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**GUIDELINES FOR BRIDGE EQUIPMENT AND SYSTEMS,
THEIR ARRANGEMENT AND INTEGRATION (BES)**

- 1 The Sub-Committee on Safety of Navigation (NAV), at its fifty-fifth session (27 to 31 July 2009), agreed on Guidelines for bridge equipment and systems, their arrangement and integration (BES).
- 2 The Maritime Safety Committee, at its eighty-seventh session (12 to 21 May 2010), in considering that these guidelines should replace the existing performance standards for IBS (resolution MSC.64(67), Annex 1), approved the circulation of the annexed Guidelines for bridge equipment and systems, their arrangement and integration (BES).
- 3 This circular supersedes resolution MSC.64(67), Annex 1 on the Recommendation on performance standards for integrated bridge systems (IBS).
- 4 Member Governments are invited to bring the information to the attention of all parties concerned.

ANNEX

GUIDELINES FOR BRIDGE EQUIPMENT AND SYSTEMS, THEIR ARRANGEMENT AND INTEGRATION (BES)

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GUIDELINES FOR BRIDGE EQUIPMENT AND SYSTEMS, THEIR ARRANGEMENT AND INTEGRATION (BES)

1 Purpose

1.1 These guidelines aim to support the design and configuration of bridge equipment and systems, their arrangement and integration for safe and effective operation of the vessel under the control of the bridge team and pilot.

1.2 These guidelines aim to allow for a task oriented presentation and integration of information on ship bridges.

1.3 These guidelines aim to assist with the management of the workload of the bridge team; enhance the safe operation of the ship; and implementing measures intended to reduce human errors.

1.4 These guidelines aim to be a guiding umbrella instrument for bridge equipment and systems, their arrangement and integration.

1.5 These guidelines support the application of SOLAS regulation V/15.

2 Scope

2.1 These guidelines provide:

2.1.1 General design principles for bridge design and arrangement

2.1.2 A methodology for the integration and arrangement of equipment and systems into an integrated bridge.

2.1.3 Definition of major bridge tasks and configuration of workstations

2.2 The design recommendations aim to ensure that the bridge is simple to be operated by a trained user. Guidance for the provision of onboard familiarization material is provided, as it is a requirement of the ISM Code that personnel working on assignments related to safety and the protection of the environment need to be given proper familiarization with their duties.

2.3 These guidelines are recommended for manufacturers, installers, yards, suppliers and ship surveyors with regard to bridge equipment and systems, their arrangement and integration.

2.4 These guidelines intend to support the design of ship bridges for ships mandated by the SOLAS Convention.

3 References

Resolution MSC.191(79)	Performance standards for the presentation of navigation-related information on shipborne navigational displays
Resolution MSC.252(83)	Revised performance standards for Integrated Navigation Systems (INS)
MSC/Circ.982	Guidelines on ergonomic criteria for bridge equipment and layout

SN/Circ.243	Guidelines for the presentation of navigation-related symbols, terms and abbreviations
SN.1/Circ.265	Guidelines on the application of SOLAS regulation V/15 to INS, IBS and bridge design
SN.1/Circ.274	Guidelines for application of the modular concept to performance standards
SOLAS regulation IX/3 SOLAS 1974, as amended	Safety management requirements The International Convention for Safety of Life at Sea, 1974, as amended
Resolution A.997(25)	Survey guidelines under the Harmonized System of Survey and Certification, 2007 (HSSC)

4 Definitions

For the purpose of these guidelines, the definitions in Appendix 1 apply.

Module A – Configuration of workstations

5 General

5.1 To support a modular and task oriented bridge design the assignment of the main tasks to the workstations are described generically in paragraph 6.

5.2 If an INS is provided the INS may cover parts of the recommended tasks.

5.3 Other workstations specific to the ship type or design are to comply with these functional requirements of these guidelines, as applicable.

5.4 The description of workstations are given in the guidelines on ergonomic criteria for bridge equipment and layout¹.

5.5 The recommended equipment for the workstations is listed in the guidelines on ergonomic criteria for bridge equipment and layout¹.

