INTERNATIONAL STANDARD

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Ships and marine technology — Ship's bridge layout and associated equipment — Requirements and guidelines

Navires et technologie maritime — Aménagement de la passerelle d'un navire et disposition de ses équipements annexes — Exigences et directives

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8468 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 5, *Ships' bridge layout*.

This third edition cancels and replaces the second edition (ISO 8468:1990) and ISO 14612:2004, which have been technically revised.

Introduction

It has become common practice for operators (officers and crew) to move between shipping companies and flag states and serve on a wide range of ships. Pilots too have to handle an increasing variety of ships and equipment. This International Standard therefore, contains requirements and guidelines which aim to ensure safe navigation by standardizing the bridge environment to provide watchkeepers with a consistent pattern of equipment layout regardless of the ship type or the navigational systems fitted on the bridge.

The requirements in this International Standard take into account human factors, ergonomic principles and advances in technology.

Functional requirements are outlined in general terms in order to prescribe the basic functionality, providing the operator at each defined workstation with

— the best possible overview of internally presented data,

— easy and ergonomic operation of equipment,

— adequate environmental conditions on the bridge.

All information made available to the operator from equipment, alarm systems and communication equipment has to be suited for the purpose, and presented in accordance with ergonomic principles. Too much information is stressing and may cause confusion.

Information and control facilities have to meet the needs of the operator and provide the level of performance appropriate to particular workstations and procedures.

Safety aspects related to the crew, cargo, ship and the environment need to be addressed in detail.

Guidelines and figures give examples, ideal and/or alternative solutions, when such are well defined. Guiding references and comments are added where applicable.

It should be noted that no specific layout presents the sole solution for a proper bridge fulfilling the requirements laid down in this International Standard. This International Standard is parametric, and different types of ships and operations have different optimum designs, even though basic safety requirements are equal.

This International Standard is related to the IMO Resolution on ergonomic criteria for bridge equipment and the general requirements in SOLAS Chapter V. Based on SOLAS Chapter IX (ISM-Code), dealing with casualties attributed to the human element, this International Standard should reduce such casualties.

Ships and marine technology — Ship's bridge layout and associated equipment — Requirements and guidelines

1 Scope

This International Standard specifies the functional requirements for bridge configuration, bridge arrangement, bridge workstations and bridge environment. Guidelines have been drawn up for the methods and solutions to meet the functional requirements.

The requirements in this International Standard apply to all bridge functions.

The purpose of this International Standard is to assist the operator(s) and pilot by providing a workplace that is conducive to safe and effective operation. It also aims to specify bridge requirements, which will secure safe and efficient operation of the ship berth-to-berth regardless of the watchkeeping arrangement in place at a particular time. This International Standard should be used in support of the aims in SOLAS Chapter V Regulation 15.

Requirements and guidance on the human element aspects of the bridge system (e.g. training, procedures) are not given. However, for safe and effective watchkeeping, these aspects will need to be addressed.

The main use of this International Standard will be for designing ships' bridges. This International Standard will also be useful to

— specifiers and procurers of ships and bridge equipment,

— operators, and

— owners for ensuring that changes made to the bridge through the life of a ship continue to conform to these requirements.

This International Standard is applicable to seagoing ships. Where there are physical limitations in applying this International Standard, i.e. to small ships or to ships of unusual design, the general functional requirements still apply.

Annex A of this International Standard applies to high speed craft.

This International Standard does not supersede performance standards for bridge equipment.

Users of this International Standard should note that while attempting to implement its requirements, they should ensure compliance with such statutory requirements, rules and regulations as may be applicable to the individual ship concerned.

Designers should consider future changes in the purpose of the ship, and availability of new equipments, in their bridge designs.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2412, *Shipbuilding — Colours of indicator lights*

ISO 3434, *Shipbuilding and marine structures — Heated glass panes for ships' rectangular windows*

ISO 3904, *Shipbuilding and marine structures — Clear-view screens*

IEC 60447, *Basic and safety principles for man-machine interface, marking and identification — Actuating principles*

IMO MSC.97(73) 2000, *International Code of Safety for High-Speed Craft, 2000 (2000 HSC Code)*

IMO Resolution A.343(IX), *Recommendation on methods of measuring noise levels at listening posts*

IMO Resolution A.468(XII), *Code on Noise Levels on Board Ships*

IMO Resolution A.694(17), *General requirements for shipbourne radio equipment forming part of the GMDSS and for electronic navigational aids*

International Convention for the Safety of Life at Sea (SOLAS)

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
abnormal operating condition
condition created when internal technical system failures require operation of back-up systems on the bridge, or when they occur under an irregular operating condition, or when the operator becomes unfit to perform his duties and has not yet been replaced by another qualified officer

3.1.2
additional bridge functions
functions performed on the bridge, but not related to a primary bridge function

EXAMPLE Extended communication functions, monitoring and control of ballasting and cargo operations, monitoring and control of machinery, monitoring and control of domestic systems, ship management.

3.1.3
alarm
audible and visual signal alerting a condition requiring immediate attention or user action

3.1.4
alarm transfer system
system which transfers an alarm from the bridge to the master and the back-up operator or any place(s) assigned by the system in the case of any operator deficiency

3.1.5
alert
announcement of an abnormal situation or condition requiring attention

NOTE Alerts may consist of alarms, warnings and cautions.

3.1.6
back-up operator
qualified officer who has been designated by the ship's master to be on call if assistance is needed on the navigation bridge

3.1.7
bridge
area from which the navigation and control of the ship is exercised, including the wheelhouse and bridge wings

3.1.8
bridge arrangement
location and interrelation of workstations and equipment on the bridge

3.1.9
bridge configuration
shape of the bridge comprising the outer bulkheads and windows of the bridge area

3.1.10
bridge navigational watch alarm system
BNWAS
alarm system comprising watch monitoring and alarm transfer

3.1.11
bridge integrator
organization that takes overall responsibility for the design of the bridge

3.1.12
bridge system
total system for the performance of bridge functions, comprising bridge personnel, technical systems, man-machine interface and procedures

3.1.13
bridge wing
part of the bridge, on both sides of the ship’s wheelhouse, which, in general, extends to the ship’s side

3.1.14
catwalk
extension to a deck outside the wheelhouse wide enough to allow the safe passage of a person

3.1.15
caution
visual alert of a condition which does not warrant an alarm or warning condition, but still requires attention out of the ordinary, consideration of the situation, or of the given information

3.1.16
collision avoidance function
detection and plotting of ships and other moving and stationary objects; determination and execution of course and speed deviations to avoid collision

3.1.17
commanding vision
view without obstructions which would interfere with the operator’s ability to perform his immediate task

3.1.18
communications workstation
workstation for operation and control of equipment for distress, safety and routine communications

3.1.19
conning position
place in the wheelhouse with commanding vision and which is used by operators when monitoring and directing the ship's movements

NOTE The conning position is frequently at the workstation for navigation and manoeuvring.

3.1.20
display
means by which a device presents visual information to the operator, including conventional instrumentation

3.1.21
docking
manoeuvring of the ship alongside a berth, another ship or other structure and controlling the mooring operations

3.1.22
docking workstation
workstation from which the ship can be manoeuvred during docking, lock passage and other manoeuvres requiring a view of the ship's side

3.1.23
electronic navigational chart
ENC
database, standardized as to content, structure and format for use with the ECDIS on the authority of government authorized hydrographic offices

NOTE The ENC contains all the chart information for safe navigation and may contain supplementary information in addition to that contained in the paper chart (e.g. sailing directions) considered necessary for safe navigation.

3.1.24
electronic chart display and information system
ECDIS
navigation information system which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulations V/19 and V/27 of the 2000-12-05 Amendments to SOLAS by displaying selected information from a system electronic navigational chart (SENC) with positional information from navigation sensors to assist the mariner in voyage planning and route monitoring, and if required additional navigation-related information

3.1.25
ergonomics
study and design of working environments and their components, work practices, and work procedures for the benefit of the worker's productivity, health, comfort and safety

3.1.26
essential information
information which is necessary for the monitoring and control of primary bridge functions

3.1.27
field of vision
angular size of a scene that can be observed from a position on the ship's bridge

3.1.28
failure mode and effects analysis
FMEA
method used for the identification of potential error types in order to define their effects on the examined object or system, and to clarify the error types with regard to criticality or persistency

3.1.29
guideline
non-mandatory information leading to a compliant solution for the related requirement

3.1.30
helmsman
person who steers the ship under way

3.1.31
irregular condition
irregular operating condition
condition causing an excessive operator workload

3.1.32
lookout
activity carried out at all times 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

3.1.33
manoeuvring
operation of steering systems and propulsion machinery as required to move the ship in predetermined directions or into predetermined positions or tracks

3.1.34
manual steering workstation
workstation from which the ship can be steered by a helmsman

3.1.35
master
ship's captain and the person in overall charge of the ship

3.1.36
monitoring
act of periodically checking equipment and environment in order to detect any changes

3.1.37
monitoring and secondary navigation workstation
workstation for an assisting operator (secondary navigation) and monitoring

3.1.38
navigation
process of position-finding as well as planning, controlling and recording the movement of a ship from one place to another

3.1.39
navigation workstations
any plurality of the navigation and manoeuvring workstation and monitoring and secondary navigation workstation

3.1.40
operating compartment
bridge

3.1.41
operator
qualified officer navigating, operating bridge equipment and manoeuvring the ship

3.1.42
navigation and manoeuvring workstation
workstation with commanding vision used by operators when carrying out navigation, traffic surveillance and manoeuvring functions

3.1.43
normal condition
normal operating condition
condition whereby all shipboard systems and equipment related to primary bridge functions operate within design limits and external conditions (i.e. weather and traffic), or when the malfunction of position-fixing systems does not cause excessive operator workloads

3.1.44
percentile
percentage of population

3.1.45
primary bridge function
function related to the determination, execution and maintenance of safe course, speed or position of the ship in relation to the waters, traffic or weather conditions

EXAMPLE Voyage planning functions, navigation functions, collision avoidance functions, manoeuvring functions, docking functions, monitoring of internal safety systems, external and internal communication related to safety in bridge operation and distress situations.

