

Marine automatic radar plotting aids (ARPA) — Operational requirements — Methods of testing and test results

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Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

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National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Policy Committee and is the English language version of EN 60872:1993 *Marine automatic plotting aids (ARPA) Operational requirements — Methods of testing and test results* together with its Amendment A1:1993, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 872:1987 together with its Amendment 1 of June 1991 published by the International Electrotechnical Commission (IEC). It supersedes BS 6919:1987 which is withdrawn and differs from it only by the addition of Annex E.

Internationally accepted conventions governing the safety of life at sea recommend that ARPA should be carried on vessels of over a certain tonnage. This equipment, associated with one or more navigational radars, makes it possible to identify and accurately follow the movement of one or more other vessels or “targets” within the area determined by the range of the ship’s radar. This standard lays down the characteristics which ARPA needs to provide essential information to operators on board.

The performance requirements of this standard are in full agreement with the relevant Resolutions of the International Maritime Organization (IMO).

Additional information. For the purposes of this British Standard, the Testing Authority referred to in 8.6 is the UK Department of Transport.

The International Standards referred to in clause 1, Scope have now been published and are as follows:

IEC 936:1988, *Shipborne radar. Operational and performance requirements. Methods of test and required test results.*

ISO 8728:1987, *Shipbuilding — Marine gyro-compasses.*

IEC 1023:1990, *Marine speed and distance measuring equipment (SDME). Operational and performance requirements. Methods of testing and required test results.*

IEC 945:1988, *Marine navigational equipment. General requirements. Methods of testing and required test results.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 30, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Descriptors: Ships, navigational instruments, automatic radars, plotting aids, ARPA, operational requirements, methods of testing, test results

English version

Marine automatic radar plotting aids (ARPA) Operational requirements — Methods of testing and test results

(Includes Amendment A1:1993)
(IEC 872:1987)

Aides de pointage radar automatiques pour navires (APRA)
Spécification opérationnelles
Méthodes et résultats d'essai
(Inclut l'amendement A1:1993)
(CEI 872:1987)

Automatische Radar-Plöthilfen für die Seeschifffahrt (ARPA)
Betriebstechnische Anforderungen
Prüfverfahren und Prüfergebnisse
(Einschließlich Änderung A1:1993)
(IEC 872:1987)

This European Standard was approved by CENELEC on 1992-12-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

At the request of the 71st Technical Board of CENELEC, HD 526 S1:1989, (IEC 872:1987) was submitted to the CENELEC voting procedure for conversion into a European Standard.

The text of the International Standard was approved by CENELEC as EN 60872 on 9 December 1992.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1993-12-01
- latest date of withdrawal of conflicting national standards (dow) —

Foreword to amendment A1

The CENELEC questionnaire procedure, performed for finding out whether or not the amendment 1:1991 to the International Standard IEC 872:1987 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as amendment A1 to EN 60872:1993 on 9 December 1992.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1993-12-01
- latest date of withdrawal of conflicting national standards (dow) 1993-12-01

For products which have complied with HD 526 S1:1989 (converted into EN 60872) before 1993-12-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1998-12-01.

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1 Scope

This standard specifies the performance and type testing of Marine Automatic Radar Plotting Aids (ARPA) required by Regulation 12 of Chapter V of “The International Convention for the Safety of Life at Sea” (SOLAS) 1974, as amended and which are associated with:

Marine Radar complying with IEC Standard No. YYY¹⁾

Marine Gyrocompass complying with ISO Standard YYY¹⁾

Marine Devices to Measure Speed and Distance complying with IEC Standard No. YYY¹⁾

General Requirements for Marine Navigational Equipment — IEC Standard No. YYY¹⁾

2 Object

To establish minimum performance standards and methods of testing and required test results for ARPA.

3 Layout

This standard is made up of two sections. Section 1 consists of the performance standards and is based upon International Maritime Organization (IMO) Resolution A.422 (XI).

All text whose meanings are identical to those in the Resolution are printed in italics.

Section 2 consists of the methods of testing and test results.

Section 1. Operational and performance requirements

4 General

4.1 *Automatic radar plotting aids (ARPA) shall, in order to improve the standard of collision avoidance at sea:*

- a) *reduce the work-load of observers by enabling them to obtain information automatically so that they can perform as well with multiple targets as they can by manually plotting a single target;*
- b) *provide continuous, accurate and rapid situation evaluation.*

NOTE “Multiple targets” is interpreted as meaning “several separate targets”.

4.2 In addition to the requirements specified in Sub-clauses **4.2.1** and **4.2.2** below, the ARPA shall comply with the minimum performance requirements of Clause **6** below and the current IEC General Requirements for Marine Navigational Equipment. The tests to be carried out in order to assess whether an equipment complies with the stated performance requirements, and the test results required for compliance are specified in Section 2. Cross-references to the tests and results required for the performance requirements of Clause **6** are given in Appendix D.

