

INTERNATIONAL STANDARD

IEC
60936-1

Edition 1.1

2002-08

Edition 1:1999 consolidated with amendment 1:2002

Maritime navigation and radiocommunication equipment and systems – Radar –

Part 1: Shipborne radar – Performance requirements – Methods of testing and required test results

*Matériels et systèmes de navigation et
de radiocommunication maritimes – Radars –*

*Partie 1:
Radars de navire – Exigences de fonctionnement –
Méthodes d'essai et résultats d'essai exigés*



Reference number
IEC 60936-1:1999(E)+A1:2002

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/catlg-e.htm) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/JP.htm) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch
Tel: +41 22 919 02 11
Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC
60936-1

Edition 1.1

2002-08

Edition 1:1999 consolidated with amendment 1:2002

Maritime navigation and radiocommunication equipment and systems – Radar –

Part 1: Shipborne radar – Performance requirements – Methods of testing and required test results

*Matériels et systèmes de navigation et
de radiocommunication maritimes – Radars –*

*Partie 1:
Radars de navire – Exigences de fonctionnement –
Méthodes d'essai et résultats d'essai exigés*

© IEC 2002 Droits de reproduction réservés — Copyright - all rights reserved

Aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'éditeur.

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE

CR

*Pour prix, voir catalogue en vigueur
For price, see current catalogue*

CONTENTS

FOREWORD	4
1 Scope	6
2 Normative references.....	6
3 Performance requirements	7
3.1 (A4/1) Introduction.....	8
3.2 (A4/2) General.....	8
3.3 (A4/3.1) Range performance.....	8
3.4 (A4/3.2) Minimum range	8
3.5 (A4/3.3) Display.....	9
3.6 (A4/3.4) Range measurement.....	10
3.7 (A4/3.5) Heading indication (heading line).....	10
3.8 (A4/3.6) Bearing measurement.....	11
3.9 (A4/3.7) Discrimination	12
3.10 (A4/3.8) Roll or pitch	12
3.11 (A4/3.9) Antenna scan.....	12
3.12 (A4/3.10) Azimuth stabilisation.....	12
3.13 (A4/3.11) Performance monitoring.....	13
3.14 (A4/3.12) Anti-clutter devices.....	13
3.15 (A4/3.13) Operation.....	13
3.16 (A4/3.14) Operation with radar beacons and SARTs.....	14
3.17 (A4/3.15) Display modes	14
3.18 (A4/3.16) Interference from magnetic fields.....	15
3.19 (A4/3.17) Radar installation.....	15
3.20 (A4/3.18) Failure warnings (alarms) and status indications	15
3.21 (A4/4) Multiple radar installations	16
3.22 (A4/5) Interface	16
3.23 (A4/6) Navigational information.....	16
3.24 (A4/7) Plotting.....	17
3.25 Standard names – abbreviations and symbols	17
3.26 (A4/8) Ergonomics.....	17
3.27 Safety precautions.....	18
4 Methods of testing and required test results.....	18
4.1 General conditions of measurement and definitions	19
4.2 Power supply, cabling distances and technical information	20
4.3 (3.3) Range performance.....	20
4.4 (3.4) Minimum range	21
4.5 (3.5) Display.....	21
4.6 (3.6) Range measurement	22
4.7 (3.7) Heading indicator (heading line).....	22
4.8 (3.8) Bearing measurement	22
4.9 (3.9) Discrimination	23