3.1.46
radar plotting
whole process of target detection, tracking, calculation of parameters and display of information

3.1.47
route monitoring
periodic surveillance of the ship's position, course and speed in relation to a pre-planned route and the surrounding waters

3.1.48
safety workstation
workstation at which monitoring displays and operating elements serving safety are concentrated

3.1.49
screen
device used for presenting visual information based on one or several displays

3.1.50
seagoing ship
ship designed, equipped and certified to go to sea

NOTE Another definition of this term, adapted from COLREGs [1)], is "any vessel including non-displacement craft, designed, equipped and certified for use as a means of transportation on the high seas and all waters connected thereto".

3.1.51
ship management
administrative and miscellaneous activity such as maintaining spares and other stores, payrolls and other activities not related to the manoeuvring of the ship

3.1.52
superstructure
decked structure, not including funnels, which is on or above the freeboard deck

3.1.53
system electronic navigational chart
SENC
database resulting from the transformation of the ENC by the ECDIS for appropriate use, updates to the ENC by appropriate means and other data added by the mariner

NOTE It is the database that is actually accessed by the ECDIS for the display generation and other navigational functions, and is the equivalent to an up-to-date paper chart. The SENC may also contain information from other sources.

1) Convention on the International Regulations for Preventing Collisions at Sea (COLREGs).

3.1.54
track monitoring
observing the position of own ship in relation to a planned route or existing track

3.1.55
tracking
process of observing the sequential changes in the position of a target, to establish its motion

3.1.56
traffic surveillance
observation of ship traffic within an area for the purpose of planning the movement of own ship in that area

3.1.57
visibility
fields and/or distance of vision to observe objects

3.1.58
voyage planning
pre-determination, from berth to berth, of courses, turns and speeds in relation to the waters to be navigated

3.1.59
voyage planning workstation
workstation at which the ship's voyage is planned

3.1.60
warning
visual alert of a condition which is not immediately hazardous, but may become so, if no action is taken

3.1.61
wheelhouse
enclosed area of the bridge

3.1.62
workstation
combination of all job-related items, including a console, if provided, with all devices, equipment and furniture, to fulfil certain tasks

3.2 Abbreviations

AIS	automatic identification system
ARPA	automatic radar plotting aid
BNWAS	bridge navigational watch alarm system
ENC	electronic navigational chart
ECDIS	electronic chart display and information system
FMEA	failure mode and effects analysis
GMDSS	global maritime distress and safety system
IMO	International Maritime Organization, a specialized agency of the United Nations devoted exclusively to maritime matters
SENC	system electronic navigational chart
SOLAS	safety of life at sea
UHF	ultra high frequency
VHF	very high frequency

4 Bridge configuration

4.1 General

4.1.1 The bridge configuration shall be arranged with special attention to maximizing the field of vision and audibility of sound signals at all workstations situated on the bridge and used during the watch under normal operating conditions at sea.

4.1.2 Every effort shall be made to place the bridge above all other superstructures.

4.2 Field of vision

4.2.1 General

4.2.1.1 It shall be possible to observe all objects necessary for navigation, such as ships and lighthouses, in any direction from inside the wheelhouse or on the wings. Artificial means approved for this purpose may be used to achieve the proper view. See 4.2.3.10.

4.2.1.2 **Guidelines**: There is to be a field of vision around the ship of 360° obtained by an observer moving within the confines of the wheelhouse or on the wings. See Figure 1.

4.2.1.3 An operator shall be able to watch the area immediately in front of the bridge superstructure from the wheelhouse.

4.2.1.4 **Guidelines**: There should be close physical access to at least one front window. The width of the close access should be sufficient to accommodate two persons.

4.2.1.5 The field of vision for a seated operating position should be made from a seated eye reference point. The field of vision for a standing operating position should allow for movement ability at that position.

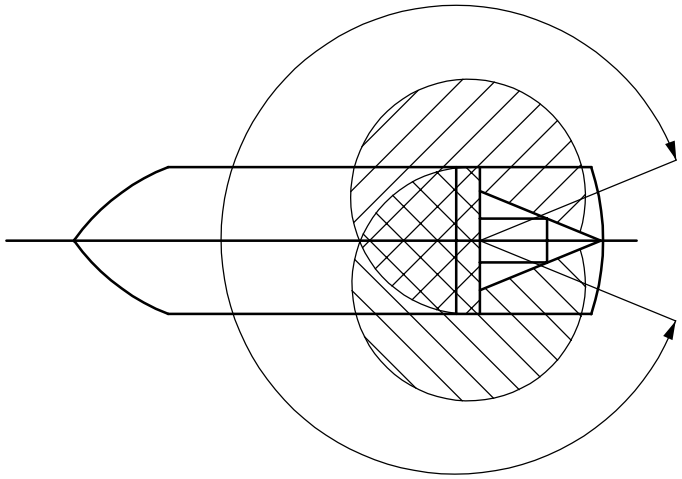
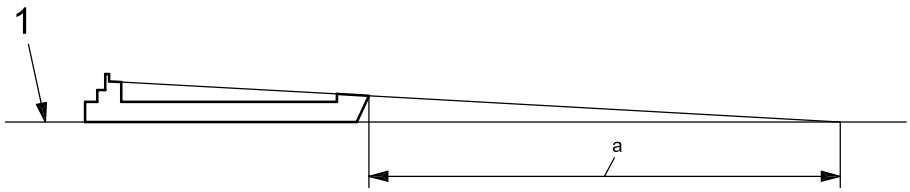


Figure 1 — 360° field of vision

4.2.2 Primary conning position

4.2.2.1 The primary conning position is frequently at the workstation for navigation and manoeuvring (as defined in 5.2.2). It shall be arranged to enable efficient and effective application of the principles of bridge resource management and bridge teamwork procedures regardless of the watchkeeping arrangement in place at a particular time. All relevant instrumentation and controls shall be easily visible, audible and accessible.

4.2.2.2 The view of the sea surface from the conning position shall not be obscured by more than two ship lengths or 500 m, whichever is less, forward of the bow to 10° on either side irrespective of the ship's draught, trim and deck cargo (e.g. containers). See Figure 2.



Key

1 sea surface

a Two ship lengths or 500 m, whichever is less.

Figure 2 — Forward view

4.2.2.3 At the navigation workstations and at the conning position (frequently the navigation and manoeuvring workstation), the operator's field of vision shall be sufficient to comply with SOLAS V/22, navigate and manoeuvre the ship safely, and enable compliance with Rule 5 of COLREGs [2)].

4.2.3 Navigation and manoeuvring workstation

4.2.3.1 Blind sectors caused by cargo, cargo gear, divisions between windows and other obstructions shall be minimized, and in no way hamper a safe lookout from the workstation for navigation and manoeuvring.

4.2.3.2 The total arc of blind sectors within the required 225° field of vision (from right ahead to 112,5° on each side) shall not exceed 20°. Each individual blind sector shall not exceed 10°. Over an arc from dead ahead to at least 10° on each side, each blind sector shall not exceed 5°. The clear sector between two blind sectors shall not be less than the broadest blind sector on either side of the clear sector.

4.2.3.3 **Guidelines**: The field of vision from the navigation workstations should be such as to enable observation of all objects which may affect the safe conning of the ship. The console should not obstruct the view of the sea surface seen over the lower edge of the windows from the workstation for navigation and manoeuvring within an arc of 10° to port and 112,5° to starboard of the bow. See Figure 3.

2) Rule 5 of COLREGs: "Every vessel shall at all times maintain a proper look-out by sight as well as by 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."

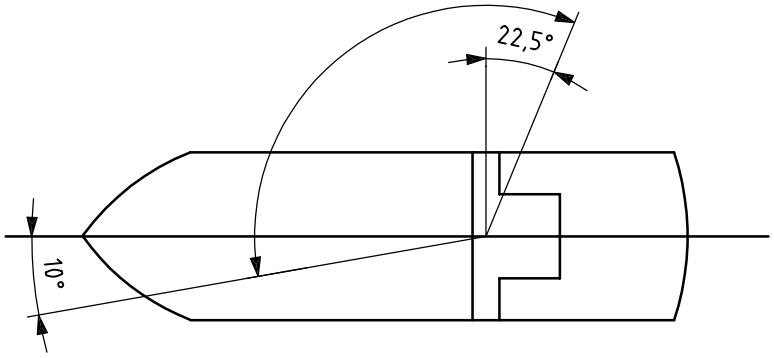


Figure 3 — Primary field of vision from navigation workstations

4.2.3.4 The height of the lower edge of the front windows shall allow a forward view over the bow for a person at any workstation, and in no case shall present an obstruction to the forward view described elsewhere.

4.2.3.5 **Guidelines**: The height of the lower edge of the front windows above the deck should be kept as low as possible, and should not, as far as practicable, be more than 1 000 mm.

