

each radar must have true north features consisting of a display that is stabilized in azimuth.

(Titles I and II, 86 Stat. 426, 427 (33 U.S.C. 1224; 46 U.S.C. 391(a); 49 CFR 1.46(n)(4))

[CGD 77-016, 43 FR 32112, July 24, 1978, as amended by CGD 79-033, 44 FR 26741, May 7, 1979; CGD 79-033, 47 FR 34389, Aug. 9, 1982; USCG-1998-3799, 63 FR 35532, June 30, 1998]

§ 164.38 Automatic radar plotting aids (ARPA).

(a) The following definitions are used in this section—

Bulk means material in any quantity that is shipped, stored, or handled without benefit of package, label, mark or count and carried in integral or fixed independent tanks.

Constructed means a stage of construction where—

(1) The keel is laid;

(2) Construction identifiable with a specific ship begins; or

(3) Assembly of that ship has commenced comprising at least 50 tons or 1 percent of the estimated mass of all structural material, whichever is less.

Hazardous material means—

(1) A flammable liquid as defined in 46 CFR 30.10-22 or a combustible liquid as defined in 46 CFR 30.10-15;

(2) A material listed in table 151.05 of 46 CFR 151.05, table 1 of 46 CFR 153, or table 4 of 46 CFR Part 154; or

(3) A liquid, liquefied gas, or compressed gas listed in 49 CFR 172.101.

Self-propelled vessel includes those combinations of pushing vessel and vessel being pushed ahead which are rigidly connected in a composite unit and are required by Rule 24(b) of the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) (App. A to 33 CFR Part 81) to exhibit the lights prescribed in Rule 23 for a “Power Driven Vessel Underway”.

Tank vessel means a vessel that is constructed or adapted to carry; or carries, oil or hazardous materials in bulk as cargo or cargo residue.

(b) An Automatic Radar Plotting Aid (ARPA) that complies with the standard for such devices adopted by the International Maritime Organization in its “Operational Standards for Automatic Radar Plotting Aids” (Appendix A), and that has both audible and vis-

ual alarms, must be installed as follows:

(1) Each self-propelled vessel, except a public vessel, of 10,000 gross tons or more carrying oil or hazardous materials in bulk as cargo or in residue on the navigable waters of the United States, or which transfers oil or hazardous materials in any port or place subject to the jurisdiction of the United States, must be equipped with an ARPA.

(2) Each tank vessel of 10,000 gross tons or more operating on the navigable waters of the United States must be equipped with an ARPA.

(3) Each self-propelled vessel of 15,000 gross tons or more that is not a tank vessel, and is not carrying oil or hazardous material in bulk as cargo or in residue operating on the navigable waters of the United States, and was constructed before September 1, 1984, must be equipped with an ARPA, except when it is operating on the Great Lakes and their connecting and tributary waters.

(4) Each vessel of 10,000 gross tons or more, except when operating on the Great Lakes and their connecting and tributary waters, constructed on or after September 1, 1984 must be equipped with an ARPA.

(c) [Reserved]

(d)(1) Each device required under paragraph (b) of this section must have a permanently affixed label containing:

(i) The name and address of the manufacturer; and

(ii) The following statement:

“This device was designed and manufactured to comply with the International Maritime Organization (IMO) ‘Performance Standards for Automatic Radar Plotting Aids (ARPA).’”

(2) Each device allowed under paragraph (c) of this section must have a permanently affixed label containing:

(i) The name and address of the manufacturer; and

(ii) The following statement:

“This device was designed and manufactured to comply with the U.S. Maritime Administration’s ‘Collision Avoidance System Specification.’”

APPENDIX A TO §164.38—PERFORMANCE STANDARDS FOR AUTOMATIC RADAR PLOTTING AIDS (ARPA)

1 Introduction

1.1 The Automatic Radar Plotting Aids (ARPA) should, in order to improve the standard of collision avoidance at sea:

.1 Reduce the work-load of observers by enabling them to automatically obtain information so that they can perform as well with multiple targets as they can by manually plotting a single target; and

.2 Provide continuous, accurate and rapid situation evaluation.

