies to ARPA only. For EPA see IEC 60872-3 C.2.7

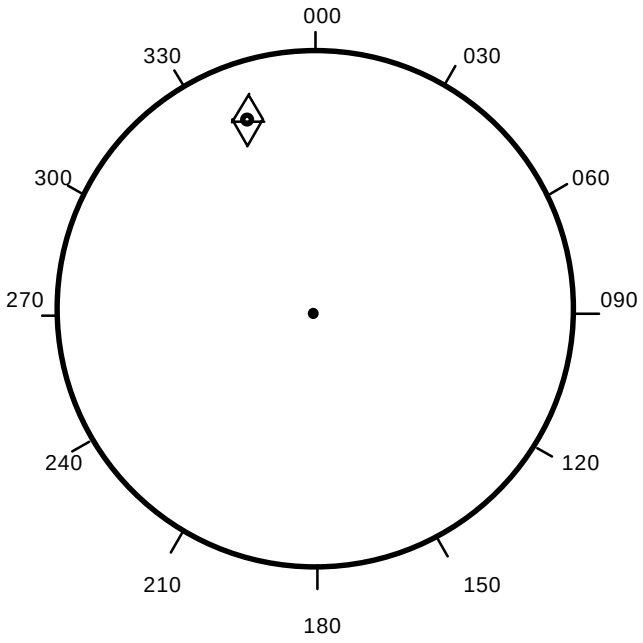
C.2.8 Symbol 7

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.5.1 of IMO A.823 3.3.5.1 of IEC 60872-1 3.3.5.1 of IEC 60872-2	**7** ARPA ATA	**Target entering guard zone.** *The ARPA*/ATA shall, and the EPA may*, have the capability to warn the observer with a visual and audible signal of any distinguishable target which closes to a range or transits a zone chosen by the observer. The target causing the warning* shall *be clearly indicated on the display.*	A flashing equilateral triangle, apex down, shall be used to mark the target. A guard zone shall consist of continuous lines bounding the area chosen by the operator.
			NOTE 1 – Flashing is at a frequency of about 0,5 Hz to 1 Hz. NOTE 2 – After acknowledgement it is permissible to cease flashing. NOTE 3 – The area chosen by the operator shall be limited in range depth. NOTE 4 – It is permissible to show symbols 4A or 4B together with this symbol.

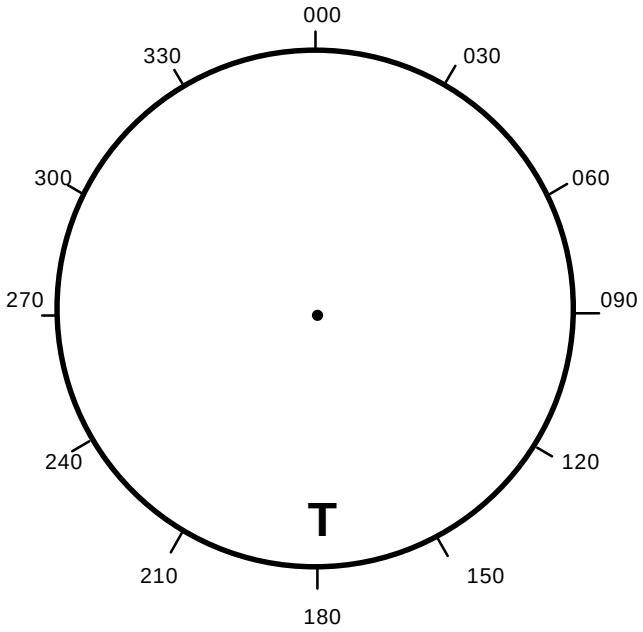
C.2.9 Symbol 8

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.5.2 of IMO A.823 3.3.5.6 of IEC 60872-1 3.3.5.4 of IEC 60872-2 3.3.13.1 of IEC 60872-3	**8** ARPA ATA EPA	**CPA /TCPA warning.** *The ARPA*/ATA shall, and the EPA may*, have the capability to warn the observer with a visual and audible signal of any tracked target which is predicted to close within a minimum range and time chosen by the observer. The target causing the warning* shall *be clearly indicated on the display.*	A flashing equilateral triangle, apex top, shall be used to mark the target. In addition, the target vector may be flashed.
			NOTE 1 – Flashing is at a frequency of about 0,5 Hz to 4 Hz. NOTE 2 – After acknowledgement it is permissible to cease flashing.