4.2.1 Where an ARPA display is intended for use as a stand-alone slave display it shall comply with the relevant clauses of the IEC Marine Radar Performance Standard where applicable to a slave display. In addition the ARPA display shall be capable of presenting readily, without significant degradation, the radar signals shown on the master display.

4.2.2 Where an ARPA display is intended for use as the master display of a complete radar system, the system shall comply with the IEC Marine Radar Performance Standard in full.

4.2.3 Where ARPA information is generated by one unit of equipment and is displayed on another unit, the combination of the two units shall be regarded as forming the ARPA, and shall be tested as an entity.

5 Definitions of terms to be used only in connection with ARPA operating standards

5.1 Relative course

The direction of motion of a target related to own ship as deduced from a number of measurements of its range and bearing on the radar, expressed as an angular distance from north.

¹⁾ These standards are in course of preparation.

5.2 Relative speed

The speed of a target related to own ship, as deduced from a number of measurements of its range and bearing on the radar.

5.3 True course

The apparent heading of a target obtained by the vectorial combination of the target's relative motion and own ship's motion²⁾, expressed as an angular distance from north.

5.4 True speed

The speed of a target obtained by the vectorial combination of its relative motion and own ship's motion²⁾.

5.5 Bearing

The direction of one terrestrial point from another, expressed as an angular distance from north.

5.6 Relative motion display

The position of own ship on such a display remains fixed.

5.7 True motion display

The position of own ship on such a display moves in accordance with its own motion.

5.8 Azimuth stabilization

Own ship's compass information is fed to the display so that echoes of targets on the display will not be caused to smear by changes of own ship's heading.

5.9 North-up

The line connecting the centre with the top of the display points north.

5.10 Head-up

The line connecting the centre with the top of the display is own ship's heading.

5.11 Course-up

An intended course can be set to the line connecting the centre with the top of the display.

5.12 Heading

The direction in which the bows of a vessel are pointing, expressed as an angular distance from north.

5.13 Target's predicted motion

The indication on the display of a linear extrapolation into the future of a target's motion, based on measurements of the target's range and bearing on the radar in the recent past.

5.14 Target's motion trend

An early indication of the target's predicted motion.

5.15 Radar plotting

The whole process of target detection, tracking, calculation of parameters and display of information.

5.16 Detection

The recognition of the presence of a target.

5.17 Acquisition

The selection of those targets requiring a tracking procedure and the initiation of their tracking.

5.18 Tracking

The process of observing the sequential changes in the position of a target, to establish its motion.

5.19 Display

The plan position presentation of ARPA data with radar data.

5.20 Manual

Relating to an activity which a radar observer performs, possibly with assistance from a machine.

²⁾ For the purpose of these definitions there is no need to distinguish between sea and ground stabilization.

5.21 Automatic

Relating to an activity which is performed wholly by a machine.

NOTE Where reference is made to target range, bearing, relative course, 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.

6 Performance requirements

6.1 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.

6.2 Acquisition

6.2.1 *Target acquisition may be manual or automatic. However there shall always be a facility to provide for manual acquisition and cancellation. ARPA 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 indicated on the display.*

The minimum requirement is that manual acquisition shall be available for targets at all ranges between 1 and 12 nautical miles for ARPA with a 12 nautical mile range scale and between 1 and 16 nautical miles for ARPA with a 16 nautical mile range scale.

6.2.2 *Automatic or manual acquisition shall have a performance not inferior to that which could be obtained by the use of the radar display.*

6.3 Tracking

6.3.1 *The ARPA shall be capable of automatically tracking, processing, simultaneously displaying and continuously updating the information on not less than:*

- a) *20 targets, if automatic acquisition is provided, whether automatically or manually acquired;*
- b) *10 targets, if only manual acquisition is provided.*

The minimum requirement is that these capabilities shall be provided for targets at all ranges between 0.25 and 12 nautical miles for ARPA with a 12 nautical mile range scale and between 0.25 mile and 16 nautical miles for ARPA with a 16 nautical mile range scale.

6.3.2 a) *If automatic acquisition is provided, a description of the criteria of selection of targets for tracking shall be provided to the user.*

This requirement shall be provided in the Operating Manual.

b) *If the ARPA does not track all targets visible on the display, targets which are being tracked shall be clearly indicated on the display.*

c) *The reliability of tracking shall not be less than that obtainable using manual recordings of successive target positions obtained from the radar display.*

6.3.3 *Provided the target is not subject to target swap, the ARPA shall continue to track an acquired target which is clearly distinguishable on the display for 5 out of 10 consecutive scans.*

6.3.4 a) *The possibility of tracking errors, including target swap, shall be minimized by ARPA design.*

b) *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.*

This shall be provided in the Operating Manual.

6.3.5 *The ARPA shall be capable of displaying on request at least four equally time-spaced past positions of any targets being tracked over a period of at least 8 min.*

The Operating Manual shall contain an explanation of what the past position plots represent.

