ANNEX 17

RESOLUTION MSC.64(67)
(adopted on 4 December 1996)

ADOPTION OF NEW AND AMENDED PERFORMANCE STANDARDS

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution A.825(19), by which the Assembly resolved that the functions of adopting performance standards for radio and navigational equipment, as well as amendments thereto, shall be performed by the Maritime Safety Committee on behalf of the Organization,

HAVING CONSIDERED new performance standards and amendments to existing performance standards adopted by the Assembly prepared by the forty-second session of the Sub-Committee on Safety of Navigation,

1. ADOPTS the following new and recommended performance standards, set out in Annexes 1 to 2 to the present resolution:

(a) Recommendation on Performance Standards for Integrated Bridge Systems (IBS) (Annex 1);

(b) Recommendation on Performance Standards for Shipborne DGPS and DGLONASS Maritime Radio Beacon Receiver Equipment (Annex 2);

2. ALSO ADOPTS the amendments to the following performance standards adopted by the Assembly, set out in Annexes 3 to 5 to the present resolution:

(a) Resolution A.342(IX) - Recommendation on Performance Standards for Automatic Pilots (Annex 3);

(b) Resolution A.447(XII) - Recommendation on Performance Standards for Radar Equipment (Annex 4);

(c) Resolution A.817(19) - Recommendation on Performance Standards for Electronic Chart Display and Information Systems (ECDIS) (Annex 5);

3. RECOMMENDS Member Governments to ensure that:

(a) integrated bridge systems (IBS), shipborne DGPS and DGLONASS maritime radio beacon receiver equipment and electronic chart display and information system (ECDIS) installed on or after 1 January 1999 conform to performance standards not inferior to those set out in the Annexes 1, 2 and 5 to the present resolution;

(b) heading control systems and radar equipment installed on or after 1 January 1999

(b) heading control systems and radar equipment installed on or after 1 January 1999 conform respectively to performance standards not inferior to those set out in Annexes 3 and 4 to the present resolution;

(c) automatic pilots and radar equipment installed before 1 January 1999 conform at least to the performance standards set out in resolutions A.342(IX) and A.477(XII), respectively.

ANNEX 1

RECOMMENDATION ON PERFORMANCE STANDARDS FOR INTEGRATED BRIDGE SYSTEMS (IBS)

1 INTRODUCTION

1.1 An integrated bridge system (IBS) is defined as a combination of systems which are interconnected in order to allow centralized access to sensor information or command/control from workstations, with the aim of increasing safe and efficient ship's management by suitably qualified personnel.

1.2 IBS, in addition to meeting the functional requirements contained in applicable IMO instruments, the general requirements in resolution A.694(17)*, should comply with the following performance standards.

2 SYSTEM REQUIREMENT

The IBS should support systems performing two or more of the following operations:

.1 passage execution;

.2 communications;

.3 machinery control

.4 loading, discharging and cargo control; and

.5 safety and security.

3 GENERAL REQUIREMENTS

3.1 General

3.1.1 The IBS should comply with all applicable IMO requirements and recommendations. Parts executing multiple operations should meet the requirements specified for each individual function they control, monitor or perform.

3.1.2 Each "part" of an IBS should meet the relevant requirements of resolution A.694(17) and their associated technical testing standards. In consequence, the IBS is in compliance with these requirements without further environmental testing.

Note: "part" is meant to be - for example - an individual module, equipment or subsystem.

3.1.3 A failure of one part should not affect the functionality of other parts except for those functions directly dependent upon the information from the defective part.

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*IEC 945 Publication.

3.2 **Integration**

The IBS should provide functional integration meeting the following requirements:

.1 The functionality of the IBS should ensure that its operation is at least as effective as for stand-alone equipment.

.2 Continuously displayed information should be reduced to the minimum necessary for safe operation of the ship. Supplementary information should be readily accessible.

.3 Where multifunction displays and controls are used to perform functions necessary for safe operation of the ship they should be duplicated and interchangeable.

.4 It should be possible to display the complete system configuration, the available configuration and the configuration in use.

.5 Each part to be integrated should provide details of its operational status and the latency and validity of essential information. Means should be provided within the IBS to make use of this information.

.6 An alternative means of operation should be provided for essential functions.

.7 An alternative source of essential information should be provided. The IBS should identify loss of either source.

.8 The source of information (sensor, result of calculation or manual input) should be displayed continuously or upon request.

3.3 **Data exchange**

3.3.1 Interfacing to an IBS should comply with the relevant international marine interface standards.*

3.3.2 Data exchange should be consistent with safe operation of the ship.

3.3.3 The integrity of data flowing on the network should be ensured.

3.3.4 A failure in the connectivity should not affect independent functionality.

3.4 **Failure analysis**

3.4.1 A failure analysis should be performed, documented and be acceptable.

4 **OPERATIONAL REQUIREMENTS**

4.1 **Human factors**

4.1.1 The IBS should be capable of being operated by personnel holding appropriate certificates.

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*IEC 1162 Publication.

4.1.2 The Man Machine Interface (MMI) should be designed to be easily understood and in a consistent style for all integrated functions.

4.1.3 Where multifunction displays are used, they should be in colour, and continuously displayed information and functional areas, e.g. menus should be presented in a consistent manner.

4.1.4 For actions which may cause unintended results, the IBS should request confirmation from the operator.

4.2 **Functionality**

4.2.1 It should always be clear, from where essential functions may be performed .

4.2.2 The system management should ensure, that one user only has the focus of an input or function at the same time. If so, all other users should be informed about that by the IBS.

