

INTERNATIONAL STANDARD

IEC
60872-1

First edition
1998-09

Maritime navigation and radiocommunication equipment and systems – Radar plotting aids –

Part 1: Automatic radar plotting aids (ARPA) – Methods of testing and required test results

*Matériels et systèmes de navigation et de radiocommunication
maritimes – Aides de pointage radar –*

*Partie 1:
Aides de pointage radar automatiques (APRA) – Méthodes
d'essai et résultats d'essai exigés*



Reference number
IEC 60872-1:1998(E)

Numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series.

Consolidated publications

Consolidated versions of some IEC publications including amendments are available. 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.

Validity of this publication

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 the date of the reconfirmation of the publication is available in the IEC catalogue.

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 to be found at the following IEC sources:

- **IEC web site***
- **Catalogue of IEC publications**
Published yearly with regular updates
(On-line catalogue)*
- **IEC Bulletin**
Available both at the IEC web site* and as a printed periodical

Terminology, graphical and letter symbols

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*.

* See web site address on title page.

INTERNATIONAL STANDARD

IEC
60872-1

First edition
1998-09

Maritime navigation and radiocommunication equipment and systems – Radar plotting aids –

Part 1: Automatic radar plotting aids (ARPA) – Methods of testing and required test results

*Matériels et systèmes de navigation et de radiocommunication
maritimes – Aides de pointage radar –*

*Partie 1:
Aides de pointage radar automatiques (APRA) – Méthodes
d'essai et résultats d'essai exigés*

© IEC 1998 — Copyright - all rights reserved

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
Telefax: +41 22 919 0300

3, rue de Varembe Geneva, Switzerland
e-mail: inmail@iec.ch IEC web site <http://www.iec.ch>



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

X

For price, see current catalogue

CONTENTS

	Page
FOREWORD	3
Clause	
1 Scope.....	4
2 Normative references.....	4
3 Performance requirements.....	5
3.1 Introduction	5
3.2 Definitions	6
3.3 Performance standards.....	6
4 Methods of testing and required test results	12
4.1 General	12
4.2 Detection, acquisition, tracking and general facilities.....	12
4.3 Tracking reliability.....	14
4.4 Tracking accuracy	15
4.5 Closing target warning	15
4.6 Collision risk (CPA/TCPA) warning.....	16
4.7 Trial manoeuvre.....	16
4.8 Display	16
4.9 Audible warnings.....	16
4.10 Data requirements	17
4.11 Interfaces.....	17
4.12 Performance test and warnings.....	17
4.13 Sea and ground stabilization	17
4.14 System configuration and quality assurance	17
Annexes	
A Definition of terms to be used in connection with ARPA performance standards.....	18
B Operational scenarios	21
C Sensor errors.....	22
D ARPA testing using simulated targets.....	24
E Electronic plotting video symbols (EPVS)	25

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION
EQUIPMENT AND SYSTEMS –
RADAR PLOTTING AIDS –****Part 1: Automatic radar plotting aids (ARPA) –
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 60872-1 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems. The IEC 60872 series, of which this is part 1, replaces IEC 60872 published in 1987 and amendment 1 (1991) and reflects the new requirements of the International Maritime Organization (IMO).

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

FDIS	Report on voting
80/192/FDIS	80/207/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 issued at a later date.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR PLOTTING AIDS –

Part 1: Automatic radar plotting aids (ARPA) – Methods of testing and required test results

1 Scope

This International Standard specifies the minimum operational and performance requirements, methods of testing and test results for equipment that complies with performance standards not inferior to those adopted by the International Maritime Organization (IMO) in Resolution A.823. In addition, this standard 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 shall take precedence.

All texts of this standard, in which the wording is identical to that in IMO Resolution A.823, 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 60872. 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 60872 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 60872-2, — *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 60936-2, — *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⁾

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

¹⁾ To be published.

IEC 61162: (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

ISO 9000:1987, *Quality management and quality assurance standards*

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

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

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

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

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

IHO S-52:1996, *Specifications for chart content and display aspects of ECDIS*

3 Performance requirements

3.1 (A.823/A.1) Introduction

3.1.1 (A.823/A.1.1) *Automatic radar plotting aids (ARPA) shall, in order to improve the standard of collision avoidance at sea:*

- .1 reduce the workload of observers by enabling them to obtain information about automatically plotted targets so that they can perform as well with several separate targets as they can by manually plotting a single target;*
- .2 provide continuous, accurate and rapid situation evaluation.*

3.1.2 (A.823/A.1.2) *The radar facilities provided by an ARPA display shall comply with the performance standards for radar equipment (Resolution A.477) appropriate to its mode of use.*

3.1.3 (A.823/A.1.3) *In addition to the general requirements contained in resolution A.694, ARPA shall comply with the following minimum performance standards.*

3.1.4 *Where an ARPA display is intended for use as the master display of a complete radar system, the system shall comply with IEC 60936-1. For high speed craft (HSC) ARPA, the relevant clauses of IEC 60936-2 apply.*

3.1.5 *Where an ARPA display is intended for use as a slave display of a complete radar system, it shall comply with the relevant clauses of IEC 60936-1, where applicable to such a display. For high speed craft (HSC) ARPA, the relevant clauses of IEC 60936-2 apply.*

3.1.6 Quality assurance

The ARPA shall be designed, produced and documented by companies complying with ISO 9000, as applicable.

3.2 (A.823/A.2) Definitions

Definitions of terms used in these performance standards are given in annex A.

3.3 (A.823/A.3) Performance standards

3.3.1 (A.823/A.3.1) Detection

Where a separate facility is provided for detection of targets, other than by the radar observer, it shall have a performance not inferior to that which could be obtained by the use of the radar display.

3.3.2 (A.823/A.3.2) Acquisition

3.3.2.1 (A.823/A.3.2.1) *Target acquisition may be manual or automatic for relative speeds up to 100 knots. However there shall always be a facility to provide for manual acquisition with the relevant symbol (see symbol 1 of annex E) and cancellation: ARPA's with automatic acquisition shall have a facility to suppress acquisition in certain areas. On any range scale where acquisition is suppressed over a certain area, the area of acquisition shall be defined and indicated on the display with the relevant symbol (see symbol 2 of annex E).*

3.3.2.2 (A.823/A.3.2.2) *Automatic or manual acquisition shall have a performance not inferior to that which could be obtained by the user of the radar display.*

3.3.3 (A.823/A.3.3) Tracking

3.3.3.1 (A.823/A.3.3.1) *The ARPA shall be able to automatically track, process, simultaneously display and continuously update the information on at least 20 targets, whether automatically or manually acquired. A target being acquired and tracked during the initial stage shall be shown by a symbol (see symbol 3 of annex E) within 3 s. Targets being tracked when tracking is in steady state shall be shown by symbols 4A or 4B and 5 of annex E within 20 scans.*

3.3.3.2 (A.823/A.3.3.2) *If automatic acquisition is provided, description of the criteria of selection of targets for tracking shall be provided to the user. If the ARPA does not track all targets visible on the display, targets which are being tracked shall be clearly indicated with the relevant symbol (see symbols 4A, 4B, or 14 of annex E) on the display. The reliability of tracking shall not be less than that obtainable using manual recordings of successive target positions obtained from the radar display.*

3.3.3.3 *In order to reduce the complexity of vectors and graphics, a facility for the input of operator interest limits may be provided. If targets are being tracked, which do not require vectors or graphics, because they are outside the operator interest limits (e.g. range, CPA, TCPA), they shall be clearly indicated with the relevant symbol (see symbol 14 of annex E). The operating manual shall contain an explanation of the operator interest limits.*

3.3.3.4 (A.823/A.3.3.3) *The ARPA shall continue to track an acquired target which is clearly distinguishable on the display for any 5 out of 10 consecutive scans, provided the target is not subject to target swop.*

3.3.3.5 (A.823/A.3.3.4) *The possibility of tracking errors, including target swop, shall be minimised by ARPA design. A qualitative description of the effects of error sources on the automatic tracking and corresponding errors shall be provided to the user, including the effects of low signal-to-noise and low signal-to-clutter ratios caused by sea returns, rain, snow, low clouds and non-synchronous emissions. Such descriptions shall be in the operating manual.*

3.3.3.6 Automatically applied "target identities" shall not be re-used until, as a minimum, the number assigned equals the maximum number of tracked targets.