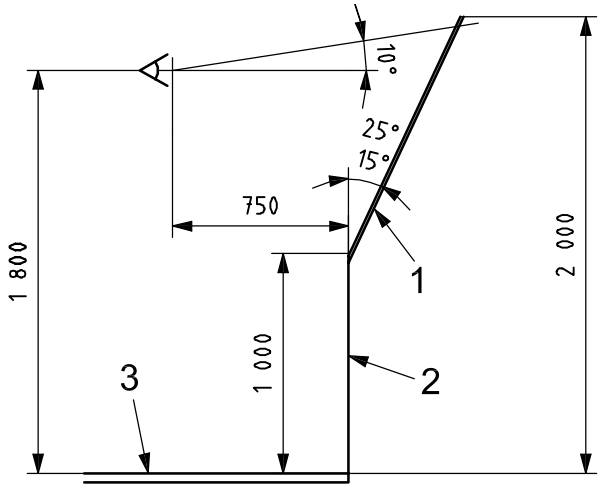
4.2.3.6 The upper edge of the front windows shall allow a forward view of the horizon for a person in a standing position with an eye height of 1 800 mm at the navigating and manoeuvring workstation when the ship is pitching in heavy seas. The administration, if satisfied that a 1 800 mm eye height is unreasonable and impractical, may allow reduction of the eye height, but not less than 1 600 mm.

4.2.3.7 **Guidelines**: The height of the upper edge of front windows above the deck should be as high as practicable and at least allow a forward view of the horizon when the bow is 10° below its position on even keel. The minimum height of the upper edge of front windows above the deck surface should be 2 000 mm. See Figure 4.

The dimensions in Figure 4 are maxima, based upon an eye height of 1 800 mm, referring to a person of a height of 1 900 mm, at a distance of 750 mm from the bridge front bulkhead.

For arrangements where the operator would normally stand further back from the bridge front bulkhead, the same eye height should be used to determine the height of the upper edge of the front windows.

Dimensions in millimetres



Key

1 window
2 bulkhead
3 deck surface

Figure 4 — Example of the height of upper edge of front window in relation to eye height, distance from front bulkhead, slanting of bulkheads, given a window slant of between 15° and 25°

4.2.3.8 **Guidelines**: The horizontal field of vision from the navigation and manoeuvring workstation and from the conning position, if different, should at least extend over an arc from 22,5° abaft the beam on one side, through forward, to 22,5° abaft the beam on the other side. See Figure 5.

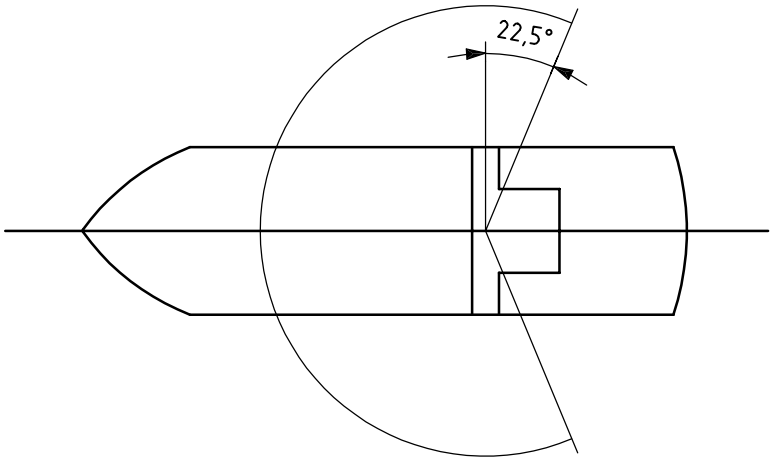
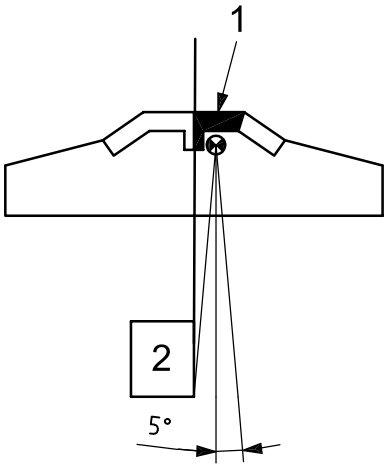


Figure 5 — Navigation and manoeuvring workstation and conning position

4.2.3.9 From the workstations for navigating and manoeuvring, it shall be possible to use lights or marks in line astern of the ship as reference for steering the ship.

4.2.3.10 **Guidelines**: The horizontal field of vision astern as seen from the workstations for navigating and manoeuvring should extend over an arc from dead astern to at least 5° to each side. See Figures 6 and 7.

Artificial means approved for this purpose may be used to achieve the proper view. Artificial means should be sufficiently dependable. Their ability to perform assigned tasks in a usable manner and in all conditions should be assured. Artificial means should be assessed at a system level, e.g. including lighting, camera controls and wiper.

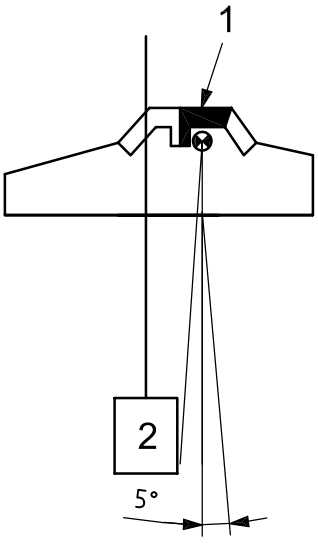


Key

1 workstation for navigation and manoeuvring

2 funnel

Figure 6 — Field of vision astern with off centre funnel



Key

1 workstation for navigation and manoeuvring

2 funnel

Figure 7 — Field of vision astern with off centre workstation

4.2.4 Monitoring and secondary navigation workstation

From the monitoring and secondary navigation workstation, and the communications workstation, the field of vision should extend at least over an arc from 90° on the port bow through forward, to 22,5° abaft the beam on starboard. See Figure 8.

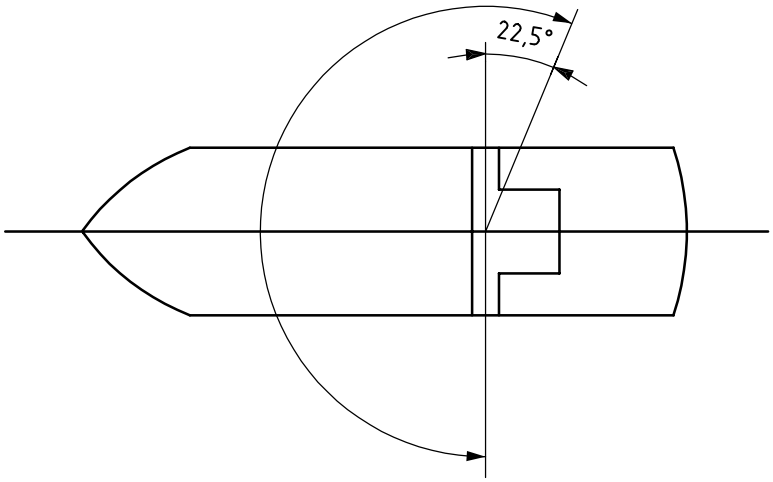


Figure 8 — Monitoring and secondary navigation workstation

4.2.5 Docking (bridge wings) workstation

4.2.5.1 The field of vision from a docking workstation, normally on the bridge wing, shall extend over an arc from at least 45° on the opposite bow through dead ahead and then aft to 180° from dead ahead. See Figure 9.

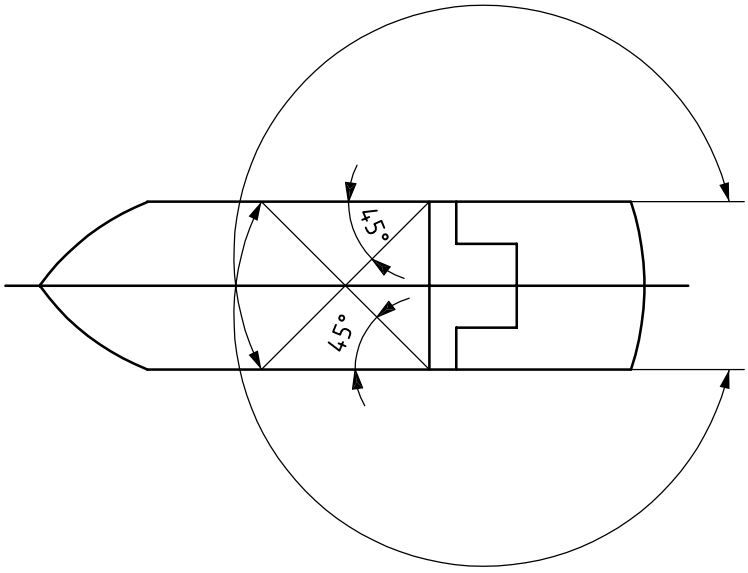


Figure 9 — Docking (bridge wing) workstation

4.2.5.2 The ship's side shall always be visible from the bridge wing especially where tugs or pilot boats come alongside and where the ship touches the jetty.

4.2.5.3 **Guidelines**: Bridge wings should be provided out to the maximum beam of the ship. The view over the ship's side should not be obstructed.

4.2.6 Manual steering (helmsman's) workstation

4.2.6.1 The workstation for manual steering shall preferably be located on the ship's centre-line. If the workstation for manual steering is located off the centre-line, special steering references for use by day and night shall be provided, e.g. sighting marks forward. The helmsman's field of vision shall be sufficiently wide to enable him to carry out his functions safely.

4.2.6.2 **Guidelines**: The helmsman's field of vision from the workstation for manual steering should extend over an arc from dead ahead to at least 60° on each side. See Figure 10. The total arc of blind sectors within the required 60° field of vision should not exceed 20°. Each individual blind sector should not exceed 10°. Over an arc from dead ahead to at least 10° on each side, each blind sector should not exceed 5°. The clear sector between two blind sectors should not be less than the broadest blind sector on either side of the clear sector.