5 TECHNICAL REQUIREMENTS

5.1 Sensors

In order to ensure an adequate system functionality the sensors employed should ensure communication compatibility in accordance with the relevant international marine interface standard*; and provide information about their operational status and about the latency and validity of essential information.

5.2 Alarm management

5.2.1 The IBS alarm management, as a minimum, should comply with the requirements of the Code on Alarms and Indicators, 1995 (resolution A.830(19)).

5.2.2 Appropriate alarm management on priority and functional groups should be provided within the IBS.

5.2.3 The number of alarm types and their release should be kept as low as possible by providing indications for information of lower importance.

5.2.4 Alarms should be displayed so that the alarm reason and the resulting functional restrictions can be easily understood. Indications should be self-explanatory.

5.3 Power interruptions and shut-down

5.3.1 If subjected to an orderly shut-down, the IBS should, upon turn-on, come to an initial default state.

5.3.2 After a power interruption full functionality of the IBS should be available after recovery 000 of all subsystems. The IBS should not increase the recovery time of individual subsystem functions after power restoration.

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*IEC 1162 Publication.

5.3.3 If subjected to a power interruption the IBS should, upon restoration of power, maintain the configuration in use and continue automated operation, as far as practicable. Safety related automatic functions should only be restored upon confirmation by the operator.

5.4 Power supply

5.4.1 Power supply requirements applying to parts of the IBS as a result of other IMO requirements should remain applicable.

5.4.2 The IBS should be supplied:

.1 from the main and emergency sources of electrical power with automated changeover through a local distribution board with provision to preclude inadvertent shut-down;

.2 from a transitional source of electrical power for a duration of not less than 1 min; and

.3 where required, parts of the IBS should also be supplied from a reserve source of electrical power.

ANNEX 2

RECOMMENDATION ON PERFORMANCE STANDARDS FOR SHIPBORNE DGPS AND DGLONASS MARITIME RADIO BEACON RECEIVER EQUIPMENT

1 INTRODUCTION

1.1 Differential services broadcast information for augmenting the Global Positioning System (GPS) and the Global Navigation Satellite System (GLONASS) to provide the accuracy and integrity required for entrances and harbour approaches and other waters in which the freedom to manoeuvre is limited. Various service providers are broadcasting differential information applicable to localized areas. Different services provide information for augmenting GPS, GLONASS, or both.

1.2 Receiver equipment for the reception and proper decoding of differential GPS and GLONASS maritime radio beacon broadcasts (fully compliant with ITU-R M.823) intended for navigational purposes on ships with maximum speeds not exceeding 50 kts shall, in addition to the general requirements contained in resolution A.694(17)*, comply with the following minimum performance requirements.

1.3 This standard covers the basic requirements of maritime radio beacon receiver equipment providing augmentation information to position-fixing equipment. It does not cover other computational facilities which may be in the equipment.

2 DGPS AND DGLONASS MARITIME RADIO BEACON RECEIVER EQUIPMENT

The words "DGPS and DGLONASS maritime radio beacon receiver equipment" as used in this performance standard includes all the components and units necessary for the system to properly perform its intended functions. The equipment should include the following minimum facilities:

.1 antenna capable of receiving DGPS or DGLONASS maritime radio beacon signals;

.2 DGPS and DGLONASS maritime radio beacon receiver and processor;

.3 receiver control interface; and

.4 data output interface.

3 FUNCTIONAL REQUIREMENTS

The DGPS and DGLONASS maritime radio beacon receiver equipment should:

.1 operate in the band of 283.5 to 315 kHz in Region 1 and 285 to 325 kHz in Regions 2 and 3 in accordance with ITU-R M.823;

.2 provide means of automatically and manually selecting the frequency, but operator acknowledgement will be required for each frequency change when in automatic mode;

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*Refer to IEC 945 Publication.

.3 make the data available for use with a delay not exceeding 100 ms after its reception;

.4 be capable of acquiring a signal in less than 45 seconds in the presence of electrical storms;

.5 have at least one serial data output that conforms to the relevant international marine interface standard*; and

.6 have an omni-directional antenna in the horizontal plane.

4 PROTECTION

Precautions should be taken to ensure that no permanent damage can result from an accidental short circuit or grounding of the antenna or any of its input or output connections or any of the DGPS and DGLONASS maritime radio beacon receiver equipment inputs or outputs for a duration of five minutes.

5 ALARMS

The DGPS and DGLONASS maritime radio beacon receiver equipment should give an alarm if no DGPS or DGLONASS message is received.

*Refer to IEC 1162 Publication.

ANNEX 3

AMENDMENT TO RESOLUTION A.342(IX) ON PERFORMANCE STANDARDS FOR AUTOMATIC PILOTS

Replace the Annex by:

"ANNEX

RECOMMENDATION ON PERFORMANCE STANDARDS FOR HEADING CONTROL SYSTEMS*

1 INTRODUCTION

In addition to the general requirements contained in resolution A.694(17)**, heading control systems should comply with the following minimum performance requirements.

2 OBJECTIVES

2.1 Within limits related to the ships's manoeuvrability the heading control system, in conjunction with its source of heading information, should enable a ship to keep a preset heading with minimum operation of the ship's steering gear.

2.2 A heading control system may work together with a track control system adjusting its heading for drift.

2.3 A turn rate control for performing turns may be provided.

3 FUNCTIONAL REQUIREMENTS

3.1 Adaption to steering characteristics and environmental conditions

The heading control system should be capable of adapting manually or automatically to different steering characteristics of the ship under various speed, weather and loading conditions, and provide reliable operation under prevailing environment and normal operational conditions.