3.3.3.7 The ARPA shall continuously track a manoeuvring target.

3.3.3.8 (A.823/A.3.3.5) *The ARPA shall be able to display on request with the relevant symbol (see symbol 6 of annex E) at least four equally time-spaced past positions of any targets being tracked over a period appropriate to the range scale in use. At least on 3, 6 and 12 nautical mile range scales, user-selectable time intervals of 0,5 min, 1,0 min and 2,0 min shall be provided. Facility to switch to other time intervals is permitted. The time scale of the past position plot shall be continuously indicated, together with an indication of whether they are true or relative "past positions". The operating manual shall contain an explanation of what the past position plots represent.*

3.3.4 (A.823/A.3.4) Display

3.3.4.1 (A.823/A.3.4.1) *The display may be a separate or integral part of the ship's radar. However, the ARPA display shall include all the data required to be provided by a radar display in accordance with the performance standards for navigational radar equipment.*

3.3.4.2 (A.823/A.3.4.2) *The design shall be such that any malfunction of ARPA parts producing data additional to information to be produced by the radar as required by the performance standards for navigational equipment shall not affect the integrity of the basic radar presentation.*

The equipment shall be regarded as complying with the above if the design is such that, where practicable, normal performance of the radar system, in accordance with IEC 60936-1, will not be affected by malfunction of any ARPA subsystem that is not an essential part of the radar.

3.3.4.3 (A.823/A.3.4.3) *The ARPA facilities shall be available on at least 3, 6 and 12 mile range scales, and there shall be a positive indication of the range scale in use.*

3.3.4.4 (A.823/A.3.4.4) *ARPA facilities may also be provided on other range scales permitted by resolution A.820 and MSC.64(67), annex 4 and, if provided, shall comply with this standard.*

3.3.4.5 (A.823/A.3.4.5) *The ARPA shall be capable of operating with a relative motion display with "north-up" and "course-up" azimuth stabilisation. In addition, the ARPA may also provide for a true motion display. If true motion is provided, the operator shall be able to select for his display either true or relative motion. There shall be a positive indication of the display mode and orientation in use.*

3.3.4.6 (A.823/A.3.4.6) *The course and speed information generated by the ARPA for acquired targets shall be displayed in a vector or graphic form which clearly indicates the target's predicted motion with the relevant symbols (see symbols 4A or 4B or 5 of annex E). In this regard:*

- .1 ARPA presenting predicted information in vector form only shall have the option of both true and relative vectors. There shall be an indication of the vector mode selected and if true vector mode is selected, the display shall show whether it is sea or ground stabilized;*
- .2 an ARPA which is capable of presenting target course and speed information in graphic form shall also, on request provide the target's true and/or relative vector;*
- .3 vectors displayed shall be time-adjustable;*
- .4 a positive indication of the time-scale of the vector in use shall be given; and*

.5 *if stationary targets are being used for ground referencing then this shall be indicated with the relevant symbols (see symbol 13 of annex E). In this mode, relative vectors including those of the targets used for ground referencing shall be displayed when requested.*

3.3.4.7 (A.823/A.3.4.7) *The ARPA information shall not obscure the visibility of radar targets. The display of ARPA data shall be under the control of the radar observer. It shall be possible to cancel the display of unwanted ARPA data within 3 s of command.*

3.3.4.8 (A.823/A.3.4.8) *Means shall be provided to adjust independently the brilliance of the ARPA data and radar data, including complete extinction of the ARPA data.*

3.3.4.9 (A.823/A.3.4.9) *The method of presentation shall ensure that the ARPA data is clearly visible in general to more than one observer in the conditions of light normally experienced on the bridge of a ship by day and by night. Screening may be provided to shade the display from sunlight but not to the extent that it will impair the observer's ability to maintain a proper look-out. Facilities to adjust the brightness shall be provided.*

3.3.4.10 (A.823/A.3.4.10) *Provisions shall be made to obtain quickly the range and bearing of any object which appears on the ARPA display. The accuracy for this data shall be as stated in IMO MSC.64(67), annex 4.*

3.3.4.11 (A.823/A.3.4.11) *When a target appears on the radar display and, in the case of automatic acquisition, enters within the acquisition area chosen by the observer or, in the case of manual acquisition, has been acquired by the observer, the ARPA shall present in a period of not more than one minute an indication of the target's motion trend, and display within 3 min the target's predicted motion in accordance with 3.3.4.6, 3.3.6, 3.3.8.2 and 3.3.8.3.*

3.3.4.12 (A.823/A.3.4.12) *After changing range scales on which the ARPA facilities are available or on resetting the display, full plotting information shall be displayed within a period of time not exceeding one scan of 360°.*

3.3.5 (A.823/A.3.5) Operational warnings

3.3.5.1 (A.823/A.3.5.1) *The ARPA shall 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 with the relevant symbols (see annex E) on the display.*

A simple guard zone (3.3.5.2) or a combined acquisition and guard zone (3.3.5.4) is required.

3.3.5.2 Guard zone

Where the zone selected is a simple guard zone, a target entering that zone shall initiate an audible and visual alarm, the visual alarm being symbol 7 of annex E. After acknowledgement the symbol may cease to flash and shall remain until outside the zone. The area chosen by the operator shall be narrow (that is of limited range depth) to avoid confusion with symbol 2 of annex E.

3.3.5.3 Acquisition zone

Where the zone selected is an acquisition zone only (3.3.4.11), without the guard zone function, a target transiting this zone will be indicated by symbol 3 of annex E, with no audible alarm. When the tracking criteria has been satisfied, the symbol will change to symbols 4A/B or 5 of annex E.

3.3.5.4 Combined acquisition and guard zone

Where the zone selected is a combined acquisition and guard zone, a target entering that zone shall initiate an audible and visual alarm, the visual alarm being symbol 7 of annex E. When the target is acknowledged, and when the acquisition criteria have been met, this symbol will change to symbols 3 or 4 of annex E, and the audible alarm shall be suppressed. Any warning message will be removed. Symbol 5 of annex E may be used instead of symbol 4 of annex E. If the target was acquired prior to entering a zone, symbols 4 or 5 of annex E shall be shown in addition to the warning symbol 7 of annex E.