The workstation should not be placed immediately behind the windows in order to protect the required field of vision of other workstations.

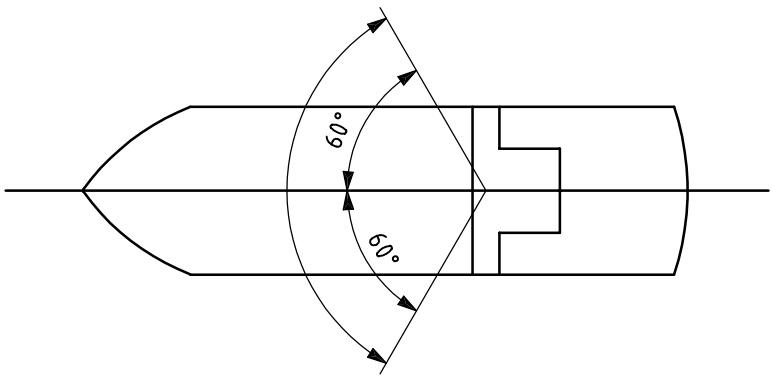


Figure 10 — Manual steering (helmsman's) workstation

4.3 Windows

4.3.1 Divisions between windows shall be kept to a minimum. No division shall be installed immediately forward of any workstation, including the centre-line. If stiffeners between windows are to be covered, this shall not cause further obstructions of the field of vision from any position inside the wheelhouse.

4.3.2 **Guidelines**: Windows, especially on the centre-line, should be as wide as possible. The divisions between front windows should not exceed 150 mm. If stiffeners are used, divisions should not exceed 100 mm in width and 120 mm in depth.

NOTE The window frame width is designed based on the size of the ship, service area and material of the structure and windows.

4.3.3 Bridge front windows shall be inclined from the vertical plane to avoid reflections. Bridge side and rear windows should also be inclined.

4.3.4 **Guidelines**: As far as is practical, all bridge windows should be inclined from the vertical plane top out, at an angle of not less than 10° and not more than 25°. Exceptions can be made for windows in bridge wing doors.

4.3.5 A clear view through the windows shall be provided at all times. Neither polarized nor tinted glass shall be fitted.

4.3.6 Guidelines: To ensure a clear view in bright sunshine, sunscreens with minimum colour distortion should be provided at all windows in front of workstations. Such screens should be readily removable and not permanently installed.

To ensure a clear view, heavy-duty wipers, preferably provided with an interval function and a fresh water wash, are recommended for the majority of the front windows. Clear-view screens should be installed on at least two windows, and should be in accordance with ISO 3904.

Such wipers should be capable of operating independently of each other.

Efficient cleaning, de-icing and de-misting systems should be installed to ensure a clear view in all operating conditions. Where necessary, electrical de-icing systems should be installed in the wiper arms. Where heated glass panes are installed, they should be in accordance with ISO 3434. A means shall be provided for safe emergency cleaning of windows and repair of wipers.

4.4 Sound reception system

4.4.1 Sounds of interest to navigation that are audible on open deck area shall also be audible inside the wheelhouse.

4.4.2 The ship may be fitted with a technical device receiving sounds outside the wheelhouse and reproducing such sounds inside the wheelhouse after amplification.

5 Bridge functions and tasks and their relations to workstations

5.1 General

The bridge layout and arrangement of equipment shall enable watchkeeping personnel to conveniently and continuously carry out their watchkeeping tasks.

5.2 Location and interrelation of workstations

5.2.1 Bridge functions

Dedicated workstations suitable for the safe and efficient performance of primary bridge functions under normal and abnormal conditions in the various phases of the voyage from berth-to-berth shall be provided for the following functions:

a) voyage planning;

b) docking operations;

c) conning;

d) navigation;

e) traffic surveillance;

f) manoeuvring;

g) manual steering;

h) safety monitoring;

i) safety operations;

j) communications;

k) security.

5.2.2 Dedicated workstations

The primary bridge functions listed in 5.2.1 are to be carried out at the following dedicated workstations:

a) navigation and manoeuvring;

b) monitoring and secondary navigation;

c) manual steering (helmsman);

d) docking;

e) voyage planning;

f) safety;

g) communications.

NOTE Any or all navigation and manoeuvring functions may need to be performed at any of the navigation workstations. Duplication of functions can be accomplished without necessarily duplicating equipment.

It may be possible for one workstation to be adjacent to another. Workstations providing additional bridge functionality may be located on the bridge.

The interrelation of workstations to primary bridge functions is illustrated by Figure 11.

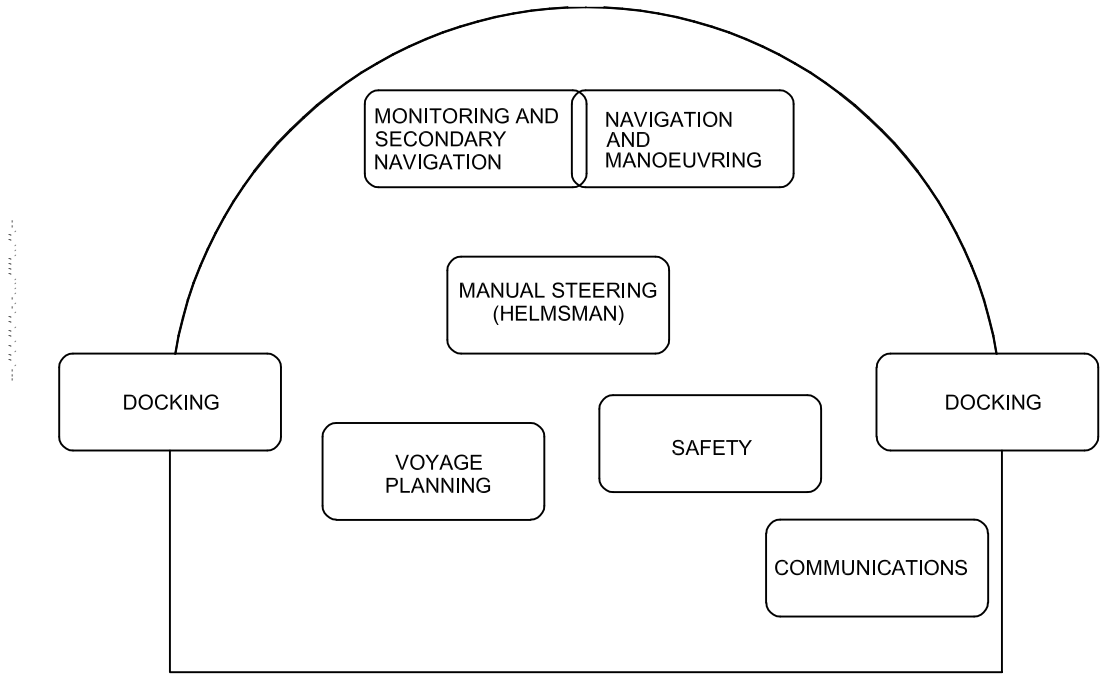


Figure 11 — Interrelation of workstations

5.2.3 Workstations for navigation and manoeuvring, and monitoring and secondary navigation

The workstation for performance of navigation and manoeuvring functions shall be designed so that all controls and information necessary for safely operating the ship are conveniently and continuously available to watchkeeping personnel responsible for these functions in all watchkeeping arrangements. A separate

workstation for monitoring shall be installed sufficiently close by to serve as a secondary navigation workstation and to allow good co-operation between two operators or an operator and a pilot performing his role as part of the bridge team.

The workstations for navigation and manoeuvring, and the arrangement of equipment pertinent to these stations, shall be located sufficiently close together to enable a single operator to cover his operation and to provide him with all necessary information so that he can carry out his functions from one working position but without being restricted to a specific location.

The main workstations should be planned, designed and placed within an area spacious enough for not less than two operators, but close enough to allow the stations to be operated by one person.

The consoles, including a chart table if provided, should be positioned so that the equipment they contain are mounted in such a manner as to face a person looking forward, but not preclude equipment mounted at an angle.

5.2.4 Workstations for docking

The workstation for docking, usually on the bridge wings, shall be located to enable the operator together with a pilot (when present) to observe all relevant external and internal information and directly or indirectly control the manoeuvring of the ship.

It shall be possible to observe the distance between the ship's side and the wharf at the water surface. From the workstation for docking, it shall be possible to communicate with the navigation and manoeuvring workstation as well as the steering (helmsman) workstation. If the workstation for docking is installed on open bridge wings, talk-back facilities shall be provided to enable unhampered communication under all operating conditions.

5.2.5 Workstation for manual steering

The workstation for manual steering shall preferably be located on the ship's centre-line. If the workstation for manual steering is located off the centre-line, special steering references for use by day and night shall be provided, e.g. sighting marks forward. These shall be mounted as far forward as practicable.

5.2.6 Workstations for voyage planning and safety

No additional requirements.

5.2.7 Workstation for communication

Workstations for communication shall preferably be located on the starboard side in such a way that the operator, while operating the equipment, is looking forward.

5.2.8 Workstations for additional functions

5.2.8.1 Workstations for additional bridge functions may be located on the bridge, provided the performance of such functions does not interfere with the tasks of maintaining safe control of the ship.

5.2.8.2 **Guideline**: A pilot plug and power supply should be provided in a position close to the bridge windows which will allow the user as good a range of unobstructed visibility as practicable.

