ANNEX 12

RESOLUTION MSC.74(69)
(adopted on 12 May 1998)

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 and prepared by the forty-third session of the Sub-Committee on Safety of Navigation,

1. ADOPTS the following new and recommended performance standards, set out in Annexes 1 to 3 to the present resolution:

(a) Recommendation on Performance Standards for Shipborne Combined GPS/GLONASS Receiver Equipment (Annex 1);

(b) Recommendation on Performance Standards for Track Control Systems (Annex 2); and

(c) Recommendation on Performance Standards for Universal Automatic Identification System (AIS) (Annex 3);

2. ADOPTS ALSO the amendments to the following performance standards adopted by the Assembly, set out in Annex 4 to the present resolution:

(a) Resolution A.224(VII) - Recommendation on Performance Standards for Echo-Sounding Equipment (Annex 4);

3. RECOMMENDS Member Governments to ensure that:

(a) shipborne combined GPS/GLONASS receiver equipment, track control systems and AIS installed on or after 1 January 2000 conform to performance standards not inferior to those set out in the Annexes 1 to 3 to the present resolution;

(b) echo-sounding equipment installed on or after 1 January 2001 conform respectively to performance standards not inferior to those set out in Annex 4 to the present resolution;

(c) echo-sounding equipment installed before 1 January 2001 conform at least to the performance standards set out in resolution A.224(VII).

ANNEX 1

RECOMMENDATION ON PERFORMANCE STANDARDS FOR SHIPBORNE COMBINED GPS/GLONASS RECEIVER EQUIPMENT

1 INTRODUCTION

1.1 The Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS) are space-based positioning, velocity and time systems. The GPS space segment will normally be composed of 24 satellites in six orbits. The spacing of satellites in orbit will be arranged so that a minimum of four satellites will be in view to users world-wide, with a position dilution of precision (PDOP) $\leq$ 6. The GLONASS space segment will normally be composed of 24 satellites placed in 3 orbital planes with 8 satellites in each plane. The spacing of satellites in orbit will be arranged so that a minimum of four satellites will be in view to users world-wide, with a PDOP $\leq$ 6.

1.2 A combined receiver, when compared to either the GPS or GLONASS receiver, offers improved availability, integrity, accuracy and resistance to interference; increased ease of installation, and the ability to operate in the differential GPS mode (DGPS), differential GLONASS mode (DGLONASS) and combined DGPS and DGLONASS mode, when available.

1.3 Receiver equipment capable of combining individual satellite measurements from GPS and GLONASS constellations to form a single solution is intended for navigational purposes on ships with maximum speeds not exceeding 50 knots. Such equipment should, in addition to the general requirements contained in resolution A.694(17), comply with the following minimum performance requirements.

1.4 These standards cover the basic requirements of position-fixing for navigation purposes only and do not cover other computational facilities which may be in the equipment.

2 COMBINED GPS/GLONASS RECEIVER EQUIPMENT

2.1 The words "combined GPS/GLONASS receiver equipment" as used in these performance standards include 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 both GPS and GLONASS signals;

.2 combined GPS/GLONASS receiver and processor;

.3 means of accessing the computed latitude/longitude position;

.4 data control and interface; and

.5 position display.

2.2 The antenna design should be suitable for fitting at a position on the ship which ensures a clear view of the satellite constellations.

3 PERFORMANCE STANDARDS FOR COMBINED GPS/GLONASS RECEIVER EQUIPMENT

3.1 The combined GPS/GLONASS receiver equipment should:

.1.1 be capable of receiving and processing the Standard Positioning Service (SPS) signals of the GPS as modified by Selective Availability (SA) and range code signals in GLONASS and provide position information in latitude and longitude World Geodetic System (WGS) 84 co-ordinates in degrees, minutes and thousandths of minutes. Means may be provided to transform the computed position into data compatible with the datum of the navigational chart in use. Where this facility exists, the display and any data output should indicate that the co-ordinate conversation is being performed and should identify the co-ordinate system in which the position is expressed;

.1.2 operate on the L1 frequency signal and C/A code in GPS and L1 frequency signal and range code in GLONASS;

.1.3 be provided with at least one output from which position information can be supplied to other equipment. The output of position information should be in accordance with the relevant international standard;[*]