3.3.5.5 The methods of operation which are provided shall be clearly described in the manufacturer's operation manual.

3.3.5.6 (A.823/A.3.5.2) *The ARPA shall 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 with the relevant symbols (see symbol 8 of annex E) on the display.*

3.3.5.7 (A.823/A.3.5.3) *The ARPA 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 (see symbol 9 of annex E).*

3.3.5.8 (A.823/A.3.5.4) *It shall be possible for the observer to activate or de-activate the audible warning signal.*

3.3.6 (A.823/A.3.6) Alpha-numeric data requirements

3.3.6.1 (A.823/A.3.6.1) *The observer shall be able to select any tracked target to obtain data. Targets selected shall be marked with the relevant symbol (see symbol 12 of annex E) 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.*

3.3.6.2 (A.823/A.3.6.2) *The following data for each selected target shall be clearly and unambiguously identified and displayed immediately and simultaneously in alpha-numeric form outside the radar area:*

- .1 present range of the target;*
- .2 present bearing of the target;*
- .3 predicted target range at the closest point of approach (CPA);*
- .4 predicted time to CPA (TCPA); if the CPA has passed, it shall be indicated by a TCPA with a negative (–) sign;*
- .5 calculated true course of the target;*
- .6 calculated true speed of the target.*

3.3.6.3 (A.823/A.3.6.3) *The display of 3.3.6.2.5 and 3.3.6.2.6 shall include an identification of whether the data provided is referenced to sea or ground stabilization.*

3.3.6.4 (A.823/A.3.6.4) *When data for several targets is displayed, not less than two items shall be displayed simultaneously for each target selected. If the items of data are displayed in pairs for each target, the groupings shall be 3.3.6.2.1 with 3.3.6.2.2; 3.3.6.2.3 with 3.3.6.2.4; and 3.3.6.2.5 with 3.3.6.2.6.*

3.3.7 (A.823/A.3.7) Trial manoeuvre

3.3.7.1 (A.823/A.3.7.1) *The ARPA shall be capable of graphically simulating the effect on all tracked targets of an own ship manoeuvre with, or without, time delay before manoeuvre, without interrupting the updating of target tracking and display of actual target alpha-numeric data. The simulation mode shall be indicated with the relevant symbol (see symbol 10 of annex E) on the display.*

3.3.7.2 (A.823/A.3.7.2) *The operating manual shall contain an explanation of the principles underlying the trial manoeuvre technique adopted including, if provided, the simulation of own ship's manoeuvring characteristics.*

3.3.7.3 (A.823/A.3.7.3) *It shall be possible to cancel a trial manoeuvre at anytime.*

3.3.8 (A.823/A.3.8) Accuracy

3.3.8.1 (A.823/A.3.8.1) *The ARPA shall provide accuracies not less than those given in 3.3.8.2 and 3.3.8.3 for the four scenarios defined in appendix 2 (annex B). With the sensor errors specified in appendix 3 (annex C), the values given relate to the best possible manual plotting performance under environmental conditions of ± 10 degrees of roll.*

3.3.8.2 (A.823/A.3.8.2) *An ARPA shall present within one minute of steady state tracking the relative motion trend of a target with the following accuracy values (95 % probability values).*

Data Scenario	Relative course (degrees)	Relative speed (knots)	CPA (nautical miles)
1	11	2,8	1,6
2	7	0,6	-----
3	14	2,2	1,8
4	15	1,5	2,0

NOTE 1 – In steady state tracking both own and target ship follow straight line course at constant speed.

NOTE 2 – Probability values are the same as confidence levels.

NOTE – In the above table, the values are plus (+) and minus (–).

3.3.8.3 (A.823/A.3.8.3) *An ARPA shall present within 3 min of steady state tracking the motion of a target with the following accuracy values (95 % probability values).*

Data Scenario	Relative course (degrees)	Relative speed (knots)	CPA (nautical miles)	TCPA (min)	True course (degrees)	True speed (knots)
1	3,0	0,8	0,5	1,0	7,4	1,2
2	2,3	0,3	---	---	2,8	0,8
3	4,4	0,9	0,7	1,0	3,3	1,0
4	4,6	0,8	0,7	1,0	2,6	1,2

NOTE – In the above table, the values are plus (+) and minus (–).

3.3.8.4 (A.823/A.3.8.4) *When a tracked target, or own ship, has completed a manoeuvre, the system shall present in a period of not more than 1 min an indication of the target's motion trend, and display within 3 min the target's predicted motion, in accordance with 3.3.4.6, 3.3.6, 3.3.8.2 and 3.3.8.3. In this context, a "manoeuvre of own ship" shall be deemed to consist of an alteration of course of $\pm 45^\circ$ in 1 min.*

3.3.8.5 (A.823/A.3.8.5) *The ARPA shall be designed in such a manner that under the most favourable conditions of own ship motion the error contribution from the ARPA shall remain insignificant compared to the errors associated with the input sensors, for the scenarios of appendix 2 (annex B).*

3.3.9 (A.823/A.3.9) Connections with other equipment

3.3.9.1 (A.823/A.3.9.1) *The ARPA shall not degrade the performance of any equipment providing sensor inputs. The connection of the ARPA to any other equipment shall not degrade the performance of that equipment. This requirement shall be met whether the ARPA is operating or not. Additionally the ARPA shall be designed to comply with this requirement under fault conditions as far as is practicable.*

3.3.9.2 (A.823/A.3.9.2) *The ARPA shall provide an indication when any input from an external sensor is absent. The ARPA shall also repeat any alarm or status messages concerning the quality or source of the input data from its external sensors which may influence its operation.*

3.3.9.3 *Information exchange between the ARPA and other equipment shall be in accordance with IEC 61162. As far as possible, such an interface shall not degrade the ARPA performance by normal or abnormal behaviour of the interface, nor of the signals on it.*

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

3.3.10 (A.823/A.3.10) Performance tests and warnings

3.3.10.1 (A.823/A.3.10.1) *The ARPA shall provide suitable warnings of ARPA malfunction to enable the observer to monitor the proper operation of the system. Additionally, test programmes shall be available so that the overall performance of ARPA can be assessed periodically against a known solution. When a test programme is being executed the relevant test symbols (see symbols 11A or B of annex E) shall be displayed.*

3.3.10.2 *The test scenario may be shown on a synthetic or live picture. For a synthetic picture symbol 11A of annex E shall be used, and for a live picture symbol 11B of annex E shall be used.*

3.3.11 (A.823/A.3.11) Sea and ground stabilisation

3.3.11.1 (A.823/A.3.11.1) *The ARPA shall be capable of sea and ground stabilisation.*

3.3.11.2 (A.823/A.3.11.2) *Log and speed indicators providing inputs to ARPA equipment shall be capable of providing the ship's speed through the water in the fore and aft direction.*

3.3.11.3 (A.823/A.3.11.3) *The ground stabilized input may be provided from the log (dual axis), or from an electronic position-fixing system, if the speed measurement accuracy is in accordance with the requirements of resolution A.824 or from tracked stationary targets.*

3.3.11.4 (A.823/A.3.11.4) *The type of input and stabilisation in use shall be displayed.*

4 Methods of testing and required test results

4.1 General

Tests shall be conducted normally by operating the ARPA under test covering the adjacent sea area and using simulated target echoes from a synthetic target generator (see annex D) whose characteristics are similar to target echoes produced by the radar. Means shall be provided for setting the effective amplitude of one or more simulated targets to 10 dB above peak noise level, such a target being referred to in the test data as a test reference target.

Unless otherwise stated, simulated targets shall follow constant courses at constant speeds and tests shall be carried out on each range scale on which ARPA facilities are provided.

Annex D shall be consulted for more details on using simulated targets.

Before these tests the equipment under test (EUT) shall be subjected to, and satisfy, the relevant parts of IEC 60945.