5.3 Tasks to be performed

5.3.1 Each workstation shall enable the operator to perform assigned functions.

5.3.2 **Guidelines**: The basic tasks for the functions to be performed are the following.

a) At the workstation for navigation and manoeuvring, and workstation for monitoring and secondary navigation, controls and displays should enable the user to

   1) continuously perform route monitoring,

   2) monitor the accuracy of the electronic chart system, if provided, by cross checking the chart and radar alignment when applicable,

   3) manoeuvre the ship by adjustment and monitoring of speed and direction controls,

   4) adjust heading/track control system and steering mode if provided,

   5) continuously monitor traffic,

   6) display AIS information,

   7) operate whistle and fog signal controls,

   8) operate navigation lights,

   9) operate VHF,

   10) operate sound reception system if provided,

   11) operate internal communications,

   12) monitor all alarm conditions on the bridge and acknowledge warnings and alarms when applicable,

   13) acknowledge watch alarm,

   14) control windscreen wiper/washer/heater,

   15) select steering gear power unit,

   16) monitor engine room functions as necessary.

b) At the workstation for manual steering (helmsman), controls and equipment should enable the helmsman to

   1) steer the ship manually,

   2) directly control windscreen wiper/washer/heater to the immediate front,

   3) communicate with workstations for docking, navigation and secondary navigation.

c) At the workstation for docking, controls and displays should enable the user to

   1) monitor the relationship of the ship to the wharf, mooring or anchorage,

   2) manoeuvre the ship by adjustment and monitoring of speed and direction controls,

   3) directly or indirectly make sound signals,

   4) monitor mooring lines,

   5) communicate with tugs and pilot boat (VHF),

   6) effect two-way communication with mooring stations onboard, machinery spaces (and wheelhouse workstations when applicable),

   7) directly or indirectly control Morse lamp and searchlight.

d) At the workstation for voyage planning, controls and equipment should enable the user to

   1) plan voyages (berth-to-berth),

   2) plan the passage utilizing charts and nautical publications to achieve the voyage,

   3) establish and monitor individual routes that make up passage,

   4) transfer the planned route to the workstation for navigation and manoeuvring and secondary navigation.

e) At the workstation for safety, controls and equipment should enable the user to

   1) monitor the safety state of the ship (fire, emergency, etc.),

   2) handle alarm conditions, execute relevant measures,

   3) organize emergency operations,

   4) consult the ship's safety plans and drawings,

   5) effect internal communication,

   6) control and monitor navigation lights.

f) At the workstation for communication, controls and equipment should enable the user to operate the GMDSS equipment.

5.3.3 Information required by more than one person on duty shall be displayed for easy viewing by all users concurrently, or if this is not possible, the information shall be duplicated.

Certain equipment displaying information to more than one workstation may be located above the front windows if dimensions allow.

5.4 Configuration and dimensions of consoles

5.4.1 The main factors to be considered are the overall view required from the navigating and manoeuvring workstations and the field of vision required from other workstations to maintain an effective lookout by sight and hearing.

Ergonomic principles and views of experienced, practicing mariners shall be taken into consideration in the design of workstations.

5.4.2 All equipment and controls necessary for navigating and manoeuvring shall be operable from any normal working position.

5.4.3 **Guidelines**: Based on ergonomic principles, the width of consoles designed for single person operation should not exceed 1 600 mm.

5.4.4 The height of consoles shall not interfere with the visibility requirements.

5.4.5 **Guidelines**: The top of the consoles should not exceed a height of 1 350 mm, or 1 200 mm if intended for seated operation.

Dimensions in millimetres

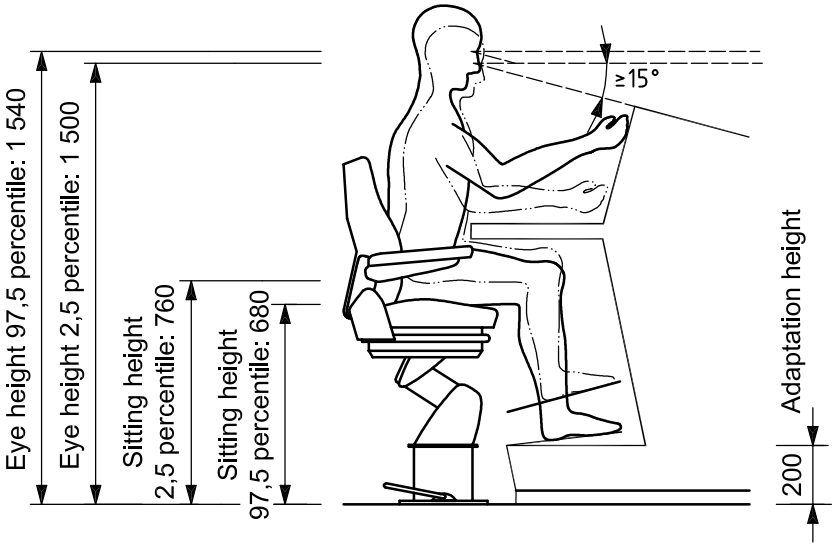


Figure 12 — Typical dimensions for seated position

Dimensions in millimetres

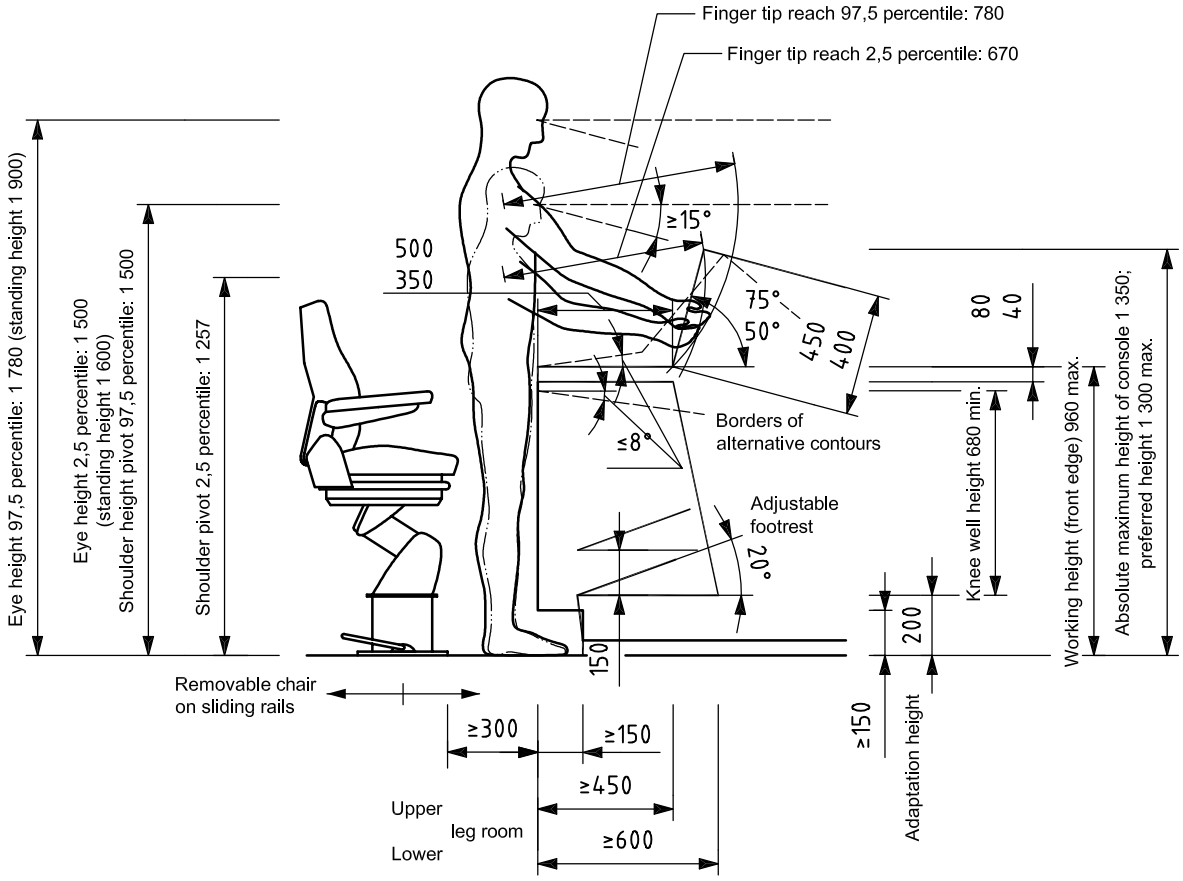


Figure 13 — Typical dimensions for standing position

5.4.6 Consoles shall principally be divided into two areas.

a) Information/presentation equipment shall be principally located in the vertical part of the console.

b) Controls shall be in the horizontal part.

5.4.7 The chart table shall be large enough to accommodate all chart sizes normally used internationally for maritime traffic. It shall have facilities for lighting the chart.

5.4.8 **Guidelines**: Chart table dimensions should be

— width: not less than 1 200 mm,

— depth: not less than 850 mm,

— height: not less than 900 mm and not more than 1 000 mm.

The chart table should have facilities to accommodate charts larger than the table depth, for example, a 10 mm slit along front and back edges of the chart table surface.

5.5 Accessibility and movement

5.5.1 Every effort shall be made to allow a clear route across the wheelhouse from bridge wing to bridge wing.

5.5.2 **Guidelines**: The width of the passageway should be at least 1 200 mm.

5.5.3 There shall be no obstructions between the points of entry to the bridge wings and wheelhouse from lower decks and the clear route referred to in 5.5.1.

5.5.3.1 The distance between adjacent workstations shall be sufficient to allow unobstructed passage to persons not working at the stations.

5.5.3.2 **Guidelines**: The free passage in passageways between different workstation areas should be at least 700 mm.

The workstation operating area should be part of the workstation and not of the passageway.