4.10 (3.10) Roll and pitch performance.....	25
4.11 (3.11) Antenna scan	25
4.12 (3.12) Azimuth stabilisation	26
4.13 (3.13.1) Performance monitor check	26
4.14 (3.14) Anti-clutter devices.....	27
4.15 (3.15) Operation	27
4.16 (3.16) Operation with radar beacons and SARTs	28
4.17 (3.17) Display modes.....	28
4.18 (3.18) Interference from external magnetic fields	28
4.19 (3.19) Radar installation	29
4.20 (3.20) Failure warnings (alarms) and status indications	29
4.21 (3.21) Multiple radar installations.....	29
4.22 (3.22) Interface.....	29
4.23 (3.23) Navigational information.....	30
4.24 (3.24) Plotting.....	30
4.25 (3.25) Standard names - abbreviations and symbols.....	30
4.26 (3.26) Ergonomics	31
4.27 (3.27) Safety precautions	31
4.28 (3) Spurious emissions	31
4.29 (3.9.3) Antenna horizontal radiation pattern.....	31
Annex A (normative) Method for relating the radar cross-section (echoing area) of one radar target with another	33
Annex B (normative) Standard names, abbreviations and symbols for control functions on marine navigational radar equipment.....	38
Annex C (normative) Guidelines for the display of navigational information on radar by means of radar maps.....	50
Annex D (normative) Unwanted emissions of radar systems – Methods of measurement and required results	58
Annex E (informative) Performance checks during environmental testing	64
Figure A.1 – Enhancement by reflection (dB) over free-space – Antenna height 15 m – Frequency 9 410 MHz	36
Figure A.2 – Enhancement by reflection (dB) over free-space – Antenna height 15 m – Frequency 3 050 MHz.....	37
Figure D.1 – B_{-40} falls within the allocated band	62
Figure D.2 – B_{-40} falls outside the allocated band	63
Table 1 – Effective side-lobes	24
Table 2 – Main beam.....	32
Table D.1 – Measurement frequency ranges	59

INTERNATIONAL ELECTROTECHNICAL COMMISSION

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR –

Part 1: Shipborne radar – Performance requirements – 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 specifications, 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 60936-1 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The IEC 60936 series, of which this is part 1, replaces IEC 60936 published in 1988, in order to reflect the new requirements of the International Maritime Organization (IMO). This part of the series contains some of the IMO specific requirements.

This consolidated version of IEC 60936-1 consists of the first edition (1999) [documents 80/235/FDIS and 80/249/RVD] and its amendment 1 (2002) [documents 80/341/FDIS and 80/346/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

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

Annex E is for information only.

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2003. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

NOTE Annex C.5.2.2 of this standard contains symbols for the display of AIS-targets. Due to the fact that AIS is a new navigation system, the process of the evaluation of different proposals for the presentation of AIS information on the bridge is still ongoing. A final decision about AIS presentation can only be drawn after functional and operational evaluation of related research projects. In this respect the symbols for AIS targets given in Annex C.5.2.2 No. 2.3, 2.4, 2.5 are provisional and subject of future decision.

WITHDRAWN

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

IEC 60936-1:1999

<https://standards.iteh.ai/catalog/standards/iec/57490c91-ea40-40cf-badd-b42d7f387784/iec-60936-1-1999>

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR –

Part 1: Shipborne radar – Performance requirements – Methods of testing and required test results

1 Scope

This International Standard specifies the minimum performance requirements, methods of testing and required test results for conformance to performance standards not inferior to those required by IMO resolution MSC.64 (67), Annex 4. In addition, it takes account of IMO resolution A.694 and is associated with IEC 60945. When a requirement of this standard is different from that of IEC 60945, the requirement in this standard shall take precedence.

This standard does not include the optional performance requirements for superimposition of selected parts of SENC information. These are specified in IEC 60936-3.

All text in this standard whose wording is identical to that in IMO resolution MSC.64 (67), Annex 4 is printed in *italics*, and the resolution (abbreviated to – A4) and paragraph numbers are indicated in brackets, for example (A4/3.3).