6 Allocation and grouping of tasks of dedicated workstations

6.1 Workstation for navigating and manoeuvring:

6.1.1 Tasks to be supported by the workstation for navigating and manoeuvring:

- Collision avoidance (traffic surveillance)
- Route monitoring (grounding avoidance):
 - Ship's position
 - Water depth
 - Chart information

¹ MSC/Circ.982.

- Monitoring of:
 - Heading
 - Ship's speed
 - Ship's rate of turn
 - Rudder angle/thrust direction
 - Main propulsion, RPM, pitch/thrust
 - Wind speed and direction
 - Time
- Internal and external communication as necessary for the defined task
- Monitoring and handling of alerts that are presented on the bridge
- Manoeuvring including:
 - Automatic steering control and operation, including non-follow up (NFU) override control
 - Manual steering control and operation
 - Steering mode selection
 - Thrusters control and operation
 - Propulsion control and operation
- Operation of navigation lights, sound and light signals
- Audible surveillance – reception of sound signals
- Operation of window wipers, washing, heating
- Operation of searchlights
- Acknowledgment of Bridge Navigational Watch Alarm Systems (BNWAS)

6.1.2 The following navigational tasks specified in the INS performance standards should be supported at the workstation for navigating and manoeuvring, if provided:

- collision avoidance (traffic surveillance)
- route monitoring (grounding avoidance)
- alert management
- navigation control data
- status and data display

6.1.3 Operation and monitoring of Centralized Alert Management HMI (CAM-HMI)*, if provided.

* As specified within the bridge alert management performance standards.

6.2 Workstation for monitoring:

6.2.1 Tasks to be supported by the workstation for monitoring:

- Collision avoidance (traffic surveillance)
- Route monitoring (grounding avoidance):
 - Ship's position
 - Water depth
 - Chart information
- Monitoring of:
 - Heading
 - Ship's speed
 - Ship's rate of turn
 - Rudder angle/thrust direction
 - Main propulsion, RPM, pitch/thrust
 - Wind speed and direction
 - Time
- Internal and external communication as necessary for the defined task
- Monitoring and handling of alerts that are presented on the bridge
- Operation of sound signals
- Operation of window wipers, washing, heating
- Acknowledgment of BNWAS

6.2.2 The following navigational tasks specified in the INS performance standards should be supported at the workstation for monitoring, if provided:

- collision avoidance
- route monitoring
- alert management
- navigation control data
- status and data display

6.2.3 Operation and monitoring of CAM-HMI^{*}, if provided.

* As specified within the bridge alert management performance standards.

6.3 Workstation for manual steering (Helmsman's workstation):

6.3.1 Tasks to be supported by the workstation for manual steering:

- Manual steering with compass heading and visual marks:
 - Control and operation of steering device for manual steering
 - monitoring of: gyro and magnetic compass heading, pre-set heading, rudder angle, rate of turn
- Communication with bridge wings

6.4 Workstation for docking (bridge wing):

6.4.1 Tasks to be supported by the workstation for docking:

- Operation for docking, pilot and safety manoeuvres including:
 - Steering control and operation
 - Propulsion control and operation
 - Thrusters control and operation
- Monitoring of:
 - Heading
 - Ship's speed including longitudinal and transversal components
 - Ship's rate of turn
 - Rudder angle/thrust direction
 - Main propulsion, RPM, pitch/thrust
 - Wind speed and direction
- Internal communication with wheelhouse (workstations for navigating and manoeuvring, monitoring, manual steering) and manoeuvring stations
- External communication as necessary for the defined task, e.g., with tugs/pilot boats
- Operation of Morse lamp and searchlight
- Acknowledgment of BNWAS

6.5 Workstation for planning and documentation:

6.5.1 Tasks to be supported by the workstation for planning and documentation:

- Voyage planning

- Documentation, recording, administration including:
 - Navigational administration, e.g., update of charts and nautical publications
 - Electronic protocol and documentation of voyage with HMI, e.g., ship's log-book
 - Ship's reporting (regulation 28 of SOLAS chapter V, 2002, as amended)

6.5.2 The following navigational tasks specified in the INS performance standards should be supported at the workstation for planning and documentation (if provided):