3.2 Performing turns

The heading control system should be able to perform turns, within the turning capability of the ship, based either on a preset turning radius or a preset rate of turn.

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*Previously "Recommendation on Performance Standards for Autopilots".

**IEC 945 Publication.

3.3 Rudder angle limitation

Means should be incorporated in the equipment to enable rudder angle limitation in the automatic mode. Means should also be available to indicate when the angle of limitation has been commanded or reached. When other means of directional control are used the requirements of this section should appropriately apply.

3.4 Permitted yaw

Means should be incorporated to prevent unnecessary activation of the rudder due to normal yaw motion.

3.5 Preset heading

Any alteration of the preset heading should not be possible without intended action of the ship's personnel.

3.6 Limiting of overshoot

The heading control system should change to a preset heading without significant overshoot.

4 CHANGE-OVER FROM AUTOMATIC TO MANUAL STEERING AND VICE VERSA

4.1 Change-over from automatic to manual steering and vice-versa should be possible at any position of the rudder and should be effected by one manual control within 3 seconds.

4.2 Change-over from automatic to manual steering should be possible under any conditions including any failure in the automatic control system.

4.3 When changing over from manual to automatic steering the heading control system shall take over the actual heading as the preset heading.

4.4 There should be a single change-over control which should be located in such a position that it is easily accessible to the officer of the watch.

4.5 Adequate indication should be provided to show which method of steering is in operation.

5 CHANGE-OVER FROM TRACK CONTROL TO HEADING CONTROL

5.1 If the heading control system works as part of a track control system, then when switching from track control to heading control, the actual heading should be taken as the preset heading.

5.2 Any switching back to track control shall not be possible without intended action of the ship's personnel.

6 ALARMS AND SIGNALLING FACILITIES

6.1 Failure or reduction in power

An alarm both audible with mute function and visual should be provided in order to indicate failure or a reduction in the power supply to the heading control system or heading monitor, which would affect the safe operation of the equipment.

6.2 Off-heading alarm

An off-heading alarm, both audible with mute function and visual should be provided when the actual heading deviates from the preset heading beyond a preset limit.

6.3 Heading monitor

If the ship is required to carry two independent compasses, a heading monitor should be provided to monitor the actual heading information by independent heading sources. The heading monitor is not required to be an integrated part of the heading control system.

An alarm both audible with mute function and visual should be provided when the heading information in use deviates from the second heading source beyond a preset limit.

6.4 Indication of heading source

A clear indication of the actual heading source should be provided.

6.5 Sensor status

The heading control system should provide an indication when any input from external sensors used for control is absent. The heading control system should also repeat any alarm on the status messages concerning the quality of the input data from its external sensors when they are used for control.

7 CONTROLS

7.1 The number of operational controls should be such that easy and safe operation can be achieved. The controls should be designed to preclude inadvertent operation.

7.2 Unless features for automatic adjustment are incorporated in the installation, the heading control system should be provided with adequate controls to adjust to effects due to weather and the ship's steering performance.

7.3 The heading control system should be designed in such a way as to ensure altering the pre-set heading to starboard by turning the heading setting control clockwise or tilting it to the right-hand side. Normal alterations of heading should be possible by one adjustment only of the preset heading control.

7.4 Where remote control stations are provided, facilities for the delegation of control to the remote station and unconditional return of control should be incorporated in the master station.

7.5 Except for the preset heading setting control, the actuation of any other control should not significantly affect the heading of the ship.

7.6 Additional controls at remote positions should comply with the provisions of this performance standard.

8 INTERFACING

8.1 The heading control system should be connected to a suitable source of heading information.

8.2 The heading control system should be connected to a suitable source of speed information when it is used in a turning radius mode or when any control parameters are automatically adapted to speed.

8.3 If a heading control system is capable of digital serial communication with the ship's navigation system then the interface facilities should comply with the relevant international marine interface standards.*

*IEC 1162 Publication.

ANNEX 4

RECOMMENDATION ON PERFORMANCE STANDARDS FOR RADAR EQUIPMENT

1 INTRODUCTION

In addition to the general requirements contained in resolution A.694(17) all radar installations should comply with the following minimum requirements.

2 GENERAL

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

3 RADAR

3.1 Range performance

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

.1 **Coastlines**

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

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

.2 **Surface objects**

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

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

At 2 nautical miles an object such as a navigational buoy having an effective echoing area of approximately 10 m^2.

3.2 Minimum range

The surface objects specified in 3.1.2 should be clearly displayed from a minimum horizontal range of 50 m from the antenna position up to a range of 1 nautical mile, without changing the setting of controls other than the range selector.

3.3 **Display**

3.3.1 The equipment should provide, without external magnification, a daylight display with a minimum effective diameter within the bearing scale of not less than:

.1 180 mm on ships of 150* gross tonnage and more but less than 1,000* gross tonnage;

.2 250 mm on ships of 1,000* gross tonnage and more but less than 10,000 gross tonnage, and

.3 340 mm on ships of 10,000 gross tonnage and upwards.

3.3.2 The equipment should provide the following set of range scales of display: 0.25, 0.5, 0.75, 1.5, 3, 6, 12 and 24 nautical miles.

3.3.3 Additional larger and smaller range scales may be provided.

3.3.4 The range scale displayed and the distance between range rings should be clearly indicated at all times.

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

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

3.3.7 Multi-colour displays are permitted but the following requirements should be met:

.1 target echoes should be displayed by means of the same basic colours and the echo strength should not be displayed in different colours; and

.2 additional information may be shown in different colours.