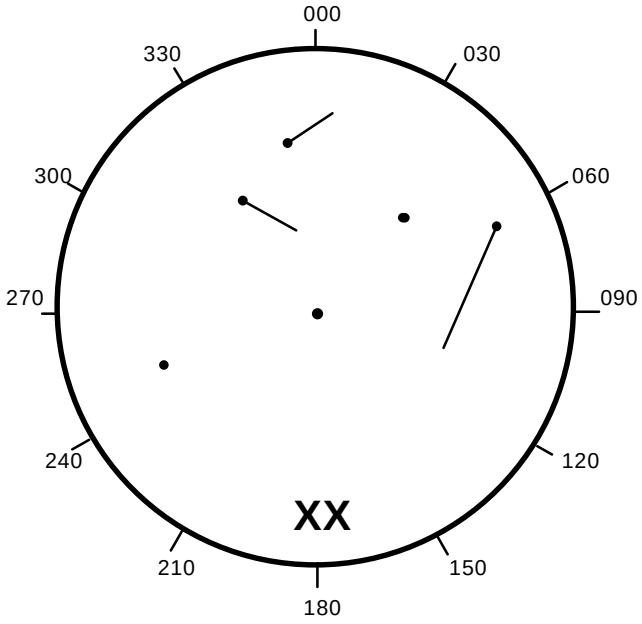
C.2.10 Symbol 9

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.5.3 of IMO A.823 3.3.5.7 of IEC 60872-1 3.3.5.5 of IEC 60872-2	**9** ARPA ATA	**Lost target warning.** *The ARPA/*ATA shall *clearly indicate if a tracked target is lost, other than out of range, and the target's last tracked position* shall *be clearly indicated on the display.*	A diamond shall flash. The diamond shall be formed from two equal triangles (one apex up, the other apex down).
			NOTE 1 – The form of the diamond consists of two equilateral triangles which are used as warning symbols. NOTE 2 – Flashing is at a frequency of about 0,5 Hz to 1 Hz. NOTE 3 – After acknowledgement it is permissible to cease flashing. NOTE 4 – This is to be used in conjunction with symbols 4, 5 and 14.

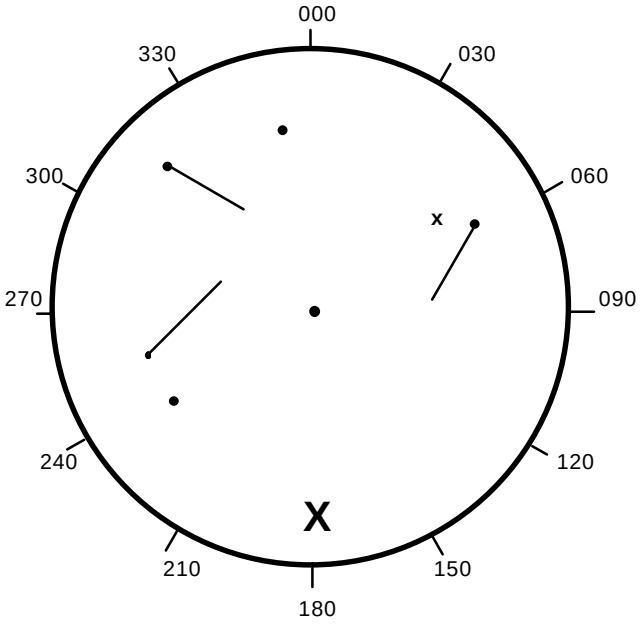
C.2.11 Symbol 10

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.7.1 of IMO A.823 3.3.7.1 of IEC 60872-1	**10** ARPA	**Trial manoeuvre.**	The letter **T**, at the bottom of the display, shall flash.
			NOTE 1 – The letter **T** shall be at least 15 mm high. The width shall be about two-thirds of the height. A letter shall be composed of lines that are not less than 2 mm thick. NOTE 2 – Flashing is at a frequency of about 0,5 Hz to 1 Hz.

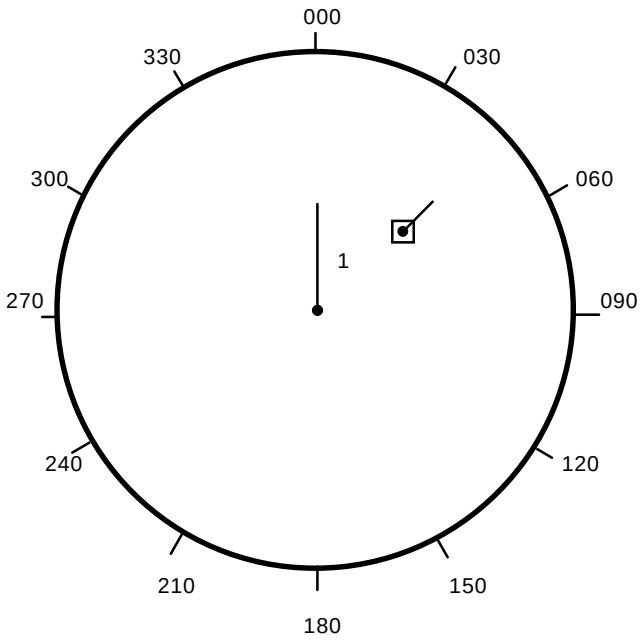
C.2.12 Symbol 11A

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.10.1 of IMO A.823 3.3.10.1 of IEC 60872-1 3.3.9.1 of IEC 60872-2	**11A** ARPA ATA	**Test targets on a synthetic picture.** *Test programmes* shall *be available so that the overall performance of ARPA*/ATA *can be assured periodically against a known solution.*	The letters **XX** at the bottom of the display shall flash. During a trial manoeuvre the letters **XXT** shall appear at the bottom of the display.
			NOTE 1 – The letters **XX**, or **XXT**, at the bottom shall be at least 15 mm high. The width shall be about two-thirds of the height. A letter shall be composed of lines that are not less than 2 mm in thickness. NOTE 2 – If an automatic test programme is incorporated, the indication of an ARPA system failure shall be given. NOTE 3 – Flashing is at a frequency of about 0,5 Hz to 1 Hz.