5.5.4.1 The distance from the bridge front bulkhead, or from any consoles and installations placed against the front bulkhead, to any consoles or installations placed away from the bridge front shall be sufficient for two persons to pass each other.

5.5.4.2 **Guidelines**: Where there is a passageway between the front bulkhead and any consoles, its width should preferably be at least 1 000 mm, and not less than 800 mm.

5.5.5.1 The clear ceiling height in the wheelhouse shall take into account the installation of overhead panels and equipment.

5.5.5.2 **Guidelines**: The clear height between the bridge deck surface covering and the underside of the deck head beams, or deckhead, whichever is lower, should be at least 2,25 m. The lower edge of deckhead mounted equipment should be at least 2,1 m above the deck in open areas, walkways and at standing workstations.

5.5.6 Workstations used for navigating, manoeuvring, manual steering, voyage planning and communication shall not cover a working area with an axis longer than 15 m.

5.5.7 Bridge decks outside, including the wings, shall be provided with adequate drainage.

5.5.8.1 Entrance doors to the wheelhouse shall be easy to operate.

5.5.8.2 **Guidelines**: All wheelhouse doors should be operable with one hand. Bridge wing doors should not be self-closing. Means should be provided to hold bridge wing doors open.

5.5.9 Talkback systems or equivalent communication between the outer end of the bridge wing and the wheelhouse shall be provided, unless equipment for remote manoeuvring is placed on the bridge wings.

5.6 Bridge alarm systems

5.6.1 Alarms

5.6.1.1 Details of bridge alarms shall comply with IMO performance standards.

5.6.1.2 Alerts and messages should enable the operator to

— devote full attention to the safe navigation of the ship,

— readily identify any abnormal situation requiring action to maintain the safe navigation of the ship, and

— avoid distraction by announcements that require attention but which do not constitute alarms.

5.6.1.3 It shall be possible for the operator to readily identify the source of the alert.

5.6.1.4 The bridge alarm system may be an integrated system for easy identification of alarm sources and acknowledgement.

5.6.1.5 A method of acknowledging audible and visual alerts should be provided on the bridge.

5.6.1.6 **Guidelines**: Acknowledge devices should be used to silence audible alarms and set visual alarms to steady state.

5.6.2 Bridge navigational watch alarm system (BNWAS)

A system may be provided which will confirm the alertness of the operator and, as appropriate, will summon back-up personnel to the bridge. See MSC.128(75) [39].

The watch monitoring system shall periodically verify that an alert operator is present on the bridge. Its operation shall not cause undue interference with the performance of bridge functions.

The watch monitoring system shall be designed and arranged such that it cannot be operated by unauthorized personnel or in an unauthorized manner.

Components for setting the appropriate intervals or for setting the operational modes (automatic, manual on, manual off) shall be arranged so that only the ship's master has access. All items of equipment forming part of the BNWAS should be tamper-proof so that no member of the crew may interfere with the systems operation.

Where a system requires manual acknowledgement by the operator, this shall be possible at the workstation for navigation and manoeuvring, and also at other appropriate locations from where a proper lookout may be kept.

An alarm is to operate on the bridge in the event of a failure of the watch alarm system.

5.6.3 Alarm transfer system

Means may be provided on the bridge to immediately activate a second, and subsequently third, stage remote audible alarms by means of an Emergency Call push button or similar.

Acknowledgement and cancellation of alarms shall only be possible from fixed locations on the bridge.

5.6.4 Centralized alarm system

Grouping of alerts may be used to reduce their variety in type and number.

If centralized alarms are installed, the indications and acknowledgement devices should be at or near to the navigation and manoeuvring workstation.

6 Bridge equipment

6.1 General

6.1.1 The requirements of this clause are not intended to prevent the use of new control or display techniques, provided the facilities offered are not inferior to those stated.

6.1.2 Equipment, panels and controls shall be permanently mounted in consoles or at other appropriate places taking into account operation, maintenance and environmental conditions.

6.1.3 Other portable items, such as safety equipment, tools, lights, pencils, shall be stored at appropriate places, specially designed wherever necessary.

6.1.4.1 The equipment located at the various workstations shall meet the need for safe and efficient performance of the functions specified in 5.2.

6.1.4.2 **Guidelines**: See 5.3.2 for the tasks to be performed at the various workstations. These guidelines lead to the following locations of the main equipment, where provided.

Ergonomic principles and the views of experienced, practicing mariners shall be taken into consideration in the selection, design and siting of equipment with the aim of ensuring the following:

a) equipment provides convenient and continuous access to essential information;

b) information is presented in a consistent manner using standardized symbols and coding systems for controls and displays;

c) information is presented in a clear and unambiguous manner.

6.2 Distribution of equipment in workstations

a) The following equipment may be distributed throughout the workstations for navigation and manoeuvring, monitoring and secondary navigation and commonly accessible areas so as to perform the required tasks listed in 5.3.2 a):

   1) radar (if only one required);

   2) radar (if two required);

   3) ARPA (if only one required);

   4) navigation radar display with ARPA if two are required;

   5) ECDIS or paper charts;

   6) automatic identification system (AIS);

   7) VHF radiotelephone;

8) heading and/or track control system if installed;

9) engine and thruster controls or telegraphs;

10) magnetic compass display;

11) conning information display or

   i) rudder angle indicator,

   ii) heading repeater,

   iii) speed and distance indicator,

   iv) rate of turn indicator,

   v) propeller revolution indicator(s),

   vi) pitch indicator,

   vii) wind speed and direction,

   viii) depth indicator,

   ix) main engine revolution indicator,

   x) torque indicator,

   xi) starting air indicator,

   xii) lateral thrust indicator,

   xiii) air and water temperature indicator,

   xiv) steering control override control,

   xv) steering position selector,

   xvi) steering gear power unit selector,

   xvii) steering gear power unit start/stop control,

   xviii) steering mode selector,

   xix) electronic position-fixing system;

12) central alarm panel;

13) BNWAS acknowledgement device;

14) alarm reset control;

15) sound reception system;

16) intercommunication systems (including specifically to emergency steering position);

17) whistle and fog signal controls;

18) searchlight controls;

19) night vision equipment;

20) Morse light keys;

21) window wiper and washer and heater control;

22) emergency stop controls;

23) clock;

24) binoculars;

25) additional engine room monitors as necessary.

NOTE Depending on the level of automation, integration of equipment and new methods of display, the workstations for navigation and manoeuvring may be designed as one combined station.

b) The following equipment may be distributed in the **workstation for manual steering**:

1) manual steering device;

2) heading repeater;

3) rudder angle indicator;

4) rate of turn indicator;

5) magnetic compass display;

6) course indicator;

7) talkback device to bridge wings;

8) window wiper and washer and heater control for window directly in front.

c) The following equipment may be distributed in the **workstation for docking**:

1) engine control;

2) thruster control;

3) rudder control;

4) steering position selector;

5) conning information display or

i) rudder angle indicator,

ii) heading repeater,

iii) speed indicator,

iv) rate of turn indicator,

v) propeller revolution indicator(s),

vi) pitch indicator,

vii) wind speed and direction indicator,

viii) depth indicator,

ix) main engine revolution indicator,

x) torque indicator,

xi) starting air indicator,

xii) lateral thrust indicator,

xiii) air and water temperature indicator,

xiv) communication (external and internal),

xv) whistle control,

xvi) Morse light keys,

xvii) Pelorus (alternatively located near the centre-line),

xviii) BNWAS acknowledge device.

d) The following equipment may be distributed in the **workstation for voyage planning**:

1) chart table and appropriate instruments;

2) navigation planning station (backup ECDIS if installed);

3) weather facsimile;

4) compass corrections;

5) nautical charts and publications.

e) The following equipment may be distributed in the **workstation for safety**:

1) alarms;

2) monitoring systems;

3) fire alarm panels;

4) remote controls for fire-extinguishing system;

5) monitoring panel and remote control for watertight doors/fire doors (open/closed);

6) emergency stop controls for air condition, ventilation and refrigerating installations;

7) main station for VHF or UHF radiotelephones (walkie-talkie);

8) ballast controls;

9) clinometer;

10) bilge monitor;

11) strength monitor;

12) ship's safety plans;

13) navigation light panel.

f) The following equipment may be distributed in the **workstation for communication**:

1) GMDSS equipment as required for the applicable sea area;

2) weather facsimile;

3) writing space.

g) The following equipment may be distributed in the **workstation for additional functions**:

1) cargo monitoring and controls;

2) power panels;

3) etc.

6.3 Equipment

6.3.1 Equipment shall be logically grouped according to function.

6.3.1.1 Equipment shall be designed to permit easy and correct reading by day and by night while preserving night vision. Electronic navigational aids shall meet the requirements of IMO Resolution A.694(17).

6.3.1.2 **Guidelines**: A digital readout should not be used where the reading changes rapidly.

For an index moving relative to a circular scale, the index should move clockwise (or the scale move anticlockwise) for increasing readings.

For an index moving relative to a linear scale, the scale should be horizontal or vertical and the pointer should move to the right or upwards for increasing readings.

NOTE There may be special cases where these guidelines do not apply; for example, where the reading may be positive or negative, or where depth is indicated.

6.3.2 Each instrument shall be placed with its face normal to the operator's line of sight, or to the mean value if the operator's line of sight varies through an angle.

6.3.3 Equipment, including any installed transparent covers, shall be designed and fitted to minimize glare or reflection or being obscured by strong light.

6.3.4 The principal manoeuvring equipment shall be readable from the workstation for navigation and manoeuvring. Equipment meant to be operated, or fitted in connection with controls, shall be readable from a distance of at least 1 000 mm. Any other equipment shall be readable from a distance of at least 2 000 mm.