.1.4 have static accuracy such that the position of the antenna is determined to within 35 m (95%) in non-differential mode and 10 m (95%) in differential mode with horizontal dilution of precision (HDOP) $\leq$ 4 or position dilution of precision (PDOP) $\leq$ 6;

.1.5 have dynamic accuracy such that the position of the ship is determined to within 35 m (95%) in non-differential mode and 10 m (95%) in differential mode with HDOP $\leq$ 4 or PDOP $\leq$ 6 under the conditions of sea states and ship's motion likely to be experienced in ships[**];

.1.6 be capable of selecting automatically the appropriate satellite transmitted signals for determination of the ship's position with the required accuracy and update rate;

.1.7 be capable of acquiring satellite signals with input signals having carrier levels in the range of -130 dBm to -120 dBm. Once the satellite signals have been acquired the equipment should continue to operate satisfactorily with satellite signals having carrier levels down to -133 dBm;

.1.8 be capable of acquiring position to the required accuracy, within 30 min, when there is no valid almanac data;

.1.9 be capable of acquiring position to the required accuracy, within 5 min, when there is valid almanac data;

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[*]IEC 1162 Publication

[**]Resolution A.694(17); IEC 721-3-6, IEC 945 and IEC 1108-3 Publications

.1.10 be capable of re-acquiring position to the required accuracy, within 5 min, when all GPS and GLONASS signals are interrupted for a period of at least 24 h, but there is no loss of power;

.1.11 be capable of re-acquiring position to the required accuracy, within 2 min, when subjected to a power interruption of 60 s;

.1.12 be capable of re-acquiring an individual satellite signal and utilizing it in the position solution within 10 s after being blocked for 30 s;

.1.13 generate and output a new position solution at least once every 1 s;

.1.14 have a minimum resolution of position, i.e. latitude and longitude of 0.001 min; and

.1.15 have the facilities to process DGPS and DGLONASS data fed to it, in accordance with Recommendation ITU-R M.823 and the appropriate RTCM standard.

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 combined GPS/GLONASS receiver equipment inputs or outputs for a duration of 5 min.

5 FAILURE WARNINGS AND STATUS INDICATIONS

5.1 The equipment should provide an indication if the position calculated is likely to be outside of the requirements of these performance standards.

5.2 The combined GPS/GLONASS receiver equipment should provide as a minimum:

.1 an indication within 5 s if either:

a) the specified HDOP has been exceeded; or

b) a new position has not been calculated for more than 1 s.

Under such conditions the last known position and the time of the last valid fix, with explicit indication of this state, so that no ambiguity can exist, should be output until normal operation is resumed;

.2 a warning of loss of position; and

.3 DGPS and DGLONASS status indication of:

a) the receipt of DGPS and DGLONASS signals; and

b) whether DGPS and DGLONASS corrections are being applied to the indicated ship's position.

ANNEX 2

RECOMMENDATION ON PERFORMANCE STANDARDS FOR TRACK CONTROL SYSTEMS

1 Scope

Track control systems in conjunction with their sources of position, heading and speed information are intended to keep a ship automatically on a pre-planned track over ground under various conditions and within the limits related to the ship's manoeuvrability. A track control system may additionally include heading control.

2 Application

2.1 These Performance Standards are applicable for track control systems working

- at ship's speed from minimum manoeuvring speed up to 30 knots; and
- at ship's maximum rate of turn not greater than 10°/s.

2.2 Track control systems fitted on ships should meet all requirements of these Performance Standards relating to straight tracks. Systems fitted on ships requiring curved track control should additionally meet all the requirements relating to curved tracks.

3 References

IMO resolutions

- MSC.64(67), Annex 3	Recommendation on performance standards for heading control systems
- A.830(19)	Code on alarms and indicators
- A.694(17)	General requirements for shipborne radio equipment forming part of the GMDSS and for electronic navigational aids
- IMO SOLAS regulation V/12	Shipborne navigational equipment carriage requirements

4 Definitions

Heading	In accordance with international definition standards
Course	In accordance with international definition standards
Speed	In accordance with international definition standards
Track	Path to be followed over ground
Active track	The track activated for track control