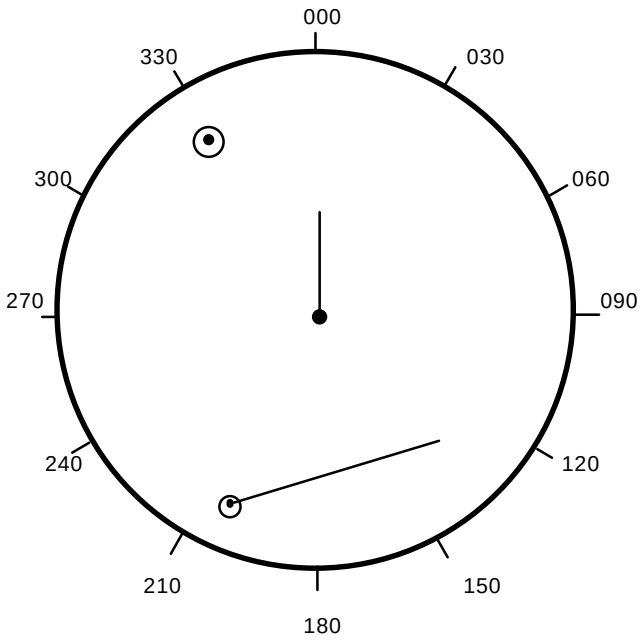
C.2.13 Symbol 11B

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.10 of IMO A.823 3.3.10.1 of IEC 60872-1 3.3.9.1 of IEC 60872-2	**11B** ARPA ATA	**Test target superimposed on a live picture.** *Test programmes* shall *be available so that the overall performance of ARPA*/ATA *can be assured periodically against a known solution.*	The letter **X** at the bottom of the display and on the test target shall flash. During a trial manoeuvre the letters **XT** shall appear at the bottom of the display.
			NOTE 1 – The letter **X**, or **XT**, at the bottom shall be at least 15 mm high. The width shall be about two-thirds of the height. A letter shall be composed of lines that are not less than 2 mm in thickness. NOTE 2 – Test targets superimposed on a live picture shall be indicated by a flashing **x** adjacent to the test target. The size of the **x** shall be as specified in paragraph C.1.2 NOTE 3 – If an automatic test programme is incorporated, the indication of an ARPA system failure shall be given. NOTE 4 – Flashing is at a frequency of about 0,5 Hz to 1 Hz.

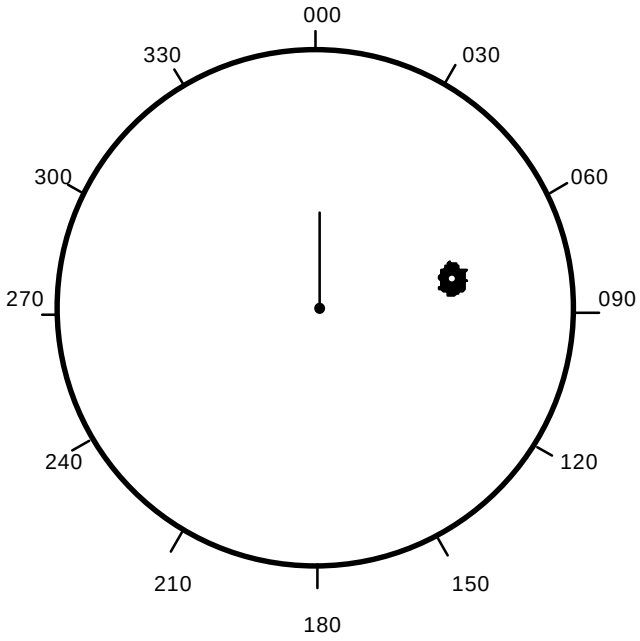
C.2.14 Symbol 12

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.6.1 of IMO A.823 3.3.6.1 of IEC 60872-1 3.3.6.1 of IEC 60872-2 3.3.10 of IEC 60872-3	**12** ARPA ATA EPA	**Data requirements.** *Targets selected* shall *be marked with the relevant symbol on the radar display. If data is required for more than one target at the same time each symbol* shall *be separately identified, for example with a number adjacent to the symbol.*	A square is to be used as a symbol to mark the data reading target.
			

C.2.15 Symbol 13

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6.5 of IMO A.823 3.3.4.6.5 of IEC 60872-1 3.3.4.6.5 of IEC 60872-2	**13** ARPA ATA	**Ground referencing.** *If stationary targets are being used for ground referencing, this fact* shall *be indicated by the relevant symbol. In this mode, relative vectors including those of the targets used for ground referencing* shall *be displayed when requested.*	Symbols 3, 4 and 9 annotated with the letter R and if more than one target is used, with R1, R2, R3, etc.
			