6.3.4.1 **Guidelines:** Character height in millimetres should be not less than three and a half times the reading distance in metres. Character width should be 0,7 times the character height, e.g.

— character height for a reading distance of 2 m: $2 \times 3{,}5 = 7$ mm,

— character width for a letter height of 7 mm: $7 \times 0{,}7 = 4{,}9$, i.e. 5 mm,

— resulting minimum character size: 7 mm × 5 mm.

6.3.4.2 All information shall be presented on background of high contrast, emitting as little light as possible by night.

6.3.4.3 **Guidelines**: All ship's bridge equipment should be designed to show a light text on a dark non-reflecting background at night. The contrast should be within 1:3 and 1:10.

6.3.4.4 Instrument character type shall be of simple, clear-cut design.

6.3.4.5 **Guidelines**: Recommended character type is Helvetica medium. However, light emitting diode text matrices are acceptable.

NOTE In descriptive text, lower case letters are easier to read than capitals.

6.3.5 The purpose of each control shall either be clearly illustrated by symbols where standard symbols have been internationally adopted, or indicated by a label in English.

6.3.5.1 Controls or combined controls/indicators shall be visually and tactually distinguishable from elements which only indicate.

6.3.5.2 **Guidelines**: Rectangular buttons should be used for control elements, and round lights for indicator elements.

The operation of a control shall not obscure indicator elements where observation of these elements is necessary to allow adjustments to be made.

The shape of mechanical controls shall indicate the method of operation of the control.

Rotary finite-position controls (e.g. stepped switches) should have toggles or levers, whereas rotary continuous-position controls (rheostats) should have knobs or wheels except for the steering control.

The position/function allocation and purpose of control elements, as well as the function and layout of indicator elements, shall be logically coordinated. Positioning according to functions should be in accordance with IEC 60447.

6.4 Illumination and individual lighting of equipment

6.4.1 Illumination

6.4.1.1 Indicator lights and the illumination of all equipment shall be designed and fitted to avoid unnecessary glare or reflections, or the equipment being obscured by strong light.

6.4.1.2 **Guidelines**: For the illumination of displays, red light (wavelength 620 nm or higher) provides the least impact on night vision.

6.4.1.3 To avoid unnecessary light sources in the front area of the bridge, only equipment necessary for the safe navigation and manoeuvring of the ship should be located in this area.

6.4.2 Alarms

6.4.2.1 Warning and alarm indicators shall be designed to show no light in normal conditions, indicating a safe situation. Means shall be provided to test the lamps.

6.4.2.2 **Guidelines**: Alarm indicator lights should be equipped with red lights of 620 nm or higher wavelength.

6.4.3 Adjustments

6.4.3.1 All illumination and lighting of equipment shall be adjustable down to zero, except the lighting of warning and alarm indicators and the control of the dimmers which shall remain readable.

6.4.3.2 Each instrument shall be fitted with an individual light adjustment. In addition, groups of equipment normally working together may be equipped with common light adjustment.

6.5 Outer shape of equipment

The outer shape of equipment for control elements and the equipment mounted in a group or console shall have a square or rectangular frame and be designed to fit internationally accepted standard size modules.

NOTE This does not imply that the instrument display itself has to be rectangular.

6.6 Power supply requirements

Equipment required to undertake a primary bridge function should be connected, as appropriate, to a self-contained emergency source of electrical power as provided in the SOLAS convention.

7 Bridge working environment

7.1 General

7.1.1 Care shall be taken to ensure a good working environment for bridge personnel.

7.1.2 Toilet facilities shall be provided on or adjacent to the bridge.

7.1.3 Refreshment facilities and other amenities provided for the bridge personnel shall include means for preventing damage to bridge equipment and injury to personnel resulting from the use of such facilities and amenities.

7.2 Vibration

Uncomfortable levels of vibration shall be avoided on the bridge.

NOTE Limits for acceptable levels of vibration are still under study (ISO 6954:2000).

7.3 Noise

7.3.1 General noise

7.3.1.1 Noise should be maintained at levels that do not: (1) interfere with necessary voice, telephone and radio communications, (2) cause fatigue or injury and (3) degrade overall system effectiveness. Noise levels shall comply with IMO Resolution A.468(XII) and take into account IMO Resolution A.343(IX).

7.3.1.2 Guidelines: The noise of ventilation fans, engine intake fans and other noise sources should be excluded from the bridge operational area by suitable siting of the fans and associated trunking.

7.3.2 Sound signals

7.3.2.1 Fixed sound signal apparatus shall not be placed in the immediate vicinity of the bridge. Reference is made to Annex III of the International Regulations for Preventing Collisions at Sea.

7.3.2.2 Guidelines: The sound signal apparatus should be sited as high as practicable and if possible, forward of the bridge.

7.4 Lighting

7.4.1 Goal

A satisfactory level of lighting shall be available to enable the bridge personnel to complete such tasks as chart work at sea, and maintenance and office work in port, by daylight or darkness.

7.4.2 Guidelines

Individual task areas should have a greater luminance than the general lighting level.

Care shall be taken to avoid glare and stray image reflections in the bridge environment.

High contrast in brightness between work area and surroundings should be avoided. Luminance of the task area should not be greater than three times the average luminance of the surrounding area.

A non-reflective or matt surface should be used to reduce indirect glare to a minimum.

NOTE Glare is experienced if windows or light sources, seen directly or by reflection in shiny surfaces, are too bright compared to the general brightness within the interior of the bridge.

7.4.3 Range of lighting

7.4.3.1 A satisfactory level of flexibility within the lighting system shall be available to enable the bridge personnel to adjust the lighting in brightness and direction as required in different areas of the bridge and by the needs of individual equipment and controls.

7.4.3.2 **Guidelines**: Table 1 lists the recommended general illumination.

Table 1

Place	Colour/illumination
Bridge and adjacent offices, day	White, continuously variable from 0 lux to at least 500 lux.
Bridge, night	Red, continuously variable from 0 lux to 20 lux.
Adjacent corridors and rooms for noisy equipment, day	White, continuously variable from 0 lux to at least 300 lux.
All adjacent corridors and rooms, night	Red, continuously variable from 0 lux to 20 lux. Automatic door switches should be fitted.
Obstacles, night	Red spotlights, continuously variable from 0 lux to 20 lux.
Chart table, day	White floodlight, continuously variable from 0 lux to 1 000 lux, White spotlights, continuously variable from 0 lux to 100 lux.
Chart table, night	Combined red and white floodlight, with each colour continuously variable from 0 lux to 20 lux. Combined red and white spotlights, with each colour continuously variable from 0 lux to 20 lux.

NOTE Vision in dim light has the following characteristics:

— detail and colour cannot be seen;

— the eye becomes more sensitive to the blue end of the light spectrum;

— peripheral vision can be used more effectively.

Dark adaptation is important to ensure a good visual lookout at night. It takes 30 min to 40 min for complete dark adaptation. Red goggles worn 5 min to 15 min prior to going on watch will aid dark adaptation.

7.4.4 Darkness

7.4.4.1 During hours of darkness, it shall be possible to discern equipment on the bridge.

7.4.4.2 **Guidelines**: Bridge equipment can be lit by internal or external lighting.

Red or equivalently filtered white light should be used to maintain dark adaptation whenever possible in areas or on items of equipment, other than the chart table, requiring illumination in the operational mode. This should include equipment in the bridge wings.

Indirect low level red lighting should be available at deck level, especially for internal doors and staircases.

Provision should be made to prevent red lights from being seen from outside the ship.

Night vision goggles are sensitive to red light. Where these are likely to be used, care should be taken to avoid glare and sources of 'flaring'.

7.5 Heating, ventilation and air conditioning

7.5.1 General

7.5.1.1 The wheelhouse shall be equipped with an efficient system to regulate temperature and humidity.

7.5.1.2 **Guidelines**: The wheelhouse should be equipped with an adequate air-conditioning or mechanical ventilation system to regulate temperature and humidity. Sufficient heating should be available according to climatic needs.

7.5.2 Temperature

7.5.2.1 The wheelhouse should be equipped with an adequate air-conditioning or mechanical ventilation system. Sufficient heating and/or cooling should be available according to climatic needs.

7.5.2.2 The optimum range of effective temperature for accomplishing light work while dressed appropriately for the season or climate is 21 °C to 27 °C in a warm climate or during summer and 18 °C to 24 °C in a colder climate or during the winter.

7.5.2.3 The temperature difference between any two points within the workplace should be maintained below 5 °C, e.g. the temperature of the air at floor level and at head level.

7.5.3 Humidity

7.5.3.1 Humidity should be maintained between 20 % and 60 %, with 40 % to 45 % preferred. Approximately 45 % humidity should be provided at 21 °C. This value should decrease with rising temperatures, but should remain above 20 % to prevent irritation and drying of body tissues, eyes, skin and respiratory tract.

7.5.3.2 The temperature and humidity should be adjustable within the foregoing requirements by closing the wheelhouse.

7.5.3.3 The wheelhouse shall be equipped with an efficient system to regulate temperature and humidity.

7.5.4 Guidelines

7.5.4.1 Humidity should be maintained between 20 % and 60 %, with 40 % to 45 % preferred. Approximately 45 % relative humidity should be provided at 21 °C. This value should decrease with rising temperatures, but should remain above 20 % to prevent irritation and drying of body tissues, eyes, skin and respiratory tract.

7.5.4.2 The wheelhouse should be equipped with an adequate air-conditioning or mechanical ventilation system to regulate temperature and humidity. The temperature and the humidity should be adjustable within the limits of the foregoing requirements by closed wheelhouse doors and windows.