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

3.3.9 Selected parts of the System Electronic Navigation Chart (SENC) information may be displayed in such a way that the radar information is not masked, obscured or degraded. If SENC information is made available for a radar display it should at least include coastlines, own ship's safety contour, dangers to navigation and fixed and floating aids to navigation. The mariner should be able to select those parts of the SENC, which can be made available and the mariner requires to be displayed.

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*Gross tonnage limits to be aligned with the carriage requirements for radar of the revised SOLAS chapter V under development.

3.3.10 For the superimposition of selected parts of the SENC:

.1 Reference management
Reference management is required to ensure that the information displayed is correlated and in the same reference and co-ordinate system;

.2 Display Area
the whole effective display area should contain the available radar and SENC information;

.3 Matching and Adjustment
in case of any deviations between the chart image and the radar image through detectable causes, manual adjustment should be possible. Any manual adjustment should be clearly indicated as long as it is activated. Resetting should be possible in a simple manner;

.4 Priority in the Display
the display of radar information should have priority;

.5 Stability
The equipment should be capable of appropriately stabilizing the radar image, ARPA vectors and SENC information. The operating mode should be clearly indicated; and

.6 Independence of Radar/ARPA and SENC

.6.1 the SENC information should not have an adverse effect on the radar picture;

.6.2 Radar/ARPA information and SENC information should be clearly recognizable as such; and

.6.3 in the case of a malfunction of one component, the function of the other component should not be affected.

3.3.11 The frequency band in use should be indicated to the operator.

3.4 **Range measurement**

3.4.1 Electronic fixed range rings should be provided for range measurements as follows:

.1 on the range scale 0.25, 0.5, 0.75 nautical miles at least two and not more than six range rings should be provided, on each of the other mandatory range scales six range rings should be provided; and

.2 where off-centred facilities have been provided, additional range rings should be provided at the same range intervals.

3.4.2 An electronic variable range marker in the form of a ring should be provided with a numeric readout of range. This readout should not display any other data. For ranges of less than 1 nautical mile, there should be only one zero before the decimal point. Additional variable range markers may be provided.

3.4.3 The fixed range rings and the variable range markers should enable the range of an object to be measured with an error not exceeding 1% of the maximum range of the scale in use, or 30 m, whichever is the greater.

3.4.4 The accuracy should be maintained when the display is off-centred.

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

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

3.5 **Heading indication**

3.5.1 The heading of the ship should be indicated by a continuous line on the display with a maximum error of not greater than ± 1°. The thickness of the displayed heading line should not be greater than 0.5° measured at maximum range at the edge of the radar display. The heading line should extend from the trace origin to the edge of the display.

3.5.2 Provision should be made to switch off the heading indicator by a device which cannot be left in the "heading line off" position.

3.5.3 A heading marker should be displayed on the bearing scale.

3.6 **Bearing measurement**

3.6.1 An Electronic Bearing Line, (EBL), should be provided with a numeric readout of bearing to obtain within 5 s the bearing of any object whose echo appears on the display.

3.6.2 The EBL should enable the bearing of a target whose echo appears at the edge of the display to be measured with a maximum error of not greater than ± 1°.

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

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

3.6.5 The rotation of the EBL should be possible in both directions continuously or in steps of not more than 0.2°.

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

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

3.6.8 The bearing scale should have division marks for at least each 5°, with the 5° and 10° divisions clearly distinguishable from each other. Numbers should clearly identify at least each 30° division.

3.6.9 It should be possible to measure the bearing relative to the heading line and relative north.

3.6.10 A minimum of two independent lines of parallel index lines should be provided.

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

3.7 Discrimination

3.7.1 Range

The equipment should be capable of displaying as separate indications on a range scale of 1.5 nautical miles, two small similar targets at a range of between 50% and 100% of the range scale, and on the same bearing, separated by not more than 40 m in range.

3.7.2 Bearing

The equipment should be capable of displaying as separate indications two small similar targets both situated at the same range between 50% and 100% of the 1.5 nautical mile range scale, and separated by not more than 2.5° in bearing.

3.8 Roll or pitch

The performance of the equipment should be such that when the ship is rolling or pitching up to $\pm$ 10° the range performance requirements of 3.1 and 3.2 continue to be met.

3.9 Antenna Scan

The scan should be clockwise, continuous and automatic through 360° of azimuth. The antenna rotation rate should be not less than 20 revolutions per minute. The equipment should start and operate satisfactorily in relative wind speeds of up to 100 knots. Alternative methods of scanning are permitted provided that the performance is not inferior.

3.10 Azimuth stabilization

3.10.1 Means should be provided to enable the display to be stabilized in azimuth by a gyro-compass, or its equivalent in performance. The accuracy of alignment with the compass transmission should be within 0.5° with a compass rotation rate of 2 revolutions per minute.

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

3.10.3 Change over from one display mode to the other should be possible within 5 s and achieve the required bearing accuracy.

3.11 **Performance monitoring**

Means should be available, while the equipment is used operationally, to determine readily a significant drop in system performance relative to a calibration standard established at the time of installation. Means should be provided to check that the equipment is correctly tuned in the absence of targets.

3.12 **Anti-clutter devices**

3.12.1 Suitable means should be provided for the suppression of unwanted echoes from sea clutter, rain and other forms of precipitation, clouds, sandstorms and from other radars. It should be possible to adjust manually and continuously the anti-clutter controls. In addition, automatic anti-clutter controls may be provided; however, they should be capable of being switched off.

3.12.2 The operational requirement, when the radar antenna is mounted at a height of 15 m above sea level, is that the equipment should, even in the presence of sea clutter, give a clear indication of a standard reflector up to 3.5 nautical miles.