Heading control	Control of the ship's heading
Track control	Control of the ship's movement along a track
Heading monitor	Monitoring the actual heading sensor by an independent second source
Position monitor	Monitoring the actual position sensor by an independent second source
Main conning position	Place on the bridge with a commanding view providing the necessary information and equipment for the conning officer to carry out his functions
Override function	An intentional fast change-over from automatic to temporary manual control
Override facility	A control to perform the override function
Curved track	Non-straight track between two straight legs
Rate of turn	Change of heading per time unit
Radius of turn	Radius of a curved track
Leg	A line between two way points
Track course	The direction from one way point to the next
Cross track distance	Perpendicular distance of the ship from the track
Cross track limit	Maximum cross track distance before an alarm is activated
Back up navigator	Any individual, generally an officer, who has been designated by the ships master to be on call if assistance is needed on the bridge
TO-waypoint	The waypoint which the ship is approaching
FROM-waypoint	The last passed waypoint
NEXT-waypoint	The waypoint following the TO-waypoint
Wheel-over-line	The line where the ship has to initiate a curved track

5 Operational requirements

5.1 Functionality

5.1.1 Steering modes

A track control system should be able to steer the ship from her position:

.1 to a single waypoint; or

.2 along a sequence of waypoints.

5.1.2 Starting requirements

The system should allow the officer of the watch to start track control only if

- the ship's position,
- the difference between track course and actual heading,
- the ship's manoeuvrability,

will result in a safe approach manoeuvre to the track.

5.1.3 Primary position-fixing system

The primary position-fixing system used for track control should be an electronic position-fixing system (EPFS) approved by the Organization.

5.1.4 Position monitoring

The ship's position should be continuously monitored by a second independent position source. This monitoring need not be an integral part of the track control system.

5.1.5 Early course change indication

In the case of track control by a sequence of waypoints, an early course change indication should be given no later than 1 min before the wheel-over line.

5.1.6 Actual course change and confirmation

(1) In the case of track control by a sequence of waypoints, an alarm should be given at the wheel-over line.

(2) The system should provide means for the officer of the watch to confirm the course change at wheel-over.

(3) With or without the confirmation, the ship should follow automatically the track.

(4) If the actual course change alarm is not confirmed by the officer of the watch within 30 s of wheel-over, a back-up navigator alarm should be given.

5.1.7 Change of waypoints

In the case of track control by a pre-planned sequence of waypoints, it should not be possible to modify the TO-waypoint, the FROM-waypoint and the NEXT-waypoint while in the track control mode without creating a new track and until:

.1 the pre-planning of the new track is completed; and

.2 the starting requirements (Section 5.1.2) are fulfilled.

5.1.8 Turn performance

The track control should enable the ship to sail from one leg to another by turns based:

.1 on a preset turn radius; or

.2 on a radius calculated on the base of a preset rate of turn within the turning capability of the ship.

5.1.9 Adaptation to steering characteristics

The track control should be capable of manual or automatic adjustment to different steering characteristics of the ship under various weather, speed and loading conditions.

5.1.10 Permitted tolerance

Means should be incorporated to prevent unnecessary activation of the rudder due to normal yaw or sway motion and statistically scattered position errors.

5.1.11 Override function

A track control system should be able to accept a signal from the override facilities to terminate track control mode and switch to the override facilities.

5.1.12 Heading control mode

A track control system may be operated in heading control mode. In this case, the performance standards of heading control systems are to be applied.

5.1.13 Manual change over from track control to manual steering

(1) Change over from track control to manual steering should be possible at any rudder angle.

(2) Change over from track control to manual steering should be possible under any conditions, including any failure in the track control system.

(3) After change over to manual control, return to automatic control should require operator intervention.

5.1.14 Manual change over from track control to heading control

(1) Any change over from track control to heading control should be possible under all conditions.

(2) The heading control system should take over the actual heading as the preset heading.

(3) Any switching back to track control should require operator intervention.

5.1.15 Steering mode indication

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

5.1.16 Heading monitoring

Heading monitoring should be provided to monitor the actual heading information by independent heading sources. The heading monitor is not required to be an integral part of the track control system.

5.2 Accuracy

5.2.1 A short qualitative description of the effect of:

.1 the accuracy of the sensors for position, heading and speed;

.2 changes of course and speed;

.3 actual speed through the water; and

.4 environmental conditions

to the track control system should be provided to the user in appropriate documentation.

5.3 Alarms and indicators

5.3.1 Failure or reduction in power supply

In case of failure or reduction of power supply to the track control system which effects its safe operation an alarms should be given.