- route planning

6.6 Workstation for safety:

6.6.1 Tasks to be supported by the workstation for safety:

- Safety operations:
 - Fire detection
 - Operation of safety related power operated doors/openings
 - Monitoring of status indications for shell doors/openings
 - Emergency stop for ventilation system and dampers, air conditioning
 - Operation of fire extinguishing systems
 - Operation general alarm/public address system
- Stability operations:
 - Ballast water management
 - Bilge control system
 - Anti-heeling
 - Stabilizer
 - Flooding valves
- Security operations including:
 - Observation with close circuit TV
 - Control of deck lights
- Internal and external communication as necessary for the defined task

6.7 Workstation for communication:

6.7.1 Tasks to be supported by the workstation for communication:

- Internal communication
- External communication:
 - Distress and safety communications

7 Requirements for allocation of tasks and functions

7.1 Allocation of tasks to workstations

7.1.1 The allocation of the functionality for the bridge tasks to the workstations should support the assigned tasks for the workstation, and should be sufficiently simple to support team working and awareness of operator roles. If task stations are provided, the selection of the dedicated functionality should be possible by a simple operator action.

7.1.2 Additional functionality provided at the specified workstations should not interfere with the functionality listed in paragraph 6 of these guidelines.

7.2 Integration of functionality, operational controls and information

7.2.1 Interrelated functionality, operational controls and information should be grouped task oriented on the workstations.

7.2.2 Interrelated functions, operational controls and information of one task should be arranged in functional groups.

Module B – Arrangement and design – human machine interface

8 Bridge design

8.1 Every ship should at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

Therefore the requirements of MSC/Circ.982 should apply.

8.2 The field of vision should not impair the performance to maintain a proper lookout by sight of the OOW at least at the following workstations: workstation for navigating and manoeuvring, workstation for monitoring, workstation for manual steering (helmsman's workstation).

8.3 The field of vision from these workstations should be such as to enable observation of all objects which may affect the safe conning of the ship.

8.4 The field of vision from all workstations should be in accordance with regulation 22 of SOLAS chapter V, 2002, as amended, and MSC/Circ.982.

8.5 It should be possible to maintain lookout and general surveillance of the ship at the workstation for navigating and manoeuvring.

8.6 External sound signals from ships and fog signals that are audible on the open deck should also be audible inside the wheelhouse; a sound reception system should be provided to reproduce such signals inside the wheelhouse, if it is enclosed.

9 Layout and physical arrangement of workstations

9.1 For the layout and physical arrangement of workstations on the bridge the requirements of MSC/Circ.982 and relevant guidance on application of SOLAS regulation V/15, adopted by the Organization, should be taken into account.

9.2 Sufficient and solidly built hand grab rails should be provided on all consoles at any workstation and as far as practicable within grab distance.

10 Design of bridge equipment

10.1 System design

10.1.1 For the design and layout of human machine interfaces (HMI), MSC/Circ.982 and relevant guidance on application of SOLAS regulation V/15 adopted by the Organization¹ should be taken into account.

10.1.2 The design and implementation of the systems and equipment should ensure that it is simple to operate by a trained user.

10.1.3 The design of the systems and equipment should facilitate the tasks to be performed by the bridge team and pilot in navigating the ship safely under all operational conditions.

10.1.4 The configuration of the systems and equipment and presentation of information at workstations should permit observation or monitoring by the bridge team and pilot under all operating conditions.

10.1.5 The operation of the systems and equipment should be designed to avoid distraction from the task of safe navigation.

10.1.6 Integrated graphical and alphanumeric display and control functions should adopt a consistent human machine interface (HMI) philosophy and implementation.

10.1.7 A central dimming functionality should be provided to adjust the illumination of task stations, displays, controls and panel labels with one control function for the bridge and/or equipment integrated in a console. Exclusions are permitted for equipment which do not provide a digital interface. Individual dimming of the task stations, displays, functional groups of controls and panel labels should also be possible. Guidance on dimming is also provided in MSC/Circ.982.

10.2 Operation of equipment – data input

10.2.1 The operation of equipment should conform to the general principles of MSC/Circ.982.

10.2.2 The bridge should be so designed that the requested manual inputs are consistent throughout the systems and equipment as far as practicable and can be easily executed.

¹ SN.1/Circ.265.