1.2 In addition to the General Requirements for Electronic Navigational Aids ([IMO] Res. A.281(VII)), the ARPA should comply with the following minimum performance standards.

2 Definitions

2.1 Definitions of terms in these performance standards are given in Annex 1.

3 Performance Standards

3.1 Detection

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

3.2 Acquisition

3.2.1 Target acquisition may be manual or automatic. However, there should always be a facility to provide for manual acquisition and cancellation. ARPA with automatic acquisition should 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 should be indicated on the display.

3.2.2 Automatic or manual acquisition should have a performance not inferior to that which could be obtained by the user of the radar display.

3.3 Tracking

3.3.1 The ARPA should be able to automatically track, process, simultaneously display and continuously update the information on at least:

.1 20 targets, if automatic acquisition is provided, whether automatically or manually acquired; or

.2 10 targets, if only manual acquisition is provided.

3.3.2 If automatic acquisition is provided, description of the criteria of selection of targets for tracking should be provided to the user. If the ARPA does not track all targets visible on the display, targets which are being tracked should be clearly indicated on the display. The reliability of tracking should not be less than that obtainable using

manual recording of successive target positions obtained from the radar display.

3.3.3 Provided the target is not subject to target swop, the ARPA should continue to track an acquired target which is clearly distinguishable on the display for 5 out of 10 consecutive scans.

3.3.4 The possibility of tracking errors, including target swop, should be minimized by ARPA design. A qualitative description of the effects of error sources on the automatic tracking and corresponding errors should 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 emission.

3.3.5 The ARPA should be able to display on request at least four equally time-spaced past positions of any targets being tracked over a period of at least eight minutes.

3.4 Display

3.4.1 The Display may be a separate or integral part of the ship's radar. However, the ARPA display should include all the data required to be provided by a radar display in accordance with the performance standards for navigational radar equipment adopted by the Organization.

3.4.2 The design should be such that any malfunction of ARPA parts producing information additional to information to be produced by the radar as required by the performance standards for navigational equipment adopted by IMO should not affect the integrity of the basic radar presentation.

3.4.3 The display on which ARPA information is presented should have an effective diameter of at least 340 mm.

3.4.4 The ARPA facilities should be available on at least the following range scales:

- .1 12 or 16 miles;
- .2 3 or 4 miles.

3.4.5 There should be a positive indication of the range scale in use.

3.4.6 The ARPA should be capable of operating with a relative motion display with "north-up" and either "head-up" or "course-up" azimuth stabilization. In addition, the ARPA may also provide for a true motion display. If true motion is provided, the operator should be able to select for his display either true or relative motion. There should be a positive indication of the display mode and orientation in use.

3.4.7 The course and speed information generated by the ARPA for acquired targets should be displayed in a vector or graphic form which clearly indicates the target's predicted motion. In this regard:

.1 ARPA presenting predicted information in vector form only should have the option of both true and relative vectors;

.2 An ARPA which is capable of presenting target course and speed information in graphic form, should also, on request, provide the target's true and/or relative vector;

3 Vectors displayed should be either time adjustable or have a fixed time-scale;

4 A positive indication of the time-scale of the vector in use should be given.

3.4.8 The ARPA information should not obscure radar information in such a manner as to degrade the process of detecting targets. The display of ARPA data should be under the control of the radar observer. It should be possible to cancel the display of unwanted ARPA data.

3.4.9 Means should be provided to adjust independently the brilliance of the ARPA data and radar data, including complete elimination of the ARPA data.

3.4.10 The method of presentation should 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 lookout. Facilities to adjust the brightness should be provided.

3.4.11 Provisions should be made to obtain quickly the range and bearing of any object which appears on the ARPA display.

3.4.12 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 should present in a period of not more than one minute an indication of the target's motion trend and display within three minutes the target's predicted motion in accordance with paragraphs 3.4.7, 3.6, 3.8.2 and 3.8.3.