5.3.2 Position monitoring alarm

An alarm should be given when the position monitor detects a deviation beyond a preset limit.

5.3.3 Heading monitoring alarm

An alarm should be given when the heading monitor detects a deviation beyond a preset limit.

5.3.4 Failure and alarm status of sensor

In the case of any failure or alarm status received from the position-fixing sensor or the heading sensor in use:

.1 an alarm should be generated at the track control system;

.2 the system should provide guidance of the user to a safe steering mode; and

.3 a back-up navigator alarm should be given if a failure or alarm status is not acknowledged by the officer of the watch within 30 seconds.

Fall-back procedures consequential to the failure and alarm conditions are states in section 9.

5.3.5 Use of faulty signals

It should not be possible to select any sensor signal tagged with a fault or alarm status.

5.3.6 Cross track alarm

A cross track alarm, should be provided when the actual position deviates from the track beyond a preset cross track limit.

5.3.7 Course difference signal

An alarm should be given if the actual heading of the ship deviates from the track course beyond a preset value.

5.3.8 Low speed alarm

If speed through the water is lower than a predefined limit necessary for steering the ship an alarm should be given.

6 Ergonomic criteria

6.1 Operational controls

6.1.1 Controls for track control

Means should be provided to:

.1 accept or calculate the course between subsequent waypoints; and

.2 adjust radius or rate of turn, all track control related limits, alarm functions and other control parameters.

6.1.2 Change over controls

(1) Track control to manual control

Changing over from track control to manual steering should be possible by a single operator action.

(2) Track control to heading control

If the track control system can be operated with a heading control system, changing over from track to heading control should be possible by a single operator action.

(3) Location of change over controls

The steering mode selector switch should be located at or in the immediate vicinity of the main conning position.

6.2 Presentation of information

6.2.1 Continuously displayed information

The following information should be displayed clearly and continuously:

.1 mode of steering;

.2 sources of actual position, heading and speed;

.3 status and failure of sensors (if any);

.4 track course and actual heading;

.5 actual position, cross track distance and speed;

.6 TO-waypoint and NEXT-waypoint;

.7 time and distance to TO-waypoint;

.8 next track course; and

.9 selected track identification.

Items .4, .5, .7 and .8 should be displayed numerically.

6.2.2 Information to be provided on demand

The following information should be provided on demand:

.1 a list of pre-planned waypoints including waypoint numbers, co-ordinates, courses and distances between waypoints, turn radius or rates of turn; and

.2 all track control related limits and other preset control parameters.

6.2.3 Presentation

Logically related values such as preset and actual values should be displayed as a pair of data.

7 Interfacing

7.1 Sensors

The track controller should be connected to position, heading and speed sensors which meet the standards of the Organization. The heading measurement system should be a gyro-compass.

7.2 Status information

All connected sensors should be able to provide status, including failure information.

7.3 Standards

The track control system should be capable of digital, serial communication with the ship's navigation system and comply with the relevant international standards.*

8 Fall-back arrangements

8.1 Failure of the track control or position sensor

(1) If the heading control is still available then the system should automatically switch over to heading control and take the actual heading as the preset heading for the heading control.

(2) If the heading control is not available the rudder angle should be maintained.

8.2 Failure of the heading measuring system

(1) The actual rudder angle should be maintained.

The associated alarms are stated in section 5.3.

*IEC 1162

ANNEX 3

RECOMMENDATION ON PERFORMANCE STANDARDS FOR AN UNIVERSAL SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM(AIS)

1 Scope

1.1 These performance standards specify the requirements for the universal AIS.

1.2 The AIS should improve the safety of navigation by assisting in the efficient navigation of ships, protection of the enviroment, and operation of Vessel Traffic Services (VTS), by satisfying the following functional requirements:

.1 in a ship-to-ship mode for collision avoidance;

.2 as a means for littoral States to obtain information about a ship and its cargo; and

.3 as a VTS tool, i.e. ship-to-shore (traffic management).

1.3 The AIS should be capable of providing to ships and to competent authorities, information from the ship, automatically and with the required accuracy and frequency, to facilitate accurate tracking. Transmission of the data should be with the minimum involvement of ship's personnel and with a high level of availability.