10.2.3 The systems and equipment should be designed that the basic functions can be easily operated.

10.2.4 Complex or error-prone interaction with the systems and equipment should be avoided.

10.2.5 Checks in the dialogue and in the input handling should be provided to prevent erroneous data or control inputs (e.g., plausibility checks).

10.2.6 For manual inputs that may cause unintended results, the systems and equipment should request confirmation before acceptance.

10.3 Presentation of information

10.3.1 The information on the bridge should be presented according to the general principles of resolution MSC.191(79) and MSC/Circ.982.

10.3.2 Mode and status awareness

10.3.2.1 The operational mode in use should be clearly indicated to the bridge team and pilot.

10.3.2.2 If the mode in use is not the normal mode to fully perform the functions, this should be clearly indicated.

Example of modes other than the normal mode are:

- degraded condition modes, in which the systems cannot fully perform all functions
- "service modes"
- simulation mode
- training (familiarization) mode

10.3.2.3 If the system is in a degraded condition this should be sufficiently clear that the bridge team and pilot can understand the nature of the failure and its consequences.

10.3.2.4 The systems should indicate the operational status of automated functions and integrated components, systems and/or subsystems.

Module C – Fault tolerance

11 Backup and redundancies

11.1 Adequate backup arrangements should be provided to ensure safe operation in case of a failure.

11.2 In case of failure of one part or function, including network failure, it should be possible to operate each other individual part or function separately, except for those functions directly dependent on the defective part; at least the requirements specified for individual equipment adopted by the Organization should be met, as far as applicable.

11.3 The backup arrangement should enable a safe takeover and ensure that a failure does not result in an unintentional and/or critical system status.

11.4 The failure of a single task station should not result in the loss of a function mandated by the carriage requirements of SOLAS.

11.5 In case of a breakdown of one task station, at least one task station should be able to take over the tasks.

12 System failures and fallback arrangements

12.1 The systems should have the capability of allowing the operator to decline or override the automated ship control functions at any time or intervene part way through a process by means of a simple operator action.

12.2 An integrated system should have the capability to re-establish the functional consistency after an interface failure.

12.3 Software requirements should be in compliance with resolution A.694(17) and in accordance with specifications at least equivalent to those acceptable to the Organization¹.

Module D – Interfacing

13 Interfacing, data transfer

13.1 To support a modular bridge design standardized interfaces should be implemented for sensor/source and operational/functional modules. Guidance on requirements for standardized interfaces is listed in resolution MSC.252(83).

13.2 The communication should allow the implementation of the tasks/functions listed in these guidelines.

13.3 The communication should be based on standardized communication protocol as far as applicable. Sensor/source and operational/functional modules may use alternative internal concepts.

13.4 This communication should be in compliance within the following requirements as far as practicable:

- .1 self-alignment of interface parameters;
- .2 automatic re-synchronization after disconnection or power failure;
- .3 unique identification of data source which includes at least cluster, function, additionally time where necessary;
- .4 provision of consistent data related to time and other relevant aspects, e.g., reference points; and
- .5 ensure the consistency of data transmission.

¹ IEC 60945.

14 Power supply

14.1 The power supply requirements applying to parts of an integrated system as a result of the requirements specified for the individual equipment by the Organization should remain applicable.

14.2 Mandatory equipment and functions/equipment necessary for the safe navigation should be supplied at least:

- .1 from both the main and the emergency source of electrical power with automated changeover through a local distribution board with provision to preclude inadvertent shutdown; and
- .2 from a transitional source of electrical power for a duration of not less than 45 s.

Module E – System configuration and integration

15 Modular concept

The design of an integrated system should be modular with operational/functional and sensor/source modules. The modules are defined in the guidelines for the application of the modular concept to performance standards (SN.1/Circ.274).

16 Integration

16.1 The integration of functions of individual equipment into an integrated system should not degrade the performance below the requirements specified for the individual equipment by the Organization.

16.2 Integrated systems and integrations combining on a functional level at least two tasks specified in resolution MSC.252(83) or one task and track control should conform regarding the integration of information to the relevant requirements of Module A of resolution MSC.252(83).

16.3 For integrated systems or integrations that do not meet the definition of an INS according to resolution MSC.252(83), the principles of the INS performance standards should be applied as appropriate to the functions being integrated.