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

3.5 *Operational Warnings*

3.5.1 The ARPA should 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 should be clearly indicated on the display.

3.5.2 The ARPA should 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 should be clearly indicated on the display.

3.5.3 The ARPA should clearly indicate if a tracked target is lost, other than out of range, and the target's last tracked position should be clearly indicated on the display.

3.5.4 It should be possible to activate or de-activate the operational warnings.

3.6 *Data Requirements*

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

1. Present range to 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);
5. Calculated true course of target;
6. Calculated true speed of target.

3.7 *Trial Manoeuvre*

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

3.8 *Accuracy*

3.8.1 The ARPA should provide accuracies not less than those given in paragraphs 3.8.2 and 3.8.3 for the four scenarios defined in Annex 2. With the sensor errors specified in Annex 3, the values given relate to the best possible manual plotting performance under environmental conditions of plus and minus ten degrees of roll.

3.8.2 An ARPA should present within one minute of steady state tracking the relative motion trend of a target with the following accuracy values (95 percent probability values):

Scenario/data	Relative course (degrees)	Relative speed (Knots)	CPA (n.m.)
1	11	2.8	1.6
2	7	0.6
3	14	2.2	1.8
4	15	1.5	2.0

3.8.3 An ARPA should present within three minutes of steady state tracking the motion of a target with the following accuracy values (95 percent probability values):

Scenario/data	Relative course (degrees)	Relative speed (knots)	C.P.A. (n.m.)	TCPA (mins)	True course (degrees)	True speed (knots)
1	3.0	0.8	0.5	1.0	7.5	1.2
2	2.3	.3	2.9	.8
3	4.4	.9	.7	1.0	3.3	1.0
4	4.6	.8	.7	1.0	2.6	1.2

3.8.4 When a tracked target, or own ship, has completed a manoeuvre, the system should present in a period of not more than one minute an indication of the target's motion trend, and display within three minutes the target's predicted motion in accordance with paragraphs 3.4.7, 3.6, 3.8.2 and 3.8.3

3.8.5 The ARPA should be designed in such a manner that under the most favorable conditions of own ship motion the error contribution from the ARPA should remain insignificant compared to the errors associated with the input sensors, for scenarios of Annex 2.

3.9 *Connections with other equipment*

3.9.1 The ARPA should not degrade the performance of any equipment providing sensor inputs. The connection of the ARPA to any other equipment should not degrade the performance of that equipment.

3.10 *Performance test and warnings*

3.10.1 The ARPA should provide suitable warnings of ARPA malfunction to enable the observer to monitor the proper operation of the system. Additionally test programmes should be available so that the overall performance of ARPA can be assessed periodically against a known solution.

3.11 *Equipment used with ARPA*

3.11.1 Log and speed indicators providing inputs to ARPA equipment should be capable of providing the ship's speed through the water.

ANNEX 1 TO APPENDIX A TO §164.38—DEFINITIONS OF TERMS TO BE USED ONLY IN CONNECTION WITH ARPA PERFORMANCE STANDARDS

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.

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.

True course—The apparent heading of a target obtained by the vectorial combination of the target's relative motion and ship's own motion¹. Expressed as an angular distance from North.

True speed—The speed of a target obtained by the vectorial combination of its relative motion and own ship's motion¹.

Bearing—The direction of one terrestrial point from another. Expressed as an angular distance from North.

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

¹For the purpose of these definitions there is no need to distinguish between sea or ground stabilization.

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

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.

North-up—The line connecting the center with the top of this display is North.

Head-up—The line connecting the center with the top of the display is own ship heading.

Course-up—An intended course can be set to the line connecting the center with the top of the display.

Heading—The direction in which the bow of a vessel is pointing. Expressed as an angular distance from North.

Target's predicted motion—The indication on the display of a liner 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.

Target's motion trend—An early indication of the target's predicted motion.

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

Detection—The recognition of the presence of a target.