3.13 **Operation**

3.13.1 **Availability**

After switching on from cold the equipment should become fully operational within 4 min.

A stand-by condition should be provided from which the equipment can be brought to an operational condition within 15 s.

3.13.2 **Controls**

Operational controls should be accessible and easy to identify and use. Controls should be identified and easy to operate.[1]

The equipment should be capable of being switched on and off and operated from the master display position.

It should be possible to vary the brilliance of the fixed range rings and the variable range markers and electronic bearing lines and to remove them independently and completely from the display.

For radars with additional synthetic information (e.g. target identifiers, vectors, navigational information), means should be provided capable of removing this additional information from the screen.

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[1]IEC 936 and IEC 945 Publications.

3.14 **Operation with radar beacons and SARTS**

3.14.1 Radar should be able to detect and display signals from radar beacons and 9 GHz radars should also be able to detect and display signals from Search and Rescue Transponders (SARTs).

3.14.2 All radars operating in the 9 GHz band should be capable of operating in a horizontally polarized mode. If other polarization modes are available there should be a positive indication of their use on the display.

3.14.3 It should be possible to switch off those signal processing facilities which might prevent a radar beacon or SART from being shown on the radar display.

3.15 **Display modes**

3.15.1 The equipment should be capable of operating in relative and true motion.

3.15.2 The radar origin should be capable of being off-set to at least 50% and not more than 75% of the radius of the display.

3.15.3 The radar should be capable of sea and ground stabilisation. With sea or ground stabilisation the accuracy and discrimination of the display should be at least equivalent to that required by this Performance Standard.

3.15.4 Speed and Distance Measuring Equipment (SDME) providing the ship's speed through the water to the radar should be capable of providing the speed in the fore and aft direction.

3.15.5 The ground stabilized input should be two-dimensional. It may be provided from the SDME, from an electronic position-fixing system or from radar tracked stationary targets. The speed accuracy should be in accordance with the requirements of resolution A.824(19).

3.15.6 The type of input and stabilisation in use should be displayed.

3.15.7 It should also be possible to input the ship's speed manually from 0 (zero) knots to 30 knots in steps of not more than 0.2 knots.

3.15.8 Provision should be made for manual input of set and drift.

3.16 **Interference from external magnetic fields**

After installation and adjustment on board, the bearing accuracy as prescribed in this Performance Standard should be maintained without further adjustment irrespective of the movement of the ship in the earth's magnetic field.

3.17 Radar installation

The radar installation, including the antenna, should be in such a manner that the performance of the radar system is not substantially impaired. Guidance on installation should be given in manufacturer documentation.

3.18 Failure Warnings and Status indications

If there is any detectable reason why the information presented to the operator is invalid, adequate and clear warning should be given to the operator.

4 MULTIPLE RADAR INSTALLATIONS

4.1 Where two radars are required to be carried they should be so installed that each radar can be operated individually and both can be operated simultaneously without being dependant upon one another. When an emergency source of electrical power is provided in accordance with the appropriate requirements of chapter II-1 of the 1974 SOLAS Convention, both radars should be capable of being operated from this source.

4.2 Where two radars are fitted, interswitching facilities may be provided to improve the flexibility and availability of the overall radar installation. They should be so installed that failure of either radar would not cause the other radar to be adversely affected.

5 INTERFACE

5.1 The radar system should be capable of receiving information from equipment such as gyro-compass, speed and distance measurement equipment (SDME) and electronic position-fixing systems (EPFS) in accordance with international standards.[1] The source of received information should be capable of being displayed.

5.2 The radar should provide an indication when any input from an external sensor is absent. The radar should also repeat any alarms or status messages concerning the quality of the input data from it's external sensors.

5.3 If any radar outputs are provided they should be in accordance with international standards.[2]

6 NAVIGATIONAL INFORMATION

The radar display should be capable of presenting in graphical form, positions, navigational lines and maps, in addition to the radar information. It should be possible to adjust these points, lines and maps relative to a geographical reference. The source of the graphical information and the method of geographical referencing should be clearly indicated.

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[1]IEC 1162 Publication.

7 PLOTTING

Plotting facilities should be provided with the radar as follows:

7.1 Ships which are fitted with an electronic plotting aid should be fitted with an "electronic plotting aid" for manual direct plotting as defined in Appendix 2.

7.2 Ships which are fitted with an Auto Tracking Aid should be fitted with an "Auto Tracking Aid" as defined in Appendix 1.

7.3 Ships which are fitted with an Automatic Radar Plotting Aid should be fitted with ARPA with a minimum effective diameter of 250 mm as defined in resolution A.823(19) The second radar should be fitted with at least an "Auto Tracking Aid".

7.4 Ships of 10,000 gross tonnage and more should be fitted with ARPAs with a minimum effective diameter of 340 mm as defined in resolution A.823(19).

7.5 It should be possible to display the trails of radar echoes of targets in the form of synthetic afterglow. The trails may be either relative or true. The true trails may be sea or ground stabilised. The trails should be distinguishable from the targets.