4.2 (3.3.1, 3.3.2, 3.3.3) Detection, acquisition, tracking and general facilities

4.2.1 Confidence

Before implementing these tests the test operator shall carry out a confidence check, by non-quantitative means, to ensure that the basic functions of 3.3.1, 3.3.2 and 3.3.3 are available.

4.2.2 (3.3.1) Detection

There is no additional test for this function, as necessary items are covered by other tests.

4.2.3 (3.3.2.1) Manual acquisition

4.2.3.1 Method of measurement

Twenty simulated radar targets superimposed on radar receiver generated noise, or equivalent, shall be fed into the ARPA. One or more of these targets shall be a reference target. The targets shall be positioned with an approximately uniform distribution at ranges between one nautical mile and the maximum of the range scale in use or the maximum acquisition range provided, and over an arc of not less than 120°.

Two or more of the simulated targets shall have a speed relative to the test radar of not less than 5 knots and one of these shall start at a range of approximately 5 nautical miles with a relative speed of 100 knots. The operation of the manual acquisition and tracking cancellation controls shall be tested on all range scales on which acquisition facilities are provided, and the target symbols of those acquired, shall be observed on the display.

Acquisition shall be tested in the following cases:

- a) each of a pair of targets on the same bearing, at a mean range of approximately 10 nautical miles, and separated by 0,5 nautical miles;
- b) as a) but at a mean range of approximately 2,5 nautical miles;
- c) each of a pair of targets at a common range of approximately 10 nautical miles and on bearings such that the adjacent edges of their targets are separated by 4°;
- d) as c) but at a common range of approximately 2,5 nautical miles.

4.2.4 (3.3.2) Automatic acquisition

4.2.4.1 Method of measurement

Where automatic acquisition is provided, the entire procedure of 4.2.3 shall be repeated. The operation of the automatic acquisition facility shall be checked by a suitable method. For example, the zone(s) of automatic acquisition shall be set to encompass the minimum possible area, and shall then be altered in size and/or position to permit successive automatic acquisition of targets.

4.2.5 (3.3.3) Tracking

4.2.5.1 Method of measurement

Following the acquisition phases of 4.2.3 (and of 4.2.4 if appropriate), the system shall be required to continue to track the acquired targets for a period of not less than 12 min or until they exceed the maximum tracking range, or fall below the reference target level.

At the end of the 12 min period the range scale shall be changed and the presentation of full plotting information shall be checked for those acquired targets which shall be displayed on the new range scale.

4.2.6 Results required (4.2.3/4.2.4/4.2.5)

- .1 It shall be possible in all cases specified in 4.2.3 (4.2.4 if appropriate) to acquire each target:
 - a) within five scans after the initiation of acquisition, i.e., from the time of the completion of the manual acquisition procedure, or
 - b) in the case of automatic acquisition, the target first entering or appearing within the acquisition zone.
- .2 In all cases, it shall be possible to acquire not less than 20 targets by manual means.
- .3 In all cases, a clearly identifiable relevant symbol (see annex E) shall appear on the display at each acquired target.
- .4 It shall be possible, by suitable means provided, including manual means, to cancel any chosen acquired target.

Immediate automatic re-acquisition is permissible inside, but not outside, any automatic acquisition zone set by the operator.
- .5 The boundary limits of every acquisition zone in use within the range scale in use shall be indicated clearly on the display with the appropriate symbol in annex E.
- .6 Within 20 scans of the initiation of acquisition of each target the appropriate symbol in annex E shall indicate the general trend of the target motion.
- .7 Within 60 scans of the initiation of acquisition, data as required by 3.3.4.6 and 3.3.6.2 shall be available on all tracked targets.
- .8 All symbols shall correlate with the relevant targets unambiguously.
- .9 For all tracked targets, the display of past history positions shall be available as required in 3.3.3.8.
- .10 The provision of suitable means of complying with 3.3.4.7 and 3.3.4.8 shall be verified.
- .11 Compliance with 3.3.4.12 shall be verified.

4.3 (3.3.3) Tracking reliability

4.3.1 (3.3.3.3) Fading target

4.3.1.1 Method of measurement

The echo due to a test reference target with a relative speed of 20 knots and on a constant course shall be fed into the ARPA and shall be acquired. To avoid the possibility of target swap, no other target shall come within 1 nautical mile of the test target.

Starting not less than 60 scans after the initiation of acquisition, the echo shall be caused to miss 50 % of any 10 consecutive paints in various patterns which shall include missing alternate paints and missing five consecutive paints. The test shall be repeated with test reference target relative speeds of five knots and 100 knots.

4.3.2 (3.3.5.7) Lost target warning

4.3.2.1 Method of measurement

At the conclusion of each test of 4.3.1 the test reference target echo shall be suppressed at its source.

4.3.3 (3.3.3.7) Target manoeuvre

4.3.3.1 Method of measurement

The echo due to a test reference target with a relative speed of 20 knots and on a collision course with own ship shall be fed into the ARPA and be acquired at a range of not less than 5 nautical miles. When the target reaches a range of 3 nautical miles, it shall be caused to turn to starboard at a rate 5°/s through an angle of 90° and shall then follow a constant course at constant speed for not less than 3 min.

4.3.4 (3.3.3.4) Target swap

4.3.4.1 Method of measurement

The echo due to a test reference target with a relative speed of 20 knots and on a collision course with own ship shall be fed into the ARPA and shall be acquired at a range of ≥ 10 nautical miles.

When the target reaches a range of 5 nautical miles it shall be caused to pass an unacquired, stationary, reference target displaced in bearing such that the adjacent edges of their echoes are separated by 4° and shall continue on the same course for not less than 1 min.

4.3.5 Results required (4.3.1/4.3.2/4.3.3/4.3.4)

- .1 The ARPA shall continue to track the test reference target throughout the test of 4.3.1 and shall not initiate the lost target warning.
- .2 The lost target warning shall be initiated automatically not more than 20 scans after the start of test of 4.3.2. Observe that the indication appears initially at the track position at which the alarm was initiated.
- .3 The ARPA shall continue to track the target throughout the test of 4.3.3.
- .4 The ARPA shall continue to track the acquired target throughout the test of 4.3.4.

4.3.6 (3.3.3.8) Past positions

By inspection of the equipment and the manufacturer's operator's manual.

4.4 (3.3.8) Tracking accuracy

4.4.1 Method of measurement

- .1 The ARPA shall be set to the 12 nautical mile range scale and shall be fed with compass and log inputs corresponding to scenario 1 of annex B. A test reference target, whose course, speed and initial position are such that 3 min after acquisition they shall correspond to those given in scenario 1 of annex B shall be fed into the ARPA. The target echo signal and own ship inputs shall be generated by means which take account of the sensor errors listed in annex C including those due to own ship roll of $\pm 10^\circ$. The target shall be acquired and the time of acquisition, t_0 , as defined in 4.2.6.1 shall be noted.

At $t_0 + 1$ min the motion trend of the target as indicated on the ARPA display in vector or graphic form shall be observed.

At $t_0 + 3$ min the true course and speed and the CPA and TCPA of the tracked test target shall be obtained from the ARPA alpha-numeric readout facility and recorded, and the motion of the target as indicated on the ARPA display in vector or graphic form shall be observed. The target echo generator shall be reset and the test repeated until a total of 20 tests have been recorded. If the target echo generator utilises pseudo-random number generators then it shall be arranged that a different sequence is used for each test.