2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this part of IEC 60936. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, 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. For undated references, the latest edition of the normative documents referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

IEC 60872-2:1999, *Maritime navigation and radiocommunication equipment and systems – Radar plotting – Part 2: Automatic tracking aids (ATA) – Methods of testing and required test results*

IEC 60872-3:2000, *Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 3: Electronic plotting aid (EPA) – Performance requirements – Methods of testing and required test results*

IEC 60936-3:2002, *Maritime navigation and radiocommunication equipment and systems – Radar – Part 3: Radar with chart facilities – Performance requirements – Methods of testing and required test results*

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

IEC 61023:1999, *Maritime navigation and radiocommunication equipment and systems – Marine speed and distance measuring equipment (SDME). Performance requirements – Methods of testing and required test results*

IEC 61162 (all parts), *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 requirements, methods of testing and required test results*

IEC 61209:1999, *Maritime navigation and radiocommunication equipment and systems – Integrated bridge systems (IBS) – Operational and performance requirements, methods of testing and required test results*

IEC 61996:2000, *Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR) – Performance requirements – Methods of testing and required test results*

ISO 9000 (all parts), *Quality management and quality assurance standards*

IMO A.477:1981, *Performance standards for radar equipment*

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

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

IMO A.824:1995, *Performance standards for devices to indicate speed and distance*

IMO A.861:1997, *Performance standards for shipborne voyage data recorders (VDRs)*

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

IMO MSC SN/Circular 197:1997, *Operation of marine radar for SART detection*

IMO:1997, *International Convention for the Safety of Life at Sea (SOLAS) Consolidated edition*

ITU:1997, *Radio Regulations*

ITU-R M.628-3:1994, *Technical characteristics for search and rescue radar transponders*

ITU-R M.824-2:1995, *Technical parameters of radar beacons (RACONS)*

ITU-R M.1177-1:1997, *Techniques for measurement of spurious emissions of radar systems*

IHO S-52 appendix 2:1997, *Colour and symbol specifications for ECDIS*

3 Performance requirements

The radio frequency of operation of the equipment shall at all times be within the limits defined in the ITU Radio Regulations.

At the World Radio Conference in 1997, the ITU modified Appendix S3 of the Radio Regulations to include maximum permitted spurious emission power levels for radiodetermination services. This Appendix S3 references ITU-R M.1177, a recommendation on measurement methods for spurious emissions of radar systems, as guidance for the measurement of the required levels.

ITU-R M.1177 has been used as the basis for the development of annex D, which presents a detailed method of measurement for spurious emissions of shipborne radar systems.

3.1 (A4/1) Introduction

In addition to the general requirements contained in resolution A.694, all radar installations shall comply with the following minimum requirements.

3.2 (A4/2) General

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

3.2.2 Quality assurance

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

3.3 (A4/3.1) Range performance

The operational requirement under normal propagation conditions, when the radar antenna is mounted at a height of 15 m above sea level, is that the equipment shall in the absence of clutter give a clear indication of:

3.3.1 (A4/3.1.1) Coastlines

At 20 nautical miles when the ground rises to 60 m.

At 7 nautical miles when the ground rises to 6 m.

3.3.2 (A4/3.1.2) Surface objects

At 7 nautical miles a ship of 5 000 GT, whatever her aspect.

At 3 nautical miles a small vessel of 10 m in length.

At 2 nautical miles an object such as a navigational buoy with a radar reflector height of 3,5 m having an effective echoing area of approximately 10 m².

3.4 (A4/3.2) Minimum range

The surface objects specified in 3.3.2 shall be clearly displayed from a minimum horizontal range of 50 m from the antenna position up to a range of 1 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 (A4/3.3) Display

3.5.1 (A4/3.3.1) The equipment shall provide, without external magnification, a daylight display with a minimum effective diameter within the bearing scale of not less than:

3.5.1.1 (A4/3.3.1.1) 180 mm on ships of 150 GT and more but less than 1 000 GT;

3.5.1.2 (A4/3.3.1.2) 250 mm on ships of 1 000 GT and more but less than 10 000 GT;

3.5.1.3 (A4/3.3.1.3) 340 mm on ships of 10 000 GT and upwards.