C.2.16 Symbol 14

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.3.3.3 of IEC 60872-1	**14** ARPA	**Tracked target without vector or graphic.** Targets being tracked on which the operator does not require a vector (symbol 4) or graphic (symbol 5), because it is outside operator interest limits (range, CPA, TCPA)	A clearly visible dot (such as negative video or different colour) over the target which is distinguishable from symbols 4A, 4B and 5.
			NOTE – If the tracked target is lost, symbol 9 shall be shown.

Annex D
(normative)

High-speed craft – radar tracking scenarios

D.1 Scope

The high-speed tracking scenarios are in addition to the four ARPA scenarios. The additional tests simulate own ship travelling at up to 70 knots, whilst tracking up to 10 targets with a speed of up to 70 knots. High rate of turn, own ship and target manoeuvring, target swap, multiple targets on a bearing, acceleration and fading are all simulated.

The simulator assumes a 3° antenna horizontal beam width, an antenna rotation rate of 40 rpm, a pulse length of 1 μs at 750 Hz pulse repetition frequency and operation in a noise free environment.

The display is set to the 12 nautical mile range scale, north up, true vectors (6 min) and relative motion mode true trails.

D.2 High-speed craft scenarios

D.2.1 Scenario 1

D.2.1.1 Method of test

This scenario simulates own ship, while on an initial heading of 000° and stationary, turning through ±180°, at a turn rate of 20°/s. Two targets are acquired and tracked for at least 2 min before own ship executes a turn to starboard (scenario 1a). The test is repeated with own ship turning to port (scenario 1b).

Initial target data is as follows:

Target	1	2
Range (nautical miles)	8	5
True bearing (°)	22,5	135
True course (°)	135	270
True speed (knots)	30	20

D.2.1.2 Result required

During both scenarios, the targets shall be tracked continuously. The tracking accuracy 1,5 min after the turns have been completed, shall be within ±5 % or ±1 knot in speed (whichever is the greater) and ±3° in course.

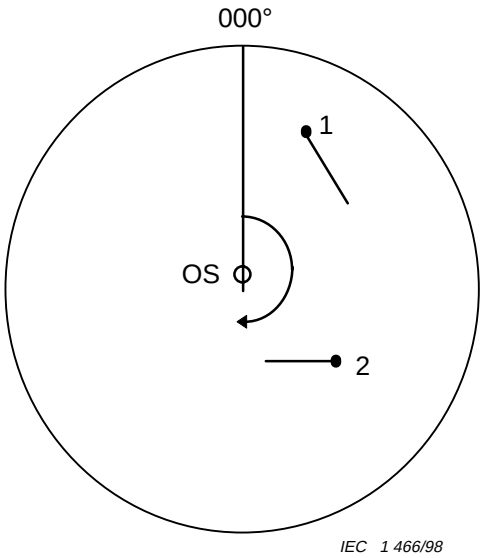


Figure D.1a

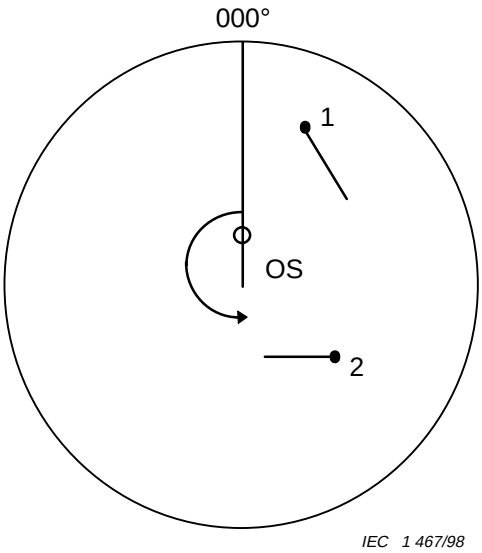


Figure D.1b

NOTE – OS is own ship

D.2.2 Scenario 2

D.2.2.1 Method of test

This scenario simulates own ship, with initial heading of 000° and a speed of 45 knots, executing a turn of ±180° at a turn rate of 10°/s. Three targets are acquired and tracked for at least 2 min before own ship and target 3 both turn to starboard at 10°/s (scenario 2a). Own ship turns 180°, while target 3 turns 90°. The test is repeated with own ship and target 3 turning to port (scenario 2b).

Initial target data is as follows:

Target	1	2	3
Range (nautical miles)	5	3	8
True bearing (°)	22,5	340	180
True course (°)	180	–	000
True speed (knots)	45	0	30

D.2.2.2 Result required

During both scenarios, the targets shall be tracked continuously. The tracking accuracy 1,5 min after the turns have been completed, shall be within ±5 % or ±1 knot in speed (whichever is the greater) and ±3° in course.