8 ERGONOMICS

8.1 The following functions should be directly accessible and immediately effected:

- On-/off-switch
- Monitor brilliance
- Tuning (if manual)
- Range selection
- Anticlutter rain
- Electronic bearing line
- Dimmer for panel illumination
- Gain
- Presentation made
- Anticlutter sea
- Variable range marker
- Marker (cursor)

8.2 The following functions should be continuously variable or in small, quasi-analogue steps:

- Monitor brilliance
- Tuning (if manual)
- Anticlutter rain
- Electronic bearing line
- Gain
- Anticlutter sea
- Variable range marker
- Marker (cursor)

8.3 The settings of the following functions should be readable in all light conditions:

- Dimmer for panel illumination
- Gain
- Anticlutter sea
- Monitor brilliance
- Tuning (if manual)
- Anticlutter rain

8.4 For the following functions additional automatic adjustment may be provided. The use of the automatic mode be indicated to the operator and be capable of being switched off:

- Monitor brilliance
- Anticlutter rain
- Gain
- Anticlutter sea

8.5 If discrete controls are available for the EBL and VRM they should be situated on the left and right hand side respectively.

APPENDIX 1

PERFORMANCE STANDARDS FOR "AUTO TRACKING"

1 INTRODUCTION

"Auto Tracking" should, 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; and

.2 provide continuous, accurate and rapid situation evaluation.

2 DEFINITIONS

Definitions of terms used in these performance standards are given in annex 1 to this appendix.

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 There should be a facility to provide for manual acquisition and cancellation for relative speeds up to 100 knots.

3.2.2 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 "auto tracking" should be able to automatically track, process, simultaneously display and continuously update the information on at least 10 targets.

3.3.2 The "auto tracking" should continue to track an acquired target which is clearly distinguishable on the display for 5 out of 10 consecutive scans, provided the target is not subject to target swop.

3.3.3 The possibility of tracking errors, including target swop, should be minimised by "auto tracking" 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 emissions.

3.4 **Display**

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

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

3.4.3 The "auto tracking" facilities should be available on at least the 3,6 and 12 nautical mile range scales, and there could be a positive indication of the range scale in use.

3.4.4 "Auto tracking" facilities may also be provided on other range scales.

3.4.5 The "auto tracking" should be capable of operating with a relative motion display with "north-up" and "course-up" azimuth stabilization. In addition, the "auto tracking" 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.

3.4.6 The course and speed information generated by the "auto tracking" for acquired targets should be displayed in a vector or graphic form which clearly indicates the target's predicted motion with relevant symbols[1]. In this regard:

.1 "auto tracking" presenting predicted information in vector form only should have the option of both true and relative vectors. There should be an indication of the vector mode selected, and if "true" is selected there should be a display of whether it is stabilized with reference to sea or ground;

.2 an "auto tracking" 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 time adjustable;

.4 a positive indication of the time-scale of vector in use should be given; and

.5 if stationary targets are being used for ground referencing then this should be indicated with the relevant symbol[1]. In this mode, relative vectors including those of the targets used for ground referencing should be displayed when requested.

3.4.7 The "auto tracking" information should not obscure the visibility of radar targets. The display of "auto tracking" data should be under the control of the radar observer. It should be possible to cancel the display of unwanted "auto tracking" data within 3 s.

3.4.8 Means should be provided to adjust independently the brilliance of the "auto tracking" data and radar data, including complete extinction of the "auto tracking" data.

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[1]IEC 872 Publication.

3.4.9 The method of presentation should ensure that the "auto tracking" data are clearly visible in general to more than one observer in the conditions of light normally experienced on the brige 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 should be provided.

3.4.10 Provisions should be made to obtain quickly the range and bearing of any object which appears on the "auto tracking" display.

3.4.11 The "auto tracking" should 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 paragraphs 3.4.6, 3.6, 3.7.2 and 3.7.3 of this Appendix.

3.4.12 After changing range scales on which the "auto tracking" facilities are available or resetting the display, full plotting information should be displayed within a period of time not exceeding one scan.

3.5 Operational warnings

3.5.1 The "auto tracking" should 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 should be clearly indicated with the relevant symbols[3] on the display.

3.5.2 The "auto tracking" should 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 should be clearly indicated with the relevant symbols[3] on the display.

3.5.3 The "auto tracking" 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 for the observer to activate or de-activate the audible warning capability.

3.6 Data requirements

3.6.1 The observer should be able to select any tracked target to obtain data. Targets selected should be marked with the relevant symbol on the radar display[3]. 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.

3.6.2 The following data for each selected target should 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);

.5 calculated true course of the target; and

.6 calculated true speed of the target.

3.6.3 The display of 3.6.2, items 5 and 6 should include an identification of whether the data uses sea or ground reference.

3.6.4 When data for several targets is displayed, not less than two items should be displayed simultaneously for each target selected. If the items of data are displayed in pairs for each target the groupings should be: 3.6.2 items 1 with 2, 3 with 4; and, 5 with 6.

3.7 **Accuracy**

3.7.1 The "auto tracking" should provide accuracies not less than those given in paragraphs 3.7.2 and 3.7.3 for the four scenarios defined in annex 2 to this appendix. With the sensor errors specified in annex 3 to this appendix, the values given relate to the best possible manual plotting performance under environmental conditions of ± 10° of roll.

3.7.2 The "auto tracking" should present within 1 min of steady state tracking the relative motion trend of a target with the following accuracy values (95% probability values).

Data / Scenario	Relative course (°)	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

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.

3.7.3 The "auto tracking" should present within three minutes of steady state tracking the motion of a target with the following accuracy values (95% probability values).

Data / Scenario	Relative course (°)	Relative speed (knots)	CPA (nautical miles)	TCPA (min)	True course (°)	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

3.7.4 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 3 min the target's predicted motion, in accordance with paragraphs 3.4.6, 3.6, 3.7.2 and 3.7.3 of this Appendix. In this context, a "manoeuvre of own ship shall be deemed to consist of an alteration of course $\pm$ 45° in 1 min.