- .2 The observed indications in vector or graphic form shall be compared with the requirements of 3.3.8.2 or 3.3.8.3 as appropriate.
- .3 The error in each recorded value shall be determined by subtracting from it the correct value for that parameter as derived from this scenario.
- .4 The above test procedure shall be repeated successively for scenarios 2, 3 and 4 of annex B.
- .5 The operating manual shall be checked for the inclusion of information relating to the requirements of 3.3.3.2 and 3.3.3.5.

4.4.2 Results required

If the results of all 20 tests are within the limits given in the tables of 3.3.8.2 or 3.3.8.3 as appropriate, the equipment shall be considered as complying with the requirements for the particular scenario under test.

If the result of any test is outside the limits, a statistical analysis shall be applied to all the results and, if necessary, additional tests shall be carried out.

4.5 (3.3.5.1-5) Closing target warning

4.5.1 Method of measurement

- .1 The echo due to a test reference target with a relative speed of 20 knots and on a collision course with own ship shall be fed into the ARPA. A zone shall be previously adjusted to be at a range of 10 nautical miles encompassing the bearing of the target and shall not include a clutter area. The target shall be initially at a range of not less than 11 nautical miles. The target shall follow a constant course until it reaches a range of 8 nautical miles. The test shall be repeated with the zone adjusted to a range of 2,5 nautical miles with initial and final ranges of the target of approximately 3 nautical miles and 1,5 nautical miles respectively.
- .2 The operation of the zone shall be observed for an extended period.
- .3 All zones ((3.3.5.2) guard, (3.3.5.3) acquisition, (3.3.5.4) combined) provided shall be checked.
- .4 The operating manual shall be checked for the inclusion of information relating to the requirements of 3.3.5.

4.5.2 Results required

- .1 The relevant zone shall be clearly indicated on the display with the relevant symbol. In each test of 4.5.1, the closing target warning shall be initiated automatically not more than 1 min after the target crosses the outer boundary of the zone as indicated on the display, and the position of the target shall be clearly indicated on the display with the relevant symbol.
- .2 The false alarm rate shall not be excessive.
- .3 The operating manual shall be satisfactory.

4.6 (3.3.5.6) Collision risk (CPA/TCPA) warning

4.6.1 Method of measurement

- .1 Using the 12 nautical mile range scale, the CPA warning limit shall be set to a range of approximately 1,5 nautical miles and the TCPA warning limit shall be set to a convenient time between 10 min and 20 min, inclusive. The echoes due to two reference targets, each with a relative speed of 20 knots and on a collision course with own ship shall be fed into the ARPA at ranges such that their TCPAs differ by 3 min. Each target shall be acquired at a range such that its TCPA is at least 4 min greater than the limit set for the TCPA warning.

The alpha-numeric readout of TCPA for the nearer target shall be monitored and its value when the warning is initiated shall be recorded. The minimum value observed before the warning is initiated shall be recorded.

Any audible warning initiated by this target shall be cancelled within 30 s of its initiation. The farther target shall then be similarly monitored and recorded.

- .2 The test shall be repeated using the same warning limit settings, but with a single test target on a succession of courses giving CPA ranges just less than and just greater than the limit set for the CPA warning, the target being tracked until it reaches its CPA.

The alpha-numeric readouts of CPA and TCPA shall be monitored and shall be recorded when the warning is initiated. Additionally, prior to the initiation of the warning the indicated CPA and TCPA shall be recorded if at any time both of them are less than 0,9 times their respective set limit values.

4.6.2 Results required

- .1 For each target in the test of 4.6.1.1, the recorded TCPA at which the warning is initiated shall be not greater than 1,1 times the limit set for the TCPA warning and the minimum TCPA recorded before the warning is initiated shall be not less than 0,9 times the limit set for the TCPA warning.
- .2 For each test of 4.6.1.2, the recorded CPA and TCPA at which the warning was initialised shall not be greater than 1,1 times their respective set limit values.

There shall be no recorded instance of the CPA and TCPA indications both being less than 0,9 times their set limit values before the warning is initiated.

4.7 (3.3.7) Trial manoeuvre

4.7.1 (3.3.7.1-3) Check by inspection

4.8 (3.3.4) Display

Check by inspection of the equipment that the requirements of 3.3.4 are complied with. In 3.3.4.11, 1 min and 3 min shall be replaced by 20 and 60 scans respectively.

4.9 (3.3.5.8) Audible warnings

Check by inspection of the EUT.

4.10 (3.3.6) Data requirements

Check by inspection of the EUT.

4.11 (3.3.9) Interfaces

By practical demonstration and inspection of the documentation.

4.12 (3.3.10) Performance test and warnings

By practical demonstration and inspection of the documentation.

4.13 (3.3.11) Sea and ground stabilization

Methods provided shall be tested by practical demonstration and inspection of the documentation.

4.14 (3.1.4/5/6) System configuration and quality assurance

By practical demonstration and inspection of the relevant documentation.

Withd
IECNORM.COM: Click to view the full PDF of IEC 60872-1:1998

Annex A (normative)

Definitions of terms to be used in connection with ARPA performance standards

(Appendix 1 to annex of IMO Resolution A.823)

<i>Acquisition:</i>	<i>The process of selecting a target or targets and initiating their tracking</i>
<i>Acquisition area:</i>	<i>An area set up by the observer which should automatically acquire a target when it enters such an area</i>
<i>Azimuth stabilized display:</i>	<i>A display in which the azimuth orientation relative to a nominated true bearing is fixed</i>
<i>Bad echo:</i>	<i>The name associated with a tracked target which appears to have been temporarily lost or which has a poorly defined radar aspect, in so much that, the target does not have tracking ability</i>
<i>Bow passing prediction:</i>	<i>Situation associated with a target which is crossing or predicted to cross ahead of own ship</i>
<i>Course-up display:</i>	<i>An azimuth stabilised display in which a line connecting the centre of own ship with the top of the display is own ship's intended course</i>
<i>CPA/TCPA:</i>	<i>Closest point of approach (CPA) and time to closest point of approach (TCPA) limit as defined by the observer to give warning when a tracked target or targets will close to within these limits from own ship</i>
<i>Detection:</i>	<i>Identification of a target in the presence of noise and clutter</i>
<i>Echo reference:</i>	<i>A facility for indicating that a particular fixed navigational mark which is being tracked is to be used as a ground stabilised reference</i>
<i>ERBL:</i>	<i>An electronic range and bearing line used to measure bearings and/or ranges</i>
<i>Ground stabilization:</i>	<i>A mode of display whereby own ship and all targets are referenced to the ground using ground track or set and drift inputs</i>
<i>Guard zone:</i>	<i>A zone in which an alarm is given when a target is detected</i>
<i>Heading:</i>	<i>The direction in which the bows of a ship are pointing expressed as an angular displacement from north</i>
<i>History:</i>	<i>Equally time-spaced past position of a target which is being tracked. The history may be relative or true</i>
<i>Lost target:</i>	<i>The name associated with a target that is no longer being tracked having become lost or obscured</i>