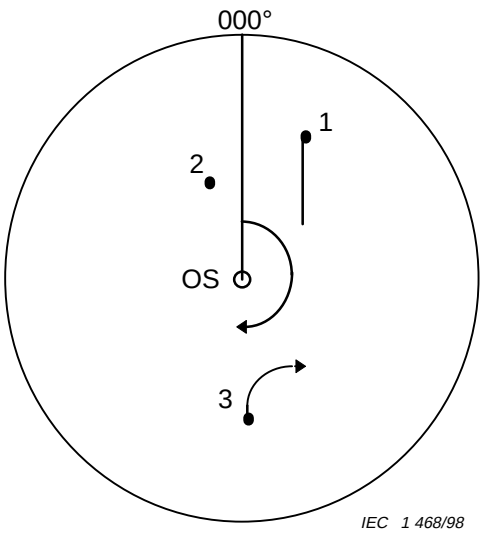


Figure D.2a

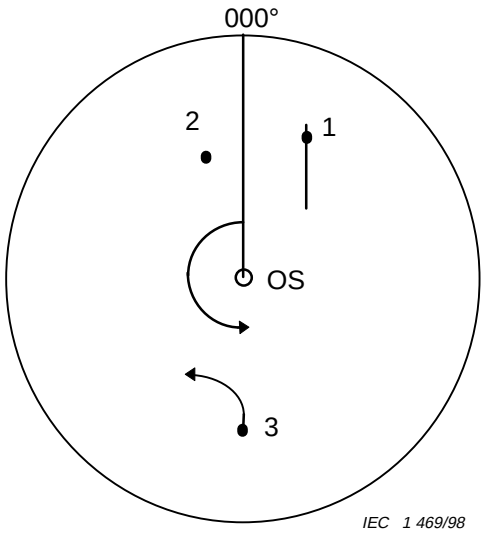


Figure D.2b

NOTE – OS is own ship

D.2.3 Scenario 3

D.2.3.1 Method of test

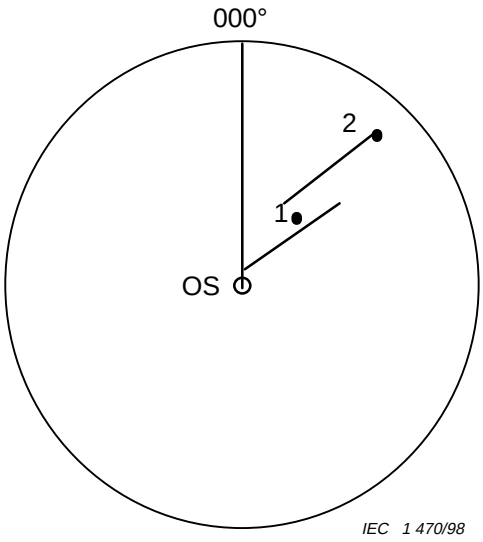
This scenario simulates a fast target approaching and passing own ship. Own ship travels on a heading of 45° at a speed of 70 knots on a straight course. A target travels at 70 knots on a reciprocal course. Own ship and the target's tracks are separated by a buoy. The buoy has a 0,5 nautical mile CPA to both own ship and the target. The high speed target and the buoy are acquired immediately after the scenario has begun. The scenario shall run for at least 10 min after acquisition.

Initial target data is as follows:

Target	1	2
Range (nautical miles)	5	10
True bearing (°)	040	040
True course (°)	–	225
True speed (knots)	0	70

D.2.3.2 Result required

The high-speed target and the buoy shall be tracked continuously and without target swop. The target data shall be checked 2 min after acquisition and again 5 min later. The tracking shall be within ±5 % or ±1 knot in speed (whichever is the greater) and ±3° in course.



NOTE – OS is own ship

Figure D.3

D.2.4 Scenario 4

D.2.4.1 Method of test

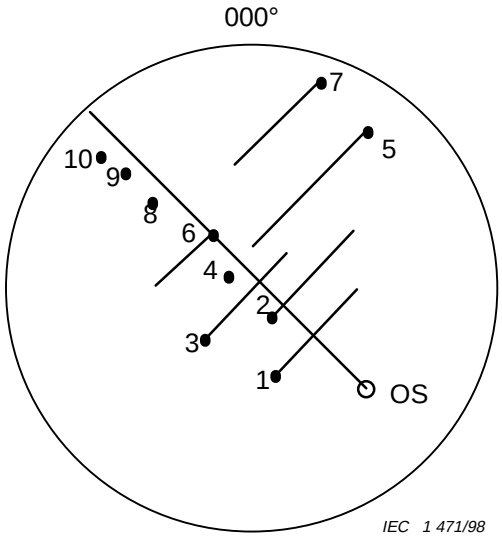
This scenario simulates a typical collision situation, with ten ships being tracked and one with zero CPA. During the scenario, four targets are tracked on a single bearing, tangential targets are tracked, own ship changes speed and performance is tested with a fading target.

Own ship is off-centred 50 % towards a bearing of 135°. The heading is 315° true. Own ship speed is initially 60 knots, decreasing linearly to 40 knots after 7 min [1)]. Target 7 has a zero CPA before the speed change. Targets 4, 8, 9 and 10 are stationary, with targets 8, 9, and 10 on a similar bearing. Crossing targets then provide the fourth target on a bearing. The scenario shall run for 15 min from the start. All targets shall be acquired within the first minute.