7.5.4.3 Heating systems should be designed so that hot air discharge is not directed at personnel. Air-conditioning systems should be designed such that cold air discharge is not directed at personnel.

7.5.4.4 Heating and air conditioning should not produce air velocities exceeding 0,5 m/s. If possible, the preferred air velocity of 0,3 m/s should be used to preclude manual pages from being turned or papers from being blown off work surfaces.

7.6 Surfaces

7.6.1 The bridge surface finishes shall be considered an integral part of the structure, layout and environmental design.

7.6.2 All prepared surfaces shall be glare-free. See 6.3.

7.6.3 Wheelhouse, bridge wing and upper bridge decks shall have non-slip surfaces whether wet or dry.

7.6.4.1 All surfaces of deck heads, bulkheads, doors and floors shall be robust enough to withstand the daily wear of the shipboard environment.

7.6.4.2 **Guidelines**: All surfaces should be capable of withstanding a temperature range of −20 °C to +70 °C, sea water, oils and solvents common to ships, and ultraviolet light.

7.7 Interior

7.7.1 Colours shall be chosen which give a calm overall impression and minimize reflectance.

7.7.2 Colour coding of functions and signals shall be in accordance with ISO 2412.

Bright colours should not be used. Dark or mid-green colours are recommended: alternatively, blue or brown may be used.

Table 2 indicates the reflectance range for some typical colour densities.

Table 2

Reflectance range	5 % to 10 %	15 % to 30 %	50 % to 60 %	80 % to 90 %
Typical colour densities	Dark green Blue/brown	Mid-green Blue/red	Pale green Blue/yellow	Off white Pale yellow

7.8 Safety of personnel

7.8.1 The bridge area shall be free of physical hazards to bridge personnel.

7.8.2 **Guidelines**: There should be no sharp edges or protuberances which could cause injury to personnel.

The bridge deck should be free of trip hazards such as curled up carpet edges, loose gratings, duckboards or equipment.

Means should be provided for properly securing portable equipment.

7.8.3 Sufficient hand- or grab-rails shall be fitted to enable personnel to move or stand safely in bad weather. Protection of stairway openings shall be given special consideration.

7.8.4 All safety equipment carried on the bridge shall be clearly marked, be easily accessible and have its stowage position clearly indicated.

8 Failure mode and effects analysis (FMEA)

8.1 General

8.1.1 The FMEA is intended to document limitations of a particular bridge design, taking into account the human element as well as equipment content and design.

8.1.2 A practical, realistic and documented assessment of the failure characteristics of the functions performed from the bridge shall be undertaken by the ship builder with the aim of defining and studying the important failure conditions that may exist. The ship builder may subcontract all or part of this effort to various system integrators.

8.2 Objectives

8.2.1 The primary objective of FMEA is to provide a comprehensive, systematic and documented investigation which establishes the important failure conditions of the bridge design and assesses their significance with regard to the safety of the ship, its occupants and the environment.

8.2.2 The main aims of undertaking the analysis are to

a) provide ship and system designers with data to audit their proposed designs,

b) provide ship operators with data to generate comprehensive training, manning, operational and maintenance programmes and documentation, and

c) provide the Administration with the results of a study into the failure characteristics of the bridge design.

8.3 Initial functional failure analysis

8.3.1 It is necessary to perform a functional failure analysis of the bridge design. In this way, only elements which fail the functional failure analysis need to be investigated by a more detailed FMEA.

8.3.2 The functional failure analysis shall consider

— normal seagoing conditions,

— restricted waters, and

— manoeuvring alongside.

8.3.3 The bridge design shall be described in either block diagrams or fault-tree diagrams or in a narrative format to enable the failure effects to be understood. Failures fall into one of the following modes:

— complete loss of function;

— uncontrolled or varying output;

— premature operation;

— failure to operate at a prescribed time; and

— failure to cease operation at a prescribed time.

Depending on the element under consideration, other failure modes may have to be taken into account.

8.3.4 For systems whose individual failure can cause hazardous or catastrophic effects and where a redundant system is not provided, a detailed FMEA as described in the following paragraphs shall be followed.

Results of the system functional failure analysis shall be documented and confirmed by a practical test programme drawn up from the analysis.

8.3.5 Where an element, the failure of which may cause a hazardous or catastrophic effect, is provided with a redundant element, a detailed FMEA may not be required provided that:

a) the redundant element can be put into operation or can take over from the failed element within the time-limit dictated by the most onerous operational mode in 8.3.2 without hazarding the ship; or

b) the redundant element is completely independent from the failed element and does not share any common element, the failure of which would cause failure of both elements; or

c) the redundant element may share the same power source as the failed element. In such case, an alternative power source shall be readily available with regard to the requirement of a); and

d) the probability and effects of operator error in engaging the redundant element have been considered.

8.3.6 The functional failure analysis shall be performed to the same standard as the detailed FMEA.

8.4 Detailed failure mode and effects analysis

8.4.1 The systems to be subject to a more detailed FMEA investigation at this stage shall include all those that have failed the initial FMEA. It may also include those that have a very important influence on the safety of the ship and its occupants and which require an investigation at a deeper level than that undertaken in the initial FMEA.

8.4.2 The FMEA process shall consist of the following steps:

a) to define the elements to be analysed;

b) to illustrate the interrelationships of functional elements by means of block diagrams;

c) to identify all potential failure modes and their causes;

d) to evaluate the effects of each failure mode;

e) to identify failure detection methods;

f) to identify corrective measures for failure modes;

g) to rank the failures based on probability, severity and detectability;

h) to document the analysis;

i) to develop a test programme;

j) to prepare the FMEA report;

k) if necessary, to act upon the findings of the report to ensure that the risk is reduced to an acceptable level.

8.4.3 For details, see IEC 60812:1985 [23].

9 Documentation

9.1 Stowage

Adequate stowage shall be provided for all manuals and other documentation.

9.2 User information which should be provided

9.2.1 By the bridge integrator — Detailed operating instructions

9.2.1.1 Individual equipment manuals.

9.2.1.2 If necessary,

— a block diagram of any integrated equipment (to be mounted on bridge bulkhead),

— supplemental information necessary to the operation of the specific bridge design.

9.2.2 By the ship owner — Bridge operational procedures and training

9.2.2.1 Familiarization with and qualification on bridge layout, such as

— location of key equipment,

— navigation and manoeuvring controls,

— lights,

— sound signals,

— alarms,

— communications equipment.

9.2.2.2 If necessary, operation of individual and integrated equipment.

9.3 Supplemental documentation

All of the above may be supplemented by a comprehensive CD or DVD.

Annex A
(normative)

Bridge layout for high speed craft

A.1 General

This annex includes special requirements for high speed craft. The requirements are additional to those contained in the main body of this International Standard.

The general requirements in the IMO MSC.97(73) code for High Speed Craft, Chapter 15, *Operating Compartment Layout*, apply.

A.2 Field of vision

A.2.1 The operating compartment shall be suitably located to allow a view all around the horizon from the workstation for navigation and manoeuvring.

A.2.2 The total arc of blind sectors from dead ahead to 22,5° abaft the beam on either side shall not exceed 20°, seen from a seated position at the workstation for navigation and manoeuvring. Each individual blind sector shall not exceed 5°. The clear sector between two blind sectors shall not be less than 10°.

A.2.3 From a seated position at a navigation and manoeuvring workstation it shall be possible

— to see the bow of the craft,

— to view the sea surface at a distance of one craft length (LOA) or less from the hull over an arc from dead ahead to the beam on each side,

— to observe leading marks (marks in line) astern for accurate track monitoring in congested waters, and

— to observe the distance of the craft's forward and stern part on either side to a wharf from a position at the controls for speed and course, if separate docking workstations are not located in adequate positions.

A.2.4 **Guidelines**: Artificial means may be used for approved purposes.

Artificial means approved for this purpose may be used to achieve the proper view. Artificial means should be sufficiently dependable. Their ability to perform assigned tasks in a usable manner and in all conditions should be assured. Artificial means should be assessed at a system level, e.g. including lighting, camera controls and wiper.

A.3 Workstations and location of equipment

A.3.1 General

A.3.1.1 The bridge shall not be used for any other purposes than those related to navigation, communications and other functions essential to the safe operation of the craft, its engines, passengers and cargo.

A.3.1.2 Each workstation on the bridge shall be provided with an adjustable chair and suitable safety belts.

A.3.1.3 Equipment, displays and indicators providing visual information to more than one person shall be located for easy viewing by all users concurrently or be duplicated as found necessary.

A.3.2 Workstation for navigation and manoeuvring

A.3.2.1 Equipment and controls necessary for navigation, traffic surveillance, manoeuvring, communication and monitoring of the safety state of the craft are to be located at the workstation for navigation and manoeuvring.

A.3.2.2 All the equipment to be operated at the workstation for navigation and manoeuvring shall be located within reach for a seated person with safety belt fastened. Equipment and indicators to be monitored shall be easily readable from this position.

A.3.2.3 The design of the workstation for navigation and manoeuvring shall allow the seating of an additional person, suitably located to assist in navigation when required and for instant take-over of primary bridge functions, including controls for speed and course.

A.3.3 Workstation for docking

If separate workstations for docking operations are provided, they shall be fully equipped for direct control of the propulsion and steering as well as special means for manoeuvring, if installed.

A.3.4 Workstation for monitoring and control of machinery

If an additional workstation for supervision of machinery is installed on the bridge, the location and use of this workstation shall not interfere with the field of vision required or the functions to be performed at the workstation for navigation and manoeuvring.

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