<i>Map lines:</i>	<i>Navigational facility whereby the observer can define lines to indicate channels or traffic separation schemes. Sometimes called nav lines, these lines require ground stabilisation to stop them drifting</i>
<i>North-up display:</i>	<i>An azimuth stabilised display in which a line connecting the centre of own ship with the top of the display is north true bearing</i>
<i>PAD:</i>	<i>Predicted area of danger defined around a predicted close quarter situation area. The size is determined by speed ratios between own ship and the target in question and CPA distance limits as defined by the observer</i>
<i>Predicted points of collision:</i>	<i>A graphical representation of where predicted collision intercept points lie with respect to own ship and other targets</i>
<i>Relative bearing:</i>	<i>The direction of a target from own ship expressed as an angular displacement from own ship's heading</i>
<i>Relative course:</i>	<i>The direction of motion of a target relative to own ship's position expressed as an angular displacement from north. It is deduced from a number of measurements of target range and bearing on own ship's radar</i>
<i>Relative motion:</i>	<i>The combination of relative course and relative speed</i>
<i>Relative motion display:</i>	<i>A display on which the position of own ship remains fixed and all targets move relative to own ship</i>
<i>Relative speed:</i>	<i>The speed of a target relative to own ship's position. It is deduced from a number of measurements of target range and bearing on own ship's radar</i>
<i>Relative vector:</i>	<i>The predicted movement of a target relative to own ship</i>
<i>Scan:</i>	<i>The interrogation of an area covering 360° in bearing. A sector, or sectors, may be suppressed within the 360° bearing</i>
<i>Sea stabilization:</i>	<i>A mode of display whereby own ship and all targets are referenced to the sea, using gyro heading and single axis log water speed inputs</i>
<i>Suppressed area:</i>	<i>An area set up by the observer within which targets are not acquired</i>
<i>Target swop:</i>	<i>A situation in which the incoming radar data for a tracked target becomes incorrectly associated with another tracked target or a non-tracked radar echo</i>
<i>Target:</i>	<i>Any object fixed or moving whose position and motion is determined by measurements of range and bearing on radar</i>
<i>Target's predicted motion:</i>	<i>A prediction of future target motion based on linear extrapolation from its present motion as determined by past measurements of its range and bearing on the radar</i>

<i>Tracking:</i>	<i>The computer process of observing the sequential changes in the position of a target in order to establish its motion</i>
<i>Trails:</i>	<i>Tracks displayed by the radar echoes of targets in the form of a synthetic afterglow. The trails may be either relative or true. The true trails may be sea or ground stabilised</i>
<i>Trial manoeuvre:</i>	<i>A facility to assist the observer in making the correct manoeuvre for navigation and collision avoidance purposes</i>
<i>True bearing:</i>	<i>The direction of a target from own ship or from another target expressed as an angular displacement from north</i>
<i>True course:</i>	<i>The true direction of motion of a target expressed as an angular displacement from north. It is obtained by a vector combination of target relative motion and own ship's true motion</i>
<i>True motion:</i>	<i>The combination of true course and true speed</i>
<i>True motion display:</i>	<i>A display across which own ship and each target moves with its own true motion</i>
<i>True speed:</i>	<i>The speed of a target obtained by a vector combination of target relative motion and own ship's true motion *</i>
<i>True vector:</i>	<i>The predicted true motion of a target as a result of own ship's direction and speed input. The true vector may be either displayed with reference to the water or to the ground</i>

* *For the purposes of these definitions there is no need to distinguish between sea and ground stabilization.*

NOTE – Where reference is made to target range, bearing, relative course or relative speed, closest point of approach (CPA) or time to closest point of approach (TCPA), these measurements are made with respect to the radar antenna.

Annex B (normative)

Operational scenarios (Appendix 2 of annex to IMO Resolution A.823)

For each of the following scenarios predictions are made at the target position defined after previously tracking for the appropriate time of one or three minutes:

Scenario 1	Own ship course	000°
	Own ship speed	10 knots
	Target range	8 nautical miles
	Bearing of target	000°
	Relative course of target	180°
	Relative speed of target	20 knots
Scenario 2	Own ship course	000°
	Own ship speed	10 knots
	Target range	1 nautical miles
	Bearing of target	000°
	Relative course of target	090°
	Relative speed of target	10 knots
Scenario 3	Own ship course	000°
	Own ship speed	5 knots
	Target range	8 nautical miles
	Bearing of target	045°
	Relative course of target	225°
	Relative speed of target	20 knots
Scenario 4	Own ship course	000°
	Own ship speed	25 knots
	Target range	8 nautical miles
	Bearing of target	045°
	Relative course of target	225°
	Relative speed of target	20 knots

Annex C (normative)

Sensor errors (Appendix 3 of annex to IMO Resolution A.823)

The accuracy figures quoted in 3.3.8 are based upon the following sensor errors and are appropriate to equipment complying with the performance standards for shipborne navigational equipment.

NOTE – σ means "standard deviation".

C.1 Radar

C.1.1 Target glint (scintillation) (for 200 m length target)

Along length of target $\sigma = 30$ m (normal distribution)

Across beam of target $\sigma = 1$ m (normal distribution)

C.1.2 Roll-pitch bearing

The bearing error will peak in each of the four quadrants around own ship for targets on relative bearings of 045°, 135°, 225° and 315° and will be zero at relative bearings of 0°, 90°, 180°, and 270°. This error has a sinusoidal variation at twice the roll frequency.

For a 10° roll the mean error is 0,22° with a 0,22° peak sine wave superimposed.

C.1.3 Beam shape – assumed normal distribution giving bearing error with $\sigma = 0,05^\circ$

C.1.4 Pulse shape – assumed normal distribution giving range error with $\sigma = 20$ m

C.1.5 Antenna backlash – assumed rectangular distribution giving bearing error $\pm 0,05^\circ$ maximum

C.1.6 Quantization

Bearing – rectangular distribution $\pm 0,1^\circ$ maximum

Range – rectangular distribution $\pm 0,01$ nautical miles maximum

Bearing encoder assumed to be running from a remote synchro giving bearing errors with a normal distribution $\sigma = 0,03^\circ$.

C.2 Gyro-compass

Calibration error $0,5^\circ$

Normal distribution about this with $\sigma = 0,12^\circ$

C.3 Log

Calibration error 0,5 knots

Normal distribution about this, $3\sigma = 0,2$ knots.

The above values were used in generating the accuracy figures quoted in 3.8 of IMO Resolution A.823 and shall be used for testing an ARPA in this standard.

The bearing error resulting from the combination of all sensor errors including target glint shall be limited to $\pm 0,6^\circ$.

IECNORM.COM: Click to view the full PDF of IEC 60872-1:1998

Withd 2020

Annex D (normative)

ARPA testing using simulated targets

IMO Resolution A.823 specifies the accuracy requirements and various other aspects of performance with which an ARPA shall comply. These requirements are contained in clause 3 of this standard.

One method of determining whether an ARPA satisfies the accuracy requirements is to simulate the radar return from a target by injecting signals into the ARPA at video frequency and causing the simulated target to move in accordance with each of the scenarios of annex B. This can be achieved by passing antenna bearing, trigger and video signals from the radar to a synthetic echo generator (SEG) which then feeds the trigger and video signals to the ARPA having mixed a synthetic echo, representing a target, with the radar video. This synthetic echo can, if required, be controlled in size and intensity.

In normal operation at sea, the data fed to the ARPA by the radar suffers from errors due to several factors. The principal ones are identified and quantified in annex C. When simulated targets are used to determine the accuracy of an ARPA, it is necessary to superimpose the effects of these errors onto the simulated target signal. This can be done by random sampling of the distributions of the various errors, using different (randomly selected) values for each successive revolution of the radar antenna.

Most errors can be expressed as simple relative range and bearing deviations of the track of a target. However, one error source identified in annex C, which has to be simplified for the purposes of the simulation, is the target glint, because real target glint is a very complex physical phenomenon, being a characteristic of the target's structure and instantaneous aspect relative to the radar. A simple and reasonably realistic method of simulating the effect of target glint is to generate a synthetic echo of fixed size and intensity and cause the position of this echo to move in accordance with the distributions identified for target glint in annex C.