1) The deceleration from 60 to 40 knots shall be at a rate of 1 knot/s.

Initial target data is as follows:

Target	1	2	3	4	5	6	7	8	9	10
Range (nautical miles)	4,47	5,10	6,71	7,07	12,0	11,0	14,4	13,0	14,0	15,0
True bearing (°)	288	304	288	307	357	315	349	313	313	313
True course (°)	045	045	045	–	225	225	225	–	–	–
True speed (knots)	20	30	40	0	60	20	40	–	–	–
Target 6 – fades and has only 50 % paint [1)]										



NOTE – OS is own ship

Figure D.4

Own ship reduces speed at 7 min from 60 knots to 40 knots. Hence CPA and TCPA changes.

D.2.4.2 Result required

All targets shall be tracked continuously and without target swop. Target course, speed, CPA and TCPA shall be monitored at T_o + 3 min, T_o + 6 min, T_o + 11 min and T_o + 14 min. Monitored errors in target data shall be within ±5 % or ±1 knot for speed (whichever is greater), ±3° for course, ±0,1 nautical miles for CPA and ±1 min for TCPA of calculated values.

1) Targets only every other scan.

Annex E
(normative)

Guidelines for the display of navigational information on radar by means of radar maps

E.1 Definitions

E.1.1 Guidelines

This guideline, as far as possible, quantifies solutions for type approval, but does not exclude the application of alternative solutions provided the functional requirements are met. This guideline will be amended when technical developments or operational experience form a basis for a better solution.

E.1.2 Radar map

A radar map is a combination of map lines and symbols whereby the user can define and input the navigation, route planning and monitoring data on the radar equipment.

E.2 Application

E.2.1 Radar maps may be displayed in such a way that the primary radar and electronic plotting (ARPA, ATA and EPA) information is clearly visible.

E.2.2 Radar maps may be displayed on multi-colour and monochrome displays.

E.2.3 Radar maps displayed on multi-colour displays shall conform as far as is practicable to the following principles:

E.2.3.1 The map information displayed is limited to items in E.4.

E.2.3.2 The map symbols used to display the information in E.2.3.1 are similar in shape to those defined in appendix 2 of IHO S-52 figure 1 – items 1 to 40.

E.2.3.3 The map colours used to display the information in E.2.3.1 are listed in E.4. Where these are not automatically selected, the operating manual shall clearly show how this is to be achieved.

E.2.4 Radar maps displayed on monochrome displays shall conform as far as is practicable to the following principles:

E.2.4.1 Those in E.2.3.1 and E.2.3.2.

E.2.4.2 Other means than colour may be used to differentiate lines.

E.2.5 Radar map colour fill may be displayed where appropriate in such a way that the primary radar and electronic plotting information is clearly visible.

E.3 Navigation symbols for use with radar maps

E.3.1 Navigation symbols for use with radar maps shall be similar to those used for the radar with chart facilities (see E.5).

E.3.2 The number of types of navigational symbols used shall be limited to provide simple operation. The minimum types of symbols normally available for use are symbols 1.1, 1.2, 5, 6, 11, 12 and 13, but the use of any symbols 1 to 16 is permitted.

E.3.3 The shape of these navigational symbols used on multi-colour and monochrome displays shall be similar to those used for the radar with chart facilities.

E.3.4 The use and selection of colours for these symbols and other non-standard navigational symbols not in E.5 is optional. For planned routes, red, as used in the ECDIS, is recommended.

E.4 Features and colours to be used for radar maps

Mapping feature	Colour to be used
Coastline (high water)	White
Own ship safety contour	Grey
Indication of isolated underwater dangers of depths less than the safety contour which lie within the safe water defined by the safety contour	Magenta
Indication of isolated dangers which lie within the safe water defined by the safety contour such as bridges, overhead wires, etc.	Magenta or grey
Buoys and beacons whether or not these are being used as aids to navigation	Red or green
Traffic routeing systems	Magenta
Prohibited and restricted areas	Magenta
Boundaries of fairways and channels	Grey
Radar background	Black or blue

E.4.1 When the “own ship safety contour” feature is used, the dangerous side shall be clearly indicated, for example, by colour fill, hatching, double lines, broken line, etc., on the dangerous side.

E.5 Navigational symbols for radar with chart facilities (also used on radar maps)

E.5.1 Introduction

This provides a definition of the navigational symbols to be used on the colour radar (that can also be used on radar maps). These symbols are for use to display navigational information on radars displaying selected parts of the ECDIS SENC.

It has been developed to harmonize the navigational and chart symbols used on the radar with those used on the ECDIS (see IEC 61174) and for electronic plotting (see IEC 60872-2) on high-speed craft (HSC).

E.5.2 Symbols

The following provides information to aid the understanding of the details of the symbols and format:

.1 Symbols 1 – 7 cover route monitoring and symbols 8 – 16 provide route planning facilities.

.2 Symbols 5 and 6 provide an emulation of paper chart position plotting facilities.