3.7.5 The "auto tracking" should be designed in such a manner that under the most favourable conditions of own ship motion the error contribution from the "auto tracking" should remain insignificant compared to the errors associated with the input sensors, for the scenarios of annex 2 to this appendix.

3.8 **Connections with other equipment**

3.8.1 The "auto tracking" should not degrade the performance of any equipment providing sensor inputs. The connection of the "auto tracking" to any other equipment should not degrade the performance of that equipment. This requirement should be met whether the 'auto tracking' is operating or not. Additionally the "auto tracking" should be designed to comply with this requirement under fault conditions as far as is practicable.

3.9 **Performance tests and warnings**

3.9.1 The "auto tracking" should provide suitable warnings of "auto tracking" 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 "auto tracking" can be assessed periodically against a known solution. When a test programme is being executed the relevant test symbols[3] should be displayed.

3.10 **Sea and ground stabilisation**

3.10.1 Log and speed indicators providing inputs to "auto tracking" equipment should be capable of providing the ship's speed through the water in the fore and aft direction.

3.10.2 If a ground stabilised input is also available from the log, from an electronic position-fixing system or from tracked stationary targets then the type of input in use should be displayed.

3.11 **Equipment connected to "Auto Tracking"**

3.11.1 Speed and course measuring equipment should be connected to the "auto tracking".

3.11.2 The speed input should provide speed through the water and may, in addition, provide speed over ground.

3.11.3 The type of measuring equipment in use should be indicated on the display.

ANNEX 1 to APPENDIX "Auto Tracking"

DEFINITIONS OF TERMS TO BE USED IN CONNECTION WITH "AUTO TRACKING" AND RADAR PERFORMANCE STANDARDS

Target: Any object fixed or moving whose position and motion is determined by measurements of range and bearing on radar.

Relative Course:	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.
Relative Speed:	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.
Relative Motion:	The combination of relative course and relative speed.
True Course:	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.*
True Speed:	The speed of a target obtained by a vector combination of target relative motion and own ship's true motion.*
True Motion:	The combination of true course and true speed.
True Bearing:	The direction of a target from own ship or from another target expressed as an angular displacement from north.
Relative Bearing:	The direction of a target from own ship expressed as an angular displacement from own ship's heading.
True Motion Display:	A display across which own ship and each target moves with its own true motion.
Relative Motion Display:	A display on which the position of own ship remains fixed and all targets move relative to own ship.
Azimuth Stabilised Display:	A display on which the azimuth orientation relative to a nominated true bearing is fixed.
North-up Display:	An azimuth stabilised display in which a line connecting the centre with the top of the display is north true bearing.
Course-up Display:	An azimuth stabilised display in which a line connecting the centre with the top or the display is own ship's intended course.

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

Heading:	The direction in which the bows of a ship are pointing expressed as an angular displacement from north.
Target's Predicted Motion:	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.
Relative Vector:	The predicted movement of a target relative to own ship.
True Vector:	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 sea or to the ground.
Acquisition:	The process of selecting a target or targets in order to initiate their tracking.
Tracking:	The computer process of observing the sequential changes in the position of a target in order to establish its motion.
Target Swop:	A situation in which the incoming radar data for a tracked target becomes incorrectly associated with another tracked target or a radar echo.
Echo Reference:	A facility for indicating that a particular fixed Navigational Mark which is being tracked is to be used as a Ground Stabilised reference.
CPA/TCPA:	Closest Point of Approach and Time to Closest Point of Approach limit as defined by the observer to give warning when a tracked target or targets will close to within these limits from own ship.
Bad Echo:	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.
Lost Target:	The name associated with a target that is no longer being tracked having become lost or obscured.
Sea Stabilization:	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. This display is ideal for both Collision Avoidance and Navigational purposes.
Ground Stabilization:	A mode of display whereby own ship and all targets are referened to the Ground using Ground Track or Set and Drift inputs. This display is ideal for Navigational purposes. However it should be used with extreme caution when assessing close quarter situations with other targets.

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.

ANNEX 2 to APPENDIX 1 "Auto Tracking"

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 min:

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 3 to APPENDIX 1 "Auto Tracking"

SENSOR ERRORS

The accuracy figures quoted in paragraph 3.7 of the Appendix are based upon the following sensor errors and are appropriate to equipment complying with the performance standards for shipborne navigational equipment.

Note: δ means "standard deviation".

Radar

Target glint (scintillation) (for 200 m length target)

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

Across beam of target $\delta = 1$ 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 000°, 090°, 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 $\delta = 0.05°$

Pulse shape - assumed normal distribution giving range error with $\delta = 20$ m

Antenna backlash - assumed rectangular distribution giving bearing error $\pm$ 0.05° maximum

Quantization

Bearing - rectangular distribution $\pm$ 0.1° maximum
Range - rectangular distribution $\pm$ 0.01 nautical miles maximum

Bearing encoded assumed to be running from a remote synchro giving bearing errors with a normal distribution $\delta = 0.03°$.

Gyro-compass

Calibration error 0.5°
Normal distribution about this with $\delta = 0.12°$

Log

Calibration error 0.5°
Normal distribution about this, $3\delta = 0.2$ knots.

APPENDIX 2

ELECTRONIC PLOTTING AIDS

1 Introduction

The electronic plotting aid for manual direct plotting is intended for small ships fitted with either a gyro compass or transmitting marine electromagnetic compass.[1] The plotting aid is not suitable for ships classed as high speed craft.