It is necessary to simulate each scenario at least 20 times using different random samples of the errors in order to assess whether or not an ARPA satisfies the accuracy requirements. All the random numbers required can be computer generated.

Many of the performance tests specified in this standard are preferably carried out by using a SEG which, for some of the tests, shall have the capability of generating up to 20 targets.

This method of testing an ARPA has certain advantages over the use of real targets. For example, each test is carried out under controlled conditions which can be set up accurately and can be repeated exactly.

Annex E (normative)

Electronic plotting video symbols (EPVS)

E.1 General

E.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.

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

E.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.

E.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.

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

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

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

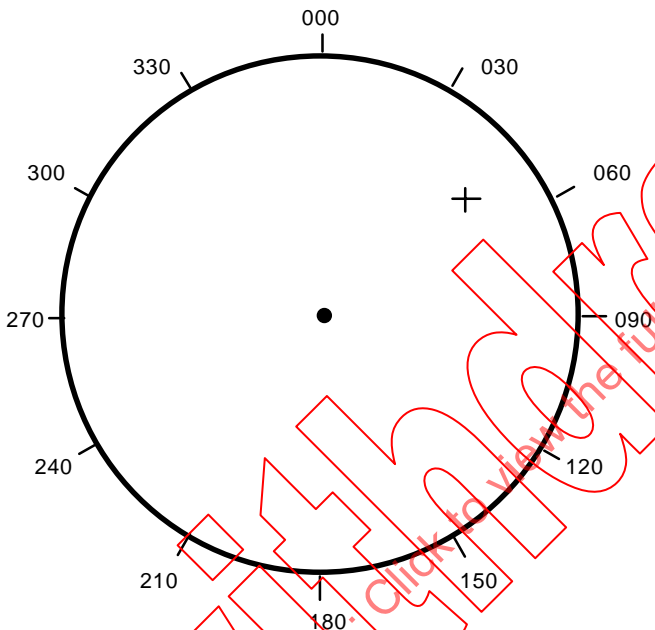
E.1.5.3 Guard zone warning (symbol 7) has a higher priority than a lost target warning (symbol 9).

E.2 Symbols

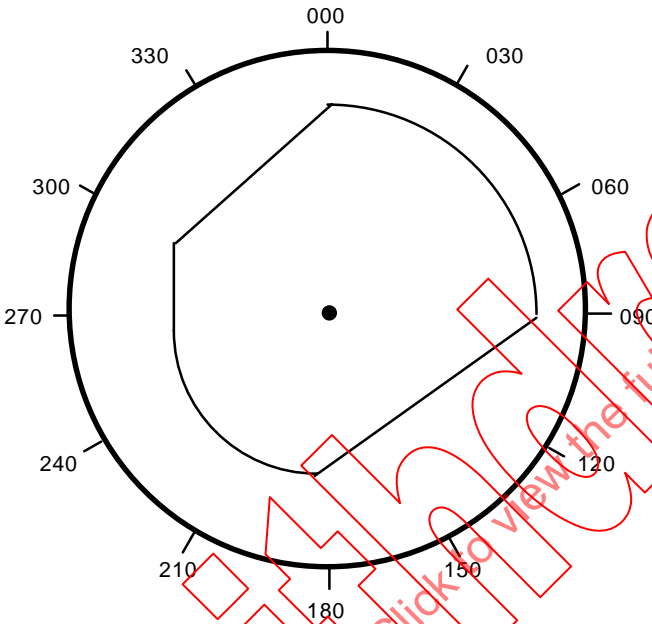
The following symbols are graphically presented within a representation of a radar plotting display, which includes a bearing scale graduated at nominal 30° intervals. In practice the bearing scale is divided into marks at least every 5° (see IEC 60936-1).

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

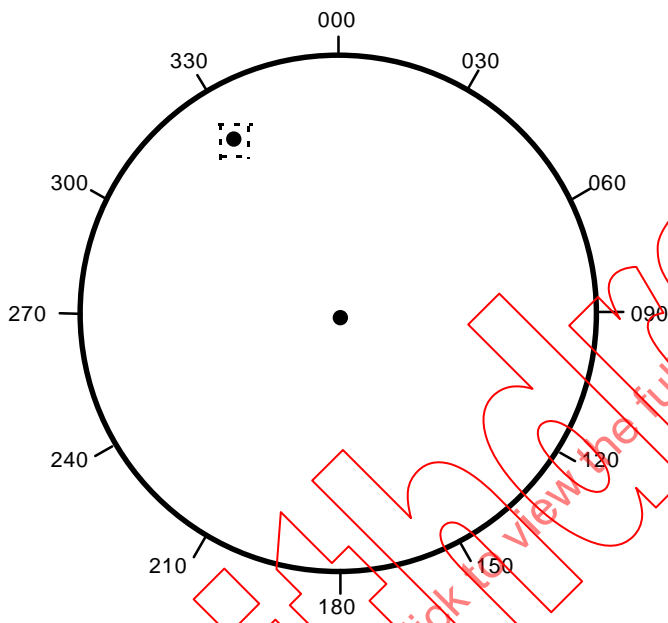
E.2.1 Symbol 1

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 3.3.2.1 of IEC 60872-2 3.3.5.1 of IEC 60872-3	1 ARPA ATA EPA	Manual acquisition and plotting	A cross shall be used as the cursor for manual acquisition on an ARPA and ATA and for plotting on an EPA.
			<p>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) harmonisation.</p> <p>NOTE 2 – The cursor is also used for other radar purposes.</p>

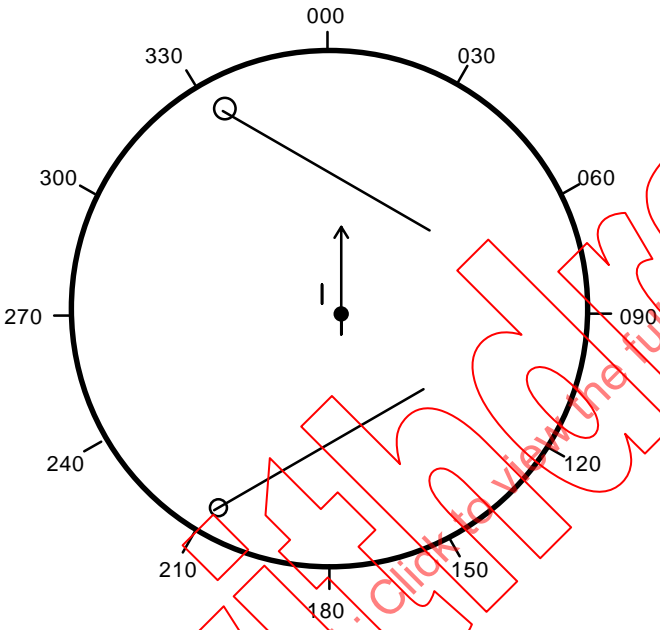
E.2.2 Symbol 2

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

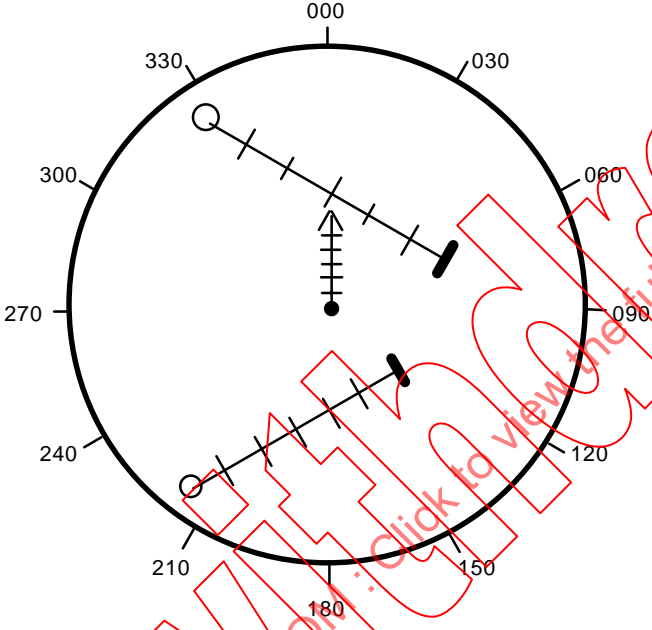
E.2.3 Symbol 3

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.
			