.3 The facilities provided by symbols 13 and 14 may be replaced by more direct means.

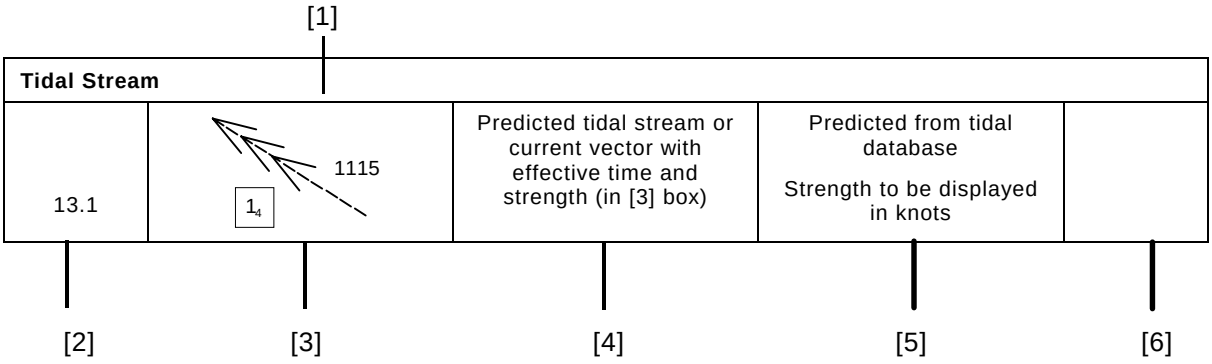
.4 Target reporting symbols 2.3, 2.4 and 2.5 shall be in a different colour to target plotting symbols 2.6, 2.7 and 2.8. The display of symbols 2.3, 2.4 and 2.5 are optional, but if used shall be capable of being removed from the display.

.5 Additional symbols may be used for other navigational purposes provided that they do not conflict with the ECDIS navigational and chart symbols or radar electronic plotting symbols.

.6 Alphanumeric labels and symbols are to be of a size such that they are clearly legible.

.7 All navigational symbol sizes relate to the minimum ECDIS screen size of 270 mm (see IEC 61174) and may be appropriately scaled for the different radar screen sizes.

E.5.2.1 Symbol definition format



[1] Section

[2] Sub-section number

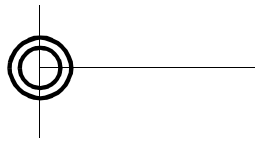
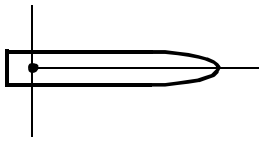
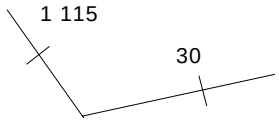
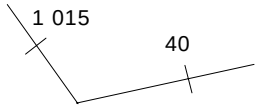
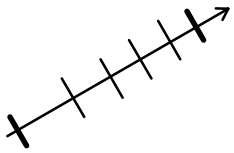
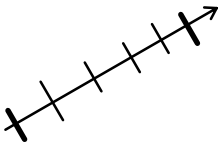
[3] Symbol to be used on radar with chart facilities

[4] Description in the English language

[5] Notes

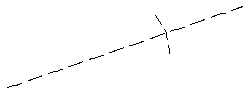
[6] The radar with chart facilities does not use this field, but it is used by ECDIS for the colour token

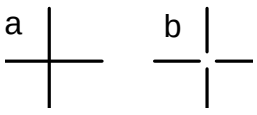
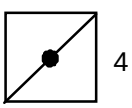
E.5.2.2 Route monitoring and route planning symbols

Route monitoring – position lines				
1	a  b 	Own ship	The use of symbol 1 – a/b on radar systems is optional. Symbol 'b' must be scaled to indicate length and beam of the vessel and may be representative of own ship's outline. In either case the largest dimension of the symbol shall not be less than 6 mm. Heading and beam lines are optional. If displayed, heading line extends to chart window edge and beam line extends 10 mm (optionally extendable).	ships
1.1		Past track with time marks for primary track	Time mark intervals may be set by the operator. Time to be HHMM or MM.	pstrk
1.2		Past track with time marks for secondary track	Time mark intervals may be set by the operator. Time to be HHMM or MM.	sytrk
2.1		Own ship's vector for course and speed made good (i.e. over ground)	Marks at 1 min intervals. Filled mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships
2.2		Own ship's vector for course and speed through water	Marks at 1 min intervals. Filled mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships

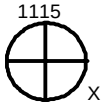
Target tracking – AIS reported targets				
2.3		"Active" AIS target	Centre is pivot point. Orientated with heading. Heading line is 25 mm long.	arpat
2.4		"Sleeping" AIS target To avoid confusion with AIS target with no associated vector.	Centre is pivot point. Orientated with heading. "Sleeping" AIS has no vector.	arpat
2.5		Vector for course and speed made good (i.e. over ground).	Marks at 1 min intervals. Filled mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	arpat