3.5.2 (A4/3.3.2) The equipment shall provide the following set of range scales of display: 0,25, 0,5, 0,75, 1,5, 3, 6, 12 and 24 nautical miles.

3.5.3 (A4/3.3.3) Additional larger and smaller range scales may be provided. These additional range scales shall be either smaller than 0,25 nautical miles or greater than 24 nautical miles.

3.5.4 (A4/3.3.4) The range scale displayed and the distance between range rings shall be clearly indicated at all times.

3.5.5 (A4/3.3.5) 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.

3.5.6 (A4/3.3.6) The origin of the range scale (radar video) shall start at own ship, be linear and shall not be delayed.

3.5.6.1 Facilities may be provided to adjust the displayed radar origin to compensate for antenna offsets (e.g. to the conning position). If used, a clear indication shall be permanently displayed on the screen.

3.5.7 (A4/3.3.7) Multi-colour displays are permitted but the following requirements shall be met:

3.5.7.1 (A4/3.3.7.1) Target echoes shall be displayed by means of the same basic colours and the echo strength shall not be displayed in different colours.

3.5.7.2 (A4/3.3.7.2) Additional information may be shown in different colours.

3.5.7.3 Day and night colours shall be provided.

3.5.8 (A4/3.3.8) The radar picture and information shall be readable under all ambient light conditions. There shall be a means of adjusting monitor brilliance. If a light shield is necessary to facilitate operation of the display in high ambient light levels, then means shall be provided for its ready attachment and removal.

3.5.9 (A4/3.3.9, 3.3.10) Radar with "chart" facilities

These IMO requirements address options that are not mandatory. They are included in IEC 60936-3.

3.5.10 (A4/3.3.11) Frequency band

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

3.6 (A4/3.4) Range measurement

3.6.1 (A4/3.4.1) *Electronic fixed range rings equally spaced from the origin shall be provided for range measurements as follows:*

3.6.1.1 (A4/3.4.1.1) *on the range scale 0,25, 0,5, 0,75 nautical miles at least two and not more than six range rings shall be provided; on each of the other mandatory range scales six range rings shall be provided; and*

3.6.1.2 (A4/3.4.1.2) *where off-centred facilities have been provided, additional range rings shall be provided at the same range intervals on the mandatory range scales indicated in 3.5.2.*

3.6.1.3 Any number of range rings is allowed on the optional additional range scales.

3.6.2 (A4/3.4.2) *An electronic variable range marker (VRM) in the form of a ring shall be provided with a numeric readout of range. This readout shall not display any other data. Temporary overlaying of the data fields is permitted. 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 separate identifiable readouts shall be provided.*

3.6.3 (A4/3.4.3) *The fixed range rings and the variable range markers 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 greater.*

3.6.4 (A4/3.4.4) *The accuracy of range rings and range markers shall be maintained when the display is off-centred.*

3.6.5 (A4/3.4.5) *The thickness of the fixed range rings shall not be greater than the maximum permissible thickness of the heading line.*

3.6.6 (A4/3.4.6) *On all range scales, it shall be possible to set the variable range marker with the required precision within 5 s in all cases. A range that is set by the user shall not change automatically when the range scale is changed.*

3.6.7 It shall be possible to vary the brilliance of the fixed range rings and the variable range markers, and to remove them independently and completely from the display.