6.4 Display

6.4.1 *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.*

The equipment shall be regarded as complying with this requirement if it satisfies Subclause 4.2 of this standard.

6.4.2 *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 Sub-clause **6.4.2** if the design is such that, where practicable, correct operation of the radar system in accordance with the IEC Marine Radar Performance Standard will not be affected by malfunction of any ARPA sub-system that is not an essential part of the radar.

6.4.3 *The display on which ARPA information is presented shall have an effective diameter of at least 340 mm.*

6.4.4 *The ARPA facilities shall be available on at least the following range scales:*

- a) *12 nautical miles or 16 nautical miles,*
- b) *3 nautical miles or 4 nautical miles.*

ARPA facilities may be provided also on other range scales, and if provided shall comply with this standard. Range scales shall be selected from those permitted by the IEC Marine Radar Performance Standard and shall be provided with the appropriate fixed range rings.

6.4.5 *There shall be a positive indication of the range scale in use.*

6.4.6 a) *The ARPA shall be capable of operating with a relative motion display with north-up and either head-up or course-up azimuth stabilization. There shall be a positive indication of the orientation in use.*
b) *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 in use.*

6.4.7 *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. In this regard:*

- a) *An ARPA which presents target course and speed information in vector form only shall provide the operator with the option of true or relative vectors.*

There shall be an indication of the vector mode selected.

- b) *An ARPA which presents target course and speed information in graphic form shall also provide the operator with the option of selecting a vector presentation, which may be true or relative.*

- c) *Vectors displayed shall be either time adjustable or have a fixed time-scale.*

- d) *There shall be a positive indication of the time-scale of the vector in use.*

6.4.8 *The ARPA information shall not obscure radar information in such a manner as to degrade the process of detecting 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.*

The equipment shall be regarded as complying with the penultimate sentence of Sub-clause **6.4.8** if it is possible to remove readily all ARPA data from the display.

6.4.9 *Means shall be provided to adjust independently the brilliance of the ARPA data and the radar data, including complete elimination of the ARPA data.*

6.4.10 *The method of presentation shall ensure that the ARPA data are 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.*

6.4.11 *Provision shall be made to obtain quickly the range and bearing of any object which appears on the ARPA display.*

The accuracies required for this data are as stated in the IEC Marine Radar Performance Standard.

6.4.12 *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 1 min an indication of the target's motion trend, and display within 3 min the target's predicted motion in accordance with Sub-clauses **6.4.7**, **6.6**, **6.8.2** and **6.8.3**.*

6.4.13 *After changing range scales on which the ARPA facilities are available or resetting the display, full plotting information shall be displayed within a period of time not exceeding 4 scans.*

6.5 Operational warnings

6.5.1 *The ARPA shall have the capability to warn the observer with a visual and/or 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.*

6.5.2 *The ARPA shall have the capability to warn the observer with a visual and/or audible signal of any tracked target which is predicted to close to within a minimum range and time chosen by the observer. The target causing the warning shall be clearly indicated on the display.*

6.5.3 *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.*

The equipment shall be regarded as complying with Sub-clause **6.5.3** if the indication appears initially at the track position at which the warning is initiated.

6.5.4 *It shall be possible to activate or de-activate the operational warnings.*

6.6 Data requirements

6.6.1 *At the request of the observer the following information shall be immediately available from the ARPA in alphanumeric form in regard to any tracked target:*

- a) *Present range of the target.*
- b) *Present bearing of the target.*
- c) *Predicted target range at the closest point of approach (CPA).*
- d) *Predicted time to CPA (TCPA).*
- e) *Calculated true course of target.*
- f) *Calculated true speed of target.*

Each item of data presented shall be clearly and unambiguously identified.

The minimum requirement is that the above data shall be readily available, with not less than two items being available simultaneously. If the items of information are displayed in pairs the groupings shall be a) with b), c) with d) and e) with f).

6.7 Trial manoeuvre

6.7.1 *The ARPA shall be capable of simulating the effect on all tracked targets of an own ship manoeuvre without interrupting the updating of target information. The simulation shall be initiated by the depression either of a spring-loaded switch, or of a function key with a positive identification on the display.*

"The effect on all tracked targets" is interpreted as meaning "the effect on the collision situation".

Any equivalent method of control which prevents the ARPA display from being left unknowingly in the trial manoeuvre mode will satisfy this requirement.

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.

6.8 Accuracy

NOTE For the term "accuracy" as used in this sub-clause, "uncertainty" is the term more commonly used.

6.8.1 *The ARPA shall provide accuracies not less than those given in Sub-clauses **6.8.2** and **6.8.3** for the four scenarios defined in Appendix B. With the sensor errors specified in Appendix C, the values given relate to the best possible manual plotting performance under environmental conditions of $\pm 10^\circ$ roll.*

6.8.2 *An ARPA shall be capable of presenting within 1 min of steady state tracking, the relative motion trend of a target with the following accuracy values (95 % probability values):*

Scenario	Data		
	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