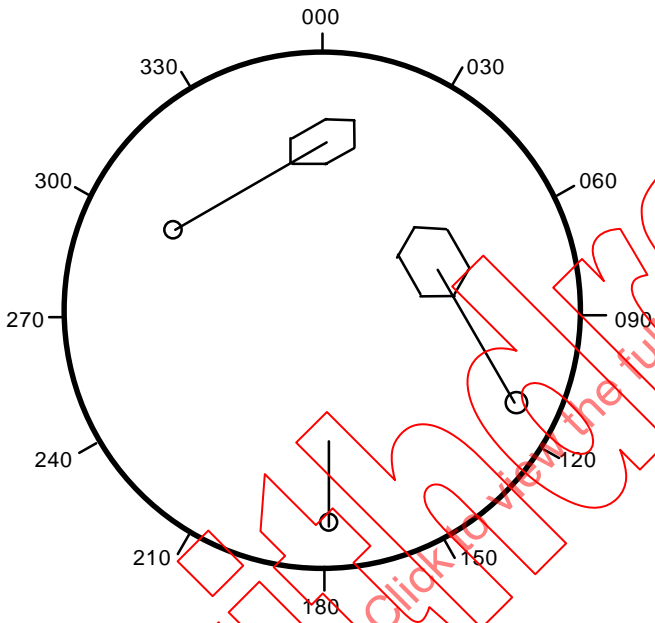
E.2.4 Symbol 4A

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. <i>The course and speed information generated by the ARPA/ATA/EPA for acquired targets shall be displayed in a vector or graphic form.</i>	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 stabilised to show course and speed through water (single arrow) or ground stabilised to show course and speed over the ground (double arrow) respectively.

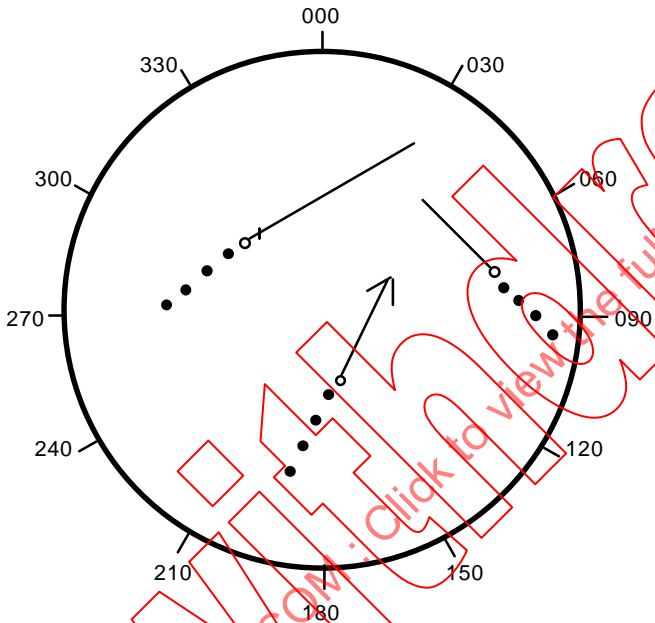
E.2.5 Symbol 4B

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
<p>3.4.6 of IMO A.823</p> <p>3.3.4.6 of IEC 60872-1</p> <p>3.3.4.6 of IEC 60872-2</p> <p>3.3.5.1 of IEC 60872-3</p>	<p>4B</p> <p>ARPA</p> <p>ATA</p> <p>EPA</p>	<p>Course and speed vector. Target being tracked when tracking is in steady state.</p> <p><i>The course and speed information generated by the ARPA/ATA/ETA for acquired targets shall be displayed in a vector or graphic form.</i></p>	<p>A vector indicating the target's predicted true or relative motion, which may have a fixed time scale or time-adjusted scale.</p> <p>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.</p>
			<p>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 stabilised to show course and speed through the water (single arrow) or ground stabilised to show course and speed over the ground (double arrow) respectively.</p> <p>NOTE 2 – Marks at 1 min intervals. Bold mark at 6 min intervals. Length represents user-selectable period applied to ALL vectors.</p>

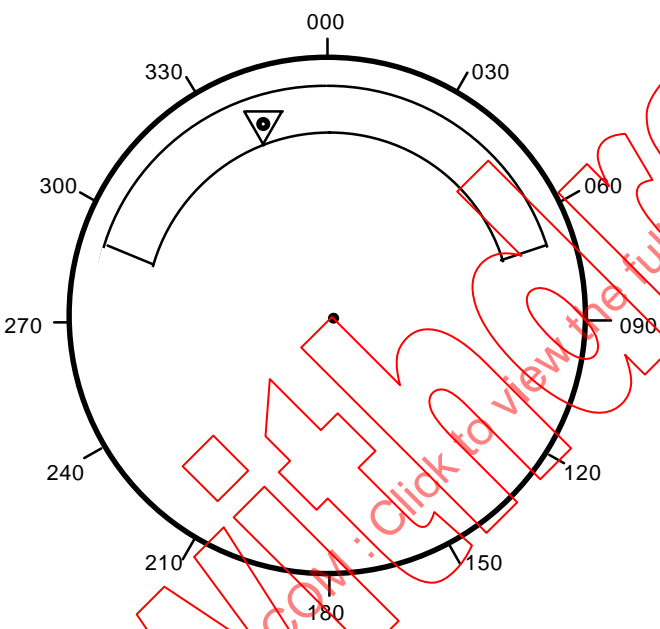
E.2.6 Symbol 5

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	5 ARPA ATA	Course and speed graphics. Target being tracked when tracking is in steady state. <i>The course and speed information generated by the ARPA/ATA for acquired targets shall be displayed in a vector or graphic form.</i>	The graphics can take the form of a shape such as a hexagon (see example) or ellipse. 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.
			<p>NOTE 1 – The form of the graphics shall avoid shapes that are being used for other ARPA symbols.</p> <p>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.</p>

E.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	<i>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.</i>	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.
			<p>This diagram applies to ARPA only. For EPA see IEC 60872-3 C.2.7</p>

E.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. <i>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.</i>	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.
			<p>NOTE 1 – Flashing is at a frequency of about 0,5 Hz to 1 Hz.</p> <p>NOTE 2 – After acknowledgement it is permissible to cease flashing.</p> <p>NOTE 3 – The area chosen by the operator shall be limited in range depth.</p> <p>NOTE 4 – It is permissible to show symbols 4A or 4B together with this symbol.</p>