3.7 (A4/3.5) Heading indication (heading line)

3.7.1 (A4/3.5.1) *The heading of the ship shall be indicated by a continuous line on the display with a maximum error of not greater than $\pm 1^\circ$. The thickness of the displayed heading line shall not be greater than $0,5^\circ$ measured at maximum range at the edge of the radar display, when the display is centred. The heading line shall extend from the trace origin (own ship's position) to the edge of the display. A bearing scale shall be provided to give an indication of the heading to within $\pm 1^\circ$ (when the display is centred).*

3.7.2 (A4/3.5.2) *Provision shall be made to switch off the heading indicator (heading line) by a device which cannot be left in the "heading line off" position.*

3.7.3 (A4/3.5.3) *A heading marker (line or mark) shall be displayed on the bearing scale.*

3.8 (A4/3.6) Bearing measurement

3.8.1 (A4/3.6.1) *An electronic bearing line (EBL), shall be provided with a numeric readout of bearing to obtain within 5 s the bearing of any object whose echo appears on the display.*

3.8.2 (A4/3.6.2) *The EBL shall enable the bearing of a target whose echo appears at the edge of the display to be measured with a maximum error of the radar system, excluding sensor errors, of not greater than $\pm 1^\circ$.*

3.8.3 (A4/3.6.3) *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 (A4/3.6.4) *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 (A4/3.6.5) *The rotation of the EBL shall be possible in both directions continuously or in steps of not more than $0,2^\circ$.*

3.8.6 (A4/3.6.6) *The numeric readout of the bearing of the EBL shall be displayed with at least four digits including one after the decimal point. The EBL readout shall not be used to display any other data. Temporary overlaying of the data fields is permitted. There shall be a positive identification of whether the bearing indicated is a relative bearing or a true bearing.*

3.8.7 (A4/3.6.7) *A bearing scale around the edge of the display shall be provided. Linear or non-linear bearing scales may be provided. The radar picture shall be within this scale.*

3.8.8 (A4/3.6.8) *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 (A4/3.6.9) *It shall be possible to measure the bearing relative to the heading line in head-up mode, and true bearings relative to North in the stabilised modes.*

3.8.10 (A4/3.6.11) *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 identifiable readouts shall be provided. These may be centred on own ship or off-centred.*

3.8.12 (A4/3.6.10) *A minimum of two independent lines or sets of parallel index lines shall be provided, independent of, and clearly distinguishable from, an EBL. They shall also be clearly distinguishable from map lines. They shall be fully adjustable independently in both range and bearing, with accuracy defined according to 3.6.3 and 3.8.2.*

3.9 (A4/3.7) Discrimination

3.9.1 (A4/3.7.1) Range

The equipment shall be capable of displaying as separate indications on a range scale of 1,5 nautical miles or less two small similar (10 m²) targets, in the absence of clutter at a range of between 50 % and 100 % of the range scale and on the same bearing, separated by not more than 40 m in range.

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

3.9.2 (A4/3.7.2) Bearing

The equipment shall be capable of displaying as separate indications two small similar (10 m²) targets both situated at the same range between 50 % and 100 % of the 1,5 nautical mile range scale, and separated by not more than 2,5° in bearing.

3.9.3 Side-lobes

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

3.10 (A4/3.8) Roll or pitch

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

3.11 (A4/3.9) Antenna scan

The scan shall be clockwise, continuous and automatic through 360 degrees of azimuth. The antenna rotation rate shall be not less than 20 rpm. 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 blanking shall be clearly indicated on the display.

3.12 (A4/3.10) Azimuth stabilisation

3.12.1 (A4/3.10.1) *Means shall be provided to enable the display to be stabilised in azimuth by a gyrocompass, or its equivalent in performance. The accuracy of alignment with the compass transmission shall be within 0,5 degrees with a compass rotation rate of 2 rpm (12°/s).*

3.12.2 (A4/3.10.2) *The equipment shall operate satisfactorily in the head-up unstabilised mode when the azimuth stabilisation is inoperative. An alarm shall be given within 5 s of this failure.*

3.12.2.1 The display shall revert to head-up mode after approximately 1 min of azimuth stabilisation becoming inoperative.

3.12.2.2 Any functional limitations shall be explained in the documentation.

3.12.3 Head-up (unstabilised) and North-up (stabilised) display modes shall be provided. Additionally, a course-up (stabilised) display mode may be provided, in which case the bearing scale shall be true and referenced to the course when the mode is selected.