Module F – System and equipment documentation

17 Manuals

17.1 Operating manuals should be provided which include as far as applicable:

- functional description
- the redundancy and backup concept and the availability of functions
- default modes and limits
- a description of alerts and related failures and their effects on the system
- guidance for the adjustment of the limits for alerts

- details of each data convention and common references: attitude axis, rotation, reference location of Consistent Common Reference Point (CCRP)
- for automatic control functions (e.g., for heading, track or speed) details of override and/or bypassing.

17.2 Installation manuals should be provided to allow the systems to be installed so that they can meet all requirements adopted by the Organization.

17.3 The installation manuals should include:

- information of systems, sensor/sources, components, interconnections, automatic control functions and interfaces
- the details of the power supply arrangements
- recommendations on the physical layout of equipment and necessary space for maintenance.

18 Information regarding system configuration for surveyor

18.1 Manufacturer or system integrator should declare the following information relating to the system configuration, if applicable:

- basic system configuration
- interconnecting block diagram (Hardware) showing all connected sensors including power supply.

Further information is provided in resolution A.997(25).

18.2 Failure analysis, at functional level, should be documented as far as practicable. The failure analysis should verify that the systems are designed on "fail-to-safe" principle and that a failure of one part of an integrated system should not affect the functionality of other parts, except for those functions directly dependent on the defective part.

19 Guidance to equipment manufactures for the provision of onboard familiarization material

19.1 Material enabling onboard familiarization training should be provided. The onboard familiarization material should explain all configuration, functions, limitations, controls, displays, alerts and indications. Guidance for equipment manufactures for the provision of onboard familiarization material is listed in appendix 2 of resolution MSC.252(83) for INS.

Appendix 1 – Definitions

Cluster	Group of functions on a high level, e.g., navigation, automation.
Degraded condition	Reduction in system functionality resulting from failure.
Failure analysis	The logical, systematic examination of an item, including its diagrams or formulas, to identify and analyse the probability, causes and consequences of potential and real failures.
Human machine interface (HMI)	The part of a system an operator interacts with. The interface is the aggregate of means by which the users interact with a machine, device, and system. The interface provides means for input, allowing the users to control the system and output, allowing the system to inform the users.
Integrated navigation system	An INS is a composite navigation system which performs at least the following tasks: collision avoidance, route monitoring thus providing "added value" for the operator to plan, monitor and safely navigate the progress of the vessel. The INS allows meeting the respective parts of SOLAS regulation V/19 and supports the proper application of SOLAS regulation V/15.
Integration	Combining of data, functions and/or operations to accomplish a high-level aim.
Interfacing	Communication between equipment and between equipment and humans.
Multifunction display	A single visual display unit that can present, either simultaneously or through a series of selectable pages, information from more than a single function of an INS.
Mode awareness	The perception of the mariner regarding the currently active Modes of Control, Operation and Display of the INS including its subsystems, as supported by the presentations and indications at an INS display or workstation.
One equipment concept	The equipment which is recognized as one type of equipment by integrating the function of mandatory equipment of SOLAS of a plural number.
Operational/functional module	The module specifies the operational and functional capabilities of systems and equipment.

Sensor/source module	The module specifies the sensor/source performance of systems and equipment.
Simple operator action	A procedure achieved by no more than two hard-key or soft-key actions, excluding any necessary cursor movements, or voice actuation using programmed codes.
Single operator action	A procedure achieved by no more than one hard-key or soft-key action, excluding any necessary cursor movements, or voice actuation using programmed codes.
Situation awareness	Situation awareness is the mariner's perception of the navigational and technical information provided, the comprehension of their meaning and the projection of their status in the near future, as required for timely reaction to the situation. Situation awareness includes mode awareness.
Task	Work to be performed by bridge team and pilot.
Task station	Multifunction display with dedicated controls providing the possibility to display and operate multiple tasks. A task station is part of a workstation.
Workstation	The combination of all job-related items, including the console with all devices, equipment and the furniture, to fulfil certain tasks. Workstations for the Bridge are specified in MSC/Circ.982.

Appendix 2 – Guidance for applicable instruments which are specifically addressed within these guidelines