1.4 The installation, in addition to meeting the requirements of the Radio Regulations, applicable ITU-R Recommendations and the general requirements as set out in resolution A.694 (17), should comply with the following performance standards.

2 Functionality

2.1 The system should be capable of operating in a number of modes:

.1 an "autonomous and continuous" mode for operation in all areas. This mode should be capable of being switched to/from one of the following alternate modes by a competent authority;

.2 an "assigned" mode for operation in an area subject to a competent authority responsible for traffic monitoring such that the data transmission interval and/or time slots may be set remotely by that authority; and

.3 a "polling" or controlled mode where the data transfer occurs in response to interrogation from a ship or competent authority.

3 Capability

3.1 The AIS should comprise:

.1 a communication processor, capable of operating over a range of maritime frequencies, with an appropriate channel selecting and switching method, in support of both short and long range applications;

.2 a means of processing data from an electronic position-fixing system which provides a resolution of one ten thousandth of a minute of arc and uses the WGS-84 datum.;

.3 a means to automatically input data from other sensors meeting the provisions as specified in paragraph 6.2;

.4 a means to input and retrieve data manually;

.5 a means of error checking the transmitted and received data; and

.6 built in test equipment (BITE).

3.2 The AIS should be capable of:

.1 providing information automatically and continuously to a competent authority and other ships, without involvement of ship's personnel;

.2 receiving and processing information from other sources, including that from a competent authority and from other ships;

.3 responding to high priority and safety related calls with a minimum of delay; and

.4 providing positional and manoeuvring information at a data rate adequate to facilitate accurate tracking by a competent authority and other ships.

4 User interface

To enable a user to access, select and display the information on a separate system, the AIS should be provided with an interface conforming to an appropriate international marine interface standard.

5 Identification

For the purpose of ship and message identification, the appropriate Maritime Mobile Service Identity (MMSI) number should be used.

6 Information

6.1 The information provided by the AIS should include

.1 Static:

- IMO number (where available)
- Call sign & name
- Length and beam
- Type of ship
- Location of position-fixing antenna on the ship (aft of bow and port or starboard of centerline)

.2 Dynamic:

- Ship's position with accuracy indication and integrity status
- Time in UTC*
- Course over ground
- Speed over ground
- Heading
- Navigational status (e.g. NUC, at anchor, etc. - manual input)
- Rate of turn (where available)
- Optional - Angle of heel (where available)**
- Optional - Pitch and roll (where available)**

.3 Voyage related:

- Ship's draught
- Hazardous cargo (type)***
- Destination and ETA (at masters discretion)
- Optional - Route plan (waypoints)**

.4 Short safety-related messages

6.2 Information update rates for autonomous mode

The different information types are valid for a different time period and thus need a different update rate:

-	Static information:	Every 6 min and on request
-	Dynamic information:	Dependant on speed and course alteration according to Table 1
-	Voyage related information:	Every 6 min, when data has been amended and on request
-	Safety-related message:	As required

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* Date to be established by receiving equipment.

** Field not provided in basic message.

*** As required by competent authority.

TABLE 1

Type of ship	Reporting interval
Ship at anchor	3 min
Ship 0-14 knots	12 sec
Ship 0-14 knots and changing course	4 sec
Ship 14-23 knots	6 sec
Ship 14-23 knots and changing course	2 sec
Ship > 23 knots	3 sec
Ship > 23 knots and changing course	2 sec

Ship Reporting Capacity - the system should be able to handle a minimum of 2000 reports per min to adequately provide for all operational scenarios envisioned.

6.3 Security

A security mechanism should be provided to detect disabling and to prevent unauthorised alteration of input or transmitted data. To protect the unauthorized dissemenation of data, the IMO guidelines (Guidelines and Criteria for Ship Reporting Systems[*]) should be followed.

7 Permissible initialization period

The installation should be operational within 2 min of switching on.

8 Power supply

The AIS and associated sensors should be powered from the ship's main source of electrical energy. In addition, it should be possible to operate the AIS and associated sensors from an alternative source of electrical energy.

9 Technical characteristics

The technical characteristics of the AIS such as variable transmitter output power, operating frequencies (dedicated internationally and selected regionally), modulation, and antenna system should comply with the appropriate ITU-R Recommendations.