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

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

Display—The plan position presentation of ARPA data with radar data.

Manual—An activity which a radar observer performs, possibly with assistance from a machine.

Automatic—An activity which is performed wholly by a machine.

ANNEX 2 TO APPENDIX A TO §164.38—OPERATIONAL SCENARIOS

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 kt
- Target range—8 n.m.
- Bearing of target—000°
- Relative course of target—180°
- Relative speed of target—20 kt

Scenario 2

- Own ship course—000°
- Own ship speed—10 kt
- Target range—1 n.m.
- Bearing of target—000°
- Relative course of target—090°

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Relative speed of target—10 kt

Scenario 3

Own ship course—000°
Own ship speed—5 kt
Target range—8 n.m.
Bearing of target—045°
Relative course of target—225°
Relative speed of target—20 kt

Scenario 4

Own ship course—000°
Own ship speed—25 kt
Target range—8 n.m.
Bearing of target—045°
Relative course of target—225°
Relative speed of target—20 kt

ANNEX 3 TO APPENDIX A TO § 164.38—SENSOR ERRORS

The accuracy figures quoted in paragraph 3.8 are based upon the following sensor errors and are appropriate to equipment complying with the Organization's performance standards for shipborne navigational equipment.²

Note: σ means "standard deviation"

Radar

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)

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.

Beam shape—assumed normal distribution giving bearing error with $\sigma = 0.05$.

Pulse shape—assumed normal distribution giving range error with $\sigma = 20$ meters.

²In calculations leading to the accuracy figures quoted in paragraph 3.8, these sensor error sources and magnitudes were used. They were arrived at during discussions with national government agencies and equipment manufacturers and are appropriate to equipments complying with the Organization's draft performance standards for radar equipment (preliminary) (NAV XXII/WP.14), gyro compasses (NAV XXI/9, Annex X) and logs (preliminary) (NAV XXII/WP.15).

Independent studies carried out by national government agencies and equipment manufacturers have resulted in similar accuracies, where comparisons were made.

Antenna backlash—assumed rectangular distribution giving bearing error ± 0.5 maximum.

Quantization

Bearing—rectangular distribution $\pm 0.01^\circ$ maximum.

Range—rectangular distribution ± 0.01 n.m. maximum.

Bearing encoder assumed to be running from a remote synchro giving bearing errors with a normal distribution $\sigma = 0.03^\circ$

Gyro compass

Calibration error 0.5°.

Normal distribution about this with $\sigma = 0.12^\circ$.

Log

Calibration error 0.5 kt.

Normal distribution about this, $\sigma = 0.2$ kt.

APPENDIX B TO § 164.38—U.S. MARITIME ADMINISTRATION COLLISION AVOIDANCE SYSTEM SPECIFICATION

A collision system designed as a supplement to both surface search navigational radars via interswitching shall be installed. The system shall provide unattended monitoring of all radar echoes and automatic audio and visual alarm signals that will alert the watch officer of a possible threat. The display shall be contained within a console capable of being installed adjacent to the radar displays in the wheelhouse and may form a part of the bridge console.

Provision for signal input from the ship's radars, gyro compass, and speed log, without modification to these equipments shall be made. The collision avoidance system, whether operating normally or having failed, must not introduce any spurious signals or otherwise degrade the performance of the radars, the gyro compass or the speed log.

Computer generated display data for each acquired target shall be in the form of a line or vector indicating true or relative target course, speed and both present and extrapolated future positions. Data shall be automatically displayed on a cathode ray tube or other suitable display contrivance sufficiently bright and unobstructed to permit viewing by more than one person at a time.

In addition to displaying the collision potential of the most threatening fixed and moving targets, the system shall be capable of simultaneously showing land masses.

The system display shall include a heading indication and bearing ring. The system shall also have the capability of allowing the operator to select "head-up" and to cancel the vector or line presentation of any of the targets. The presentation shall be non-smearing when changing modes or display

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scales in order to permit rapid evaluation of the displayed data.