Electronic plotting video symbols – IEC 60872				
2.6	See IEC 60872	Plotted target – Course and speed vector IEC 60872 video symbol 4A		arpat
2.7	See IEC 60872	Vector for course and speed made good (i.e. over ground). IEC 60872 video symbol 4B	Marks at 1 min intervals. Thick mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships
2.8	See IEC 60872	Vector for course and speed through water. IEC 60872 video symbol 4B	Marks at 1 min intervals. Thick mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships

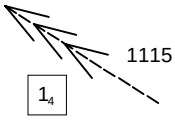
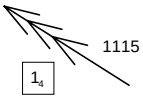
Route monitoring – position lines				
3		Variable range marker and/or electronic bearing line	The VRM and EBL may be ship centred or freely movable. A small filled circle indicates the EBL origin when offset. An EBL is to be an interrupted line with long dashes. The first VRM is to be a long dashed ring. The second VRM is to be a long dashed ring distinguished by a different line style of dashes.	ninfo

Route monitoring – general				
4		Cursor	The cursor crossover point may be left blank as shown in 'b'. In either case the largest dimension of the symbol shall not be less than 10 mm.	cursr
5		Event	The symbol may be numbered and have additional text such as time/"MOB" associated with it.	ninfo
All own ship references relate to the conning position				

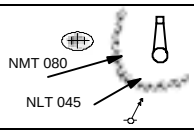
Route monitoring – calculated positions (indicated by thickened circle)				
5.1		Dead reckoning position and time (DR)		ninfo
5.2		Estimated position and time (EP)		ninfo

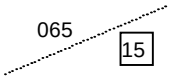
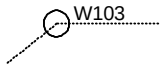
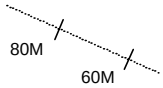
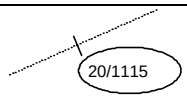
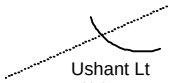
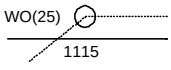
Route monitoring – position fixes				
6		Fix and time	X indicates method of fix	ninfo
V Visual A Astronomical R Radar D Decca G GPS		Gl Glonass L Loran/Tchaika M MFDF O Omega T Transit/Tsikada		
A differential system is denoted by a prefix ‘d’, e.g. dG, dO, etc.				

Route monitoring – position lines				
7	0705	Position line and time		ninfo
8	0705 TPL	Transferred position line and time		ninfo

Route planning – tidal stream				
8.1		Predicted tidal stream or current vector with effective time and strength (in box)	Predicted from tidal database	ninfo
8.2		Actual tidal stream or current vector with effective time and strength (in box)	Measured from available sensor information. Strength to be displayed in knots	ninfo

Route planning – danger highlight				
9		Danger highlight	Transparent red danger arcs drawn by the operator. May be flashing. Examples shown are wrecks. All underlying chart data shall be clearly visible.	dnghl

Route planning – clearing lines				
10		Clearing line NMT = Not more than NLT = Not less than	Example is shown for clearing a wreck and north mark buoy	ninfo

Route monitoring – calculated positions (indicated by thickened circle)				
11		Planned course and speed to make good. Speed is shown in box.		plrte/aplrt
12		Waypoint (Used in conjunction with symbols 14 and 19)	Waypoints may be labelled. Label shall be unique. First character shall be a letter but not 'O', 'I' or 'Z'	plrte/aplrt
13		Distance to run	May be replaced by more direct means	plrte/aplrt
14		Planned position with date and time	May be replaced by more direct means	plrte/aplrt
15		Visual limits of lights, arc to shore rising/dipping range	Inscriptions are optional NOTE – Not shown on alternate route	ninfo
16		Estimated position and time (EP). Position and time of "wheel-over"*	Minimum symbol to indicate "wheel-over" line (annotated 'WO'), other data can be optionally provided. NOTE – Not shown on alternate route	ninfo

* Wheel-over is defined as a geographic position along the ship's intended track where, taking into account the dynamics of the ship and the prevailing environmental conditions, the mariner considers it necessary to put the wheel-over to achieve the intended new track.

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Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: *(e.g. 60601-1-1)*

.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ❑
librarian ❑
researcher ❑
design engineer ❑
safety engineer ❑
testing engineer ❑
marketing specialist ❑
other.....

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ❑
consultant ❑
government ❑
test/certification facility ❑
public utility ❑
education ❑
military ❑
other.....

Q4 This standard will be used for: *(tick all that apply)*

general reference ❑
product research ❑
product design/development ❑
specifications ❑
tenders ❑
quality assessment ❑
certification ❑
technical documentation ❑
thesis ❑
manufacturing ❑
other.....

Q5 This standard meets my needs: *(tick one)*

not at all ❑
nearly ❑
fairly well ❑
exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ❑
standard is incomplete ❑
standard is too academic ❑
standard is too superficial ❑
title is misleading ❑
I made the wrong choice ❑
other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness.....
quality of writing.....
technical contents.....
logic of arrangement of contents .....
tables, charts, graphs, figures.....
other .....

Q8 I read/use the: *(tick one)*

French text only ❑
English text only ❑
both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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