2 Performance standards

2.1 The electronic plotting aid should provide a means to plot a minimum of 10 targets on a radar display.

2.2 It should be possible to plot targets on the 3, 6 and 12 nautical mile range scales. The facility may be provided on additional range scales. Plots should be maintained when switching between range scales.

2.3 It should be possible to plot targets with a relative speed up to 75 knots.

2.4 It should be possible for the operator to adjust the CPA/TCPA limits and the vector time.

2.5 Plot positions should be identified by an approved symbol and an associated plot number. It should be possible to switch off the plot number.

2.6 The minimum lapsed time between any two plots should be greater than 30 s.

2.7 After the second plot, a vector should be displayed on the target. It should be possible to select a true or relative vector. There should be a positive indication of vector mode.

2.8 The vector origin should move across the screen at a rate and direction defined by the calculated true course and speed.

2.9 It should be possible to correct the position of a plot.

2.10 It should be possible, on demand, to display the following data on a selected target:

.1 plot number: time since last plot (min)

.2 present range of the target

.3 present bearing of the target

.4 predicted target range at the closest point of approach (CPA)

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[1]ISO 11606 Publication.

.5 predicted time to CPA (TCPA)

.6 calculated true course of target

.7 calculated true speed of target

The selected plot should be clearly identified with an approved symbol and the plot data should be displayed outside of the screen radar area.

2.11 There should be an indication of any plot that is not updated for 10 min. The plot should be dropped if the time between consecutive plots exceeds 15 min.

ANNEX 5

AMENDMENT TO RESOLUTION A.817(19) - PERFORMANCE STANDARDS FOR ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEMS (ECDIS)

Add a new Appendix 6 to the Annex to the resolution:

"APPENDIX 6

BACK-UP REQUIREMENTS

1 INTRODUCTION

As prescribed in section 14 of this performance standard, adequate independent back-up arrangements should be provided to ensure safe navigation in case of ECDIS failure. Such arrangements include:

.1 facilities enabling a safe take-over of the ECDIS functions in order to ensure that an ECDIS failure does not result in a critical situation;

.2 a means to provide for safe navigation for the remaining part of the voyage in case of ECDIS failure.

2 PURPOSE

The purpose of an ECDIS back-up system is to ensure that safe navigation is not compromised in the event of ECDIS failure. This should include a timely transfer to the back-up system during critical navigation situations. The back-up system shall allow the vessel to be navigated safely until the termination of the voyage.

3 FUNCTIONAL REQUIREMENTS

3.1 Required functions and their availability

3.1.1 Presentation of chart information

The back-up system should display in graphical (chart) form the relevant information of the hydrographic and geographic environment which are necessary for safe navigation.

3.1.2 Route planning

The back-up system should be capable of performing the route planning functions, including:

.1 taking over of the route plan originally performed on the ECDIS;

.2 adjusting a planned route manually or by transfer from a route planning device.

3.1.3 **Route monitoring**

The back-up system should enable a take-over of the route monitoring originally performed by the ECDIS, and provide at least the following functions:

.1 plotting own ship's position automatically, or manually on a chart;

.2 taking courses, distances and bearings from the chart;

.3 displaying the planned route;

.4 displaying time labels along ship's track;

.5 plotting an adequate number of points, bearing lines, range markers, etc., on the chart.

3.1.4 **Display information**

If the back-up is an electronic device, it should be capable of displaying at least the information equivalent to the standard display as defined in this performance standard.

3.1.5 **Provision of chart information**

.1 The chart information to be used should be the latest editions of that originated by a government hydrographic office, and based on IHO standards.

.2 It should not be possible to alter the contents of the electronic chart information.

.3 The chart or chart data edition and issuing date should be indicated.

3.1.6 **Updating**

The information displayed by the ECDIS back-up arrangements should be up-to-date for the entire voyage.

3.1.7 **Scale**

If an electronic device is used, it should provide an indication:

.1 if the information is displayed at a larger scale than that contained in the database; and

.2 if own ship's position is covered by a chart at a larger scale than that provided by the system.

3.1.8 If radar and other navigational information are added to an electronic back-up display, all the corresponding requirements of this performance standard should be met.

3.1.9 If an electronic device is used, the display mode and generation of the neighbouring area should be in accordance with section 7 of this performance standard.

3.1.10 **Voyage recording**

The back-up arrangements should be able to keep a record of the ship's actual track, including positions and corresponding times.

3.2 Reliability and accuracy

3.2.1 **Reliability**

The back-up arrangements should provide reliable operation under prevailing environmental and normal operating conditions.

3.2.2 **Accuracy**

Accuracy shall be in accordance with section 11 of this performance standard.

3.3 **Malfunctions, warnings, alarms and indications**

If an electronic device is used, it should provide a suitable indication of system malfunction.

4 OPERATIONAL REQUIREMENTS

4.1 Ergonomics

If an electronic device is used, it should be designed in accordance with the ergonomic principles of ECDIS.

4.2 Presentation of information

4.2.1 Colours and symbols used in the back-up arrangements should be based on IHO recommendations.

4.2.2 If an electronic device is used, the effective size of the chart presentation shall be in accordance with section 9.2 of this performance standard.

5 POWER SUPPLY

If an electronic device is used:

.1 the back-up power supply should be separate from the ECDIS; and

.2 conform to the requirements in this ECDIS performance standard.

6 CONNECTIONS WITH OTHER EQUIPMENT

6.1 If an electronic device is used, it should:

.1 be connected to systems providing continuous position-fixing capability; and

.2 not degrade the performance of any equipment providing sensor input.

6.2 If radar with selected parts of the ENC chart information overlay is used as an element of the back-up, the radar should comply with resolution A.477(XII), as amended.

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