[*]Resolution MSC.43(64)

ANNEX 4

AMENDMENTS TO RESOLUTION A.224(VII) - PERFORMANCE STANDARDS FOR ECHO SOUNDING EQUIPMENT

Replace the Annex by:

"ANNEX

RECOMMENDATION ON PERFORMANCE STANDARDS FOR ECHO-SOUNDING EQUIPMENT

1 SCOPE

The purpose of echo sounding equipment is to provide reliable information on the depth of water under a ship to aid navigation in particular in shallow water.

2 APPLICATION

Echo sounding equipment should comply with the following performance requirements. These Performance Standards are applicable for ship speeds from 0 up to 30 knots.

3 REFERENCES

- *IMO resolution A.694(17)* — *General requirements for shipborne radio equipment forming part of the GMDSS and for electronic navigational aids*
- *IMO resolution A.830(19)* — *Code on alarms and indicators*
- *SOLAS chapter V, regulation 12* — *Carriage requirements (being revised)*

4 DEFINITIONS

Sound speed in water for the purpose of this standard is set at 1500 m/s

5 OPERATIONAL REQUIREMENTS

5.1 Functionality

5.1.1 Range of depth

Under normal propagation and sea bed reflectibility conditions the equipment should be capable of measuring any clearance under the transducer between 2 m and 200 m.

5.1.2 Range scales

The equipment should provide a minimum of two range scales one of which, the shallow range, should cover a range of 20 m, and the other, the deep range, should cover a range of 200 m.

5.1.3 **Main display**

The primary presentation should be a suitable graphical display which provides the immediate depth and a visible record of soundings. The displayed record should, show at least 15 min of soundings.

5.1.4 **Other displays**

Other forms of display may be added but these should not affect the normal operation of the main display.

5.1.5 **Pulse repetition rate**

The pulse repetition rate should not be slower than 12 pulses per minute on the deep range and 36 pulses per minute on the shallow range.

5.1.6 **Roll and pitch**

The performance of the equipment should be such that it will meet the requirements of these performance standards when the ship is rolling $\pm$ 10° and/or pitching $\pm$ 5°.

5.1.7 **Multiple installations**

5.1.7.1 More than one transducer and associated transmitter-receiver may be fitted.

5.1.7.2 If more than one transducer is used:

- means should be available to display the depths from the different transducers separately; and

- a clear indication of the transducer(s) in use should be provided.

5.1.8 **Data storage**

It should be possible to record on paper recording or other means the information about:

- the depth(s), and

- the associated time for 12 h.

There should be means to retrieve the recorded information.

5.2 Accuracy

5.2.1 **Accuracy of measurement**

Based on a sound speed in water of 1,500 m/s, the tolerance of the indicated depth should be either:

- $\pm$ 0.5 m on the 20 m range scale, respectively $\pm$ 5 m on the 200 m range scale; or

- $\pm$ 2.5% of the indicated depth,

whichever is greater.

5.2.2 **Discrimination**

The scale of display should not be smaller than 5.0 mm per metre depth on the shallow range scale and 0.5 mm per metre depth on the deep range scale.

5.3 Malfunctions, alarms and indications

5.3.1 **Depth alarm**

An alarm signal - both visual and audible with mute function - should be provided when the water depth is below a preset value.

5.3.2 **Failure or reduction in power supply**

Alarm signals, both visual and audible (with mute function) to the navigator on the watch should be provided to indicate failure or a reduction in the power supply to the echo sounder which would affect the safe operation of the equipment.

6 ERGONOMIC CRITERIA

6.1 Operational controls

The function of range scale selection should be directly accessible.

The settings for the following functions should be recognizable in all light conditions:

- range scale; and
- preset depth alarm.

6.2 Presentation of information

6.2.1 **Marks**

The graphical display should be capable of showing:

- depth marks at intervals not larger than one-tenth of the range/scale in use; and
- time marks at intervals not exceeding 5 min.

6.2.2 **Paper recording**

If paper is used for recording either by marks on the recording paper, or by other means, there should be a clear indication when the paper remaining is less than 1 m.

7 DESIGN AND INSTALLATION

The equipment should comply with IMO resolution A.694(17).*

8 INTERFACING

Output(s) should be available from which depth information may be supplied to other equipment such as remote digital displays, voyage data recorder and a track control system.

These outputs should be digital, serial communication, facilities which should comply with the relevant international standards.**

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*IEC 945

**IEC 1162