Target acquisition, for display data purposes, may be manual, automatic or both, as specified by Owner.

For any manual acquisition system the alarms shall be initiated by a preset minimum range; and likewise for any automatic acquisition system the alarms shall be initiated by a preset minimum acceptable passing distance (CPA—Closest Point of Approach) and a preset advance warning time (TCPA—Time to Closest Point of Approach). Means shall be provided to silence the audio alarm for a given threat but the alarm shall resound upon a subsequent threat. The visual alarm shall continue to operate until all threats have been eliminated. If the collision avoidance system fails to perform as indicated above, after the system is set for unattended monitoring, the system shall produce both audio and visual warning alarms.

The system shall be capable of simulating a trial maneuver.

In addition to the target display, an alphanumeric readout shall be provided which can present range, bearing, course, speed, CPA and TCPA for any selected target, either on the target display or by other display means.

The collision avoidance system shall be energized from the interior communications panel board in the wheelhouse.

The collision avoidance function may be incorporated in an integrated conning system, provided that failure of any other integrated system component will not degrade the collision avoidance function.

[CGD 79-148, 45 FR 54039, Aug. 14, 1980; 45 FR 71800, Oct. 30, 1980, as amended by CGD 83-004, 49 FR 43467, Oct. 29, 1984; USCG-1998-3799, 63 FR 35532, June 30, 1998]

§ 164.39 Steering gear: Foreign tankers.

(a) This section applies to each foreign tanker of 10,000 gross tons or more, except a public vessel, that—

(1) Transfers oil at a port or place subject to the jurisdiction of the United States; or

(2) Otherwise enters or operates in the navigable waters of the United States, except a vessel described by § 164.02 of this part.

(b) *Definitions.* The terms used in this section are as follows:

Constructed means the same as in Chapter II-1, Regulations 1.1.2 and 1.1.3.1, of SOLAS 74.

Existing tanker means a tanker—

(1) For which the building contract is placed on or after June 1, 1979;

(2) In the absence of a building contract, the keel of which is laid or which is at a similar stage of construction on or after January 1, 1980;

(3) The delivery of which occurs on or after June 1, 1982; or

(4) That has undergone a major conversion contracted for on or after June 1, 1979; or construction of which was begun on or after January 1, 1980, or completed on or after June 1, 1982.

Public vessel, oil, hazardous materials, and foreign vessel mean the same as in 46 U.S.C. 2101.

SOLAS 74 means the International Convention for the Safety of Life at Sea, 1974, as amended.

Tanker means a self-propelled vessel defined as a tanker by 46 U.S.C. 2101(38) or as a tank vessel by 46 U.S.C. 2101(39).

(c) Each tanker constructed on or after September 1, 1984, must meet the applicable requirements of Chapter II-1, Regulations 29 and 30, of SOLAS 74.

(d) Each tanker constructed before September 1, 1984, must meet the requirements of Chapter II-1, Regulation 29.19, of SOLAS 74.

(e) Each tanker of 40,000 gross tons or more, constructed before September 1, 1984, that does not meet the single-failure criterion of Chapter II-1, Regulation 29.16, of SOLAS 74, must meet the requirements of Chapter II-1, Regulation 29.20, of SOLAS 74.

(f) Each tanker constructed before September 1, 1984, must meet the applicable requirements of Chapter II-1, Regulations 29.14 and 29.15, of SOLAS 74.

[CGD 83-043, 60 FR 24771, May 10, 1995]

§ 164.40 Devices to indicate speed and distance.

(a) Each vessel required to be fitted with an Automatic Radar Plotting Aid (ARPA) under § 164.38 of this part must be fitted with a device to indicate speed and distance of the vessel either through the water or over the ground.

(b) The device must meet the following specifications:

(1) The display must be easily readable on the bridge by day or night.

(2) Errors in the indicated speed, when the vessel is operating free from shallow water effect, and from the effects of wind, current, and tide, should not exceed 5 percent of the speed of the