RULES FOR CLASSIFICATION

Ships

Edition July 2019
Amended October 2020

Part 6 Additional class notations

Chapter 3 Navigation, manoeuvring and position keeping

DNV GL AS

FOREWORD

DNV GL rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

This document supersedes the January 2018 edition of DNVGL-RU-SHIP Pt.6 Ch.3.
Numbering and/or title of items containing changes are highlighted in red colour.

Amendments October 2020, entering into force 1 January 2021

Topic	*Reference*	*Description*
Verification and testing	Sec.1 [3.1] and Sec.2 [3.1]	A new guidance note is added to provide reference to, and inform about the alternative verification methods made available by introduction of the new additional class notations for data-driven verification, **DDV** class notation.

Amendments October 2019, entering into force as from date of publication

Topic	*Reference*	*Description*
Central alert management system	Sec.4 [3.2.1.1], Sec.4 [3.2.2.2], Sec.4 [3.3.3]	Requirement for central alert management system for docking stations has been lifted. Previous Sec.4 [3.3.3] *Central alert management system* deleted.
Indication at the docking workstation for rate-of-turn, speed and wind direction	Sec.4 [3.2.4.2]	Requirement for information on rate-of-turn, speed and wind direction/speed at the docking workstation has been lifted.
Indication at the docking workstation for gyro compass	Sec.4 [3.2.4.2]	Gyro compass heading information at the docking workstations may be covered by applicable gyro compass bearing repeaters.
Introducing new definition 'easily accessible'	Sec.4 Table 1, Sec.4 [3.2.1.4]	The instruments, indicators and displays providing information as described in [3.2.1.4] has changed from being easily readable to be easily accessible from the navigating and manoeuvring workstation. Definition of easily accessible is included in Table 1.

Changes July 2019, entering into force 1 January 2020

Topic	*Reference*	*Description*
Replacing **NAUT**-qualifier **ICS** with **INS+** due to alignment with international regulations	Sec.3 Table 2	Terms and abbreviations have been updated to be in line with the updated Sec.3 [7].
	Sec.3 [4.4]	**ICS** changed to **INS+** and carriage requirements are moved to [7].
	Sec.3 [7]	The qualifier **ICS** has been changed to **INS+** and the qualifier requirements have been updated to be in line with the revised IMO and IEC standards for integrated navigation systems (INS). This include restructuring of the subsections; hence continued rule content may have changed references.

Editorial corrections

In addition to the above stated changes, editorial corrections may have been made.

CONTENTS

SECTION 1 DYNAMIC POSITIONING SYSTEMS - DYNPOS AND DPS

1 General

1.1 Introduction

The additional class notations **DPS** and **DYNPOS** set requirements for dynamic positioning for all types of vessel. For vessels with a requirement for dynamic positioning systems with redundancy and a higher degree of flexibility, based on utilization of stand-by units and/or change-over mechanisms, is described in Sec.2.

1.2 Scope

The scope for additional class notations **DPS** and **DYNPOS** provides technical requirements for design, documentation, certification and testing of systems for dynamic positioning for all types of vessel. These rules do not include requirements or recommendations in regard to vessel operation or other characteristics.

Requirements additional to these rules may be imposed by the national authority with whom the vessel is registered and/or by the administration within whose territorial jurisdiction it is intended to operate. Where national legislative requirements exist, compliance with such regulations will also be necessary.

These rules do not give guidance on the suitability of the different intended technical system configurations, with respect to the vessels various industrial mission(s). Reference is given to the recommended practice: DNVGL-RP-E306 *Dynamic positioning vessel design philosophy guidelines*.

The requirements in these rules are additional to the rules for main class. In particular see the relevant sections of:

— Pt.4 Ch.1 *Machinery systems, general*
— Pt.4 Ch.2 *Rotating machinery, general*
— Pt.4 Ch.3 *Rotating machinery - drivers*
— Pt.4 Ch.4 *Rotating machinery - power transmissions*
— Pt.4 Ch.5 *Rotating machinery - driven units*
— Pt.4 Ch.8 *Electrical installations*
— Pt.4 Ch.9 *Control and monitoring systems*.

1.3 Application

The additional class notations **DPS** and **DYNPOS** apply to all vessels with dynamic positioning systems. This section concerns requirements for two different types of class notation; **DPS**- series and **DYNPOS**-series, as defined in Table 2. Both series are characterised and structured in line with the IMO MSC/Circ.645 *Guidelines for vessels with dynamic positioning systems* and IMO MSC.1/Circ.1580 *Guidelines for vessels and units with dynamic positioning (DP) systems*, see Table 1. The two class notation series differ in their specific requirements, and in general the **DYNPOS**-series notations require a higher degree of availability and robustness than compared to the **DPS**-series. For example: **DYNPOS(AUTS)**/**DPS(1), DYNPOS(AUTR)**/**DPS(2)** and **DYNPOS(AUTRO**)/**DPS(3)** are notations requiring contrasting levels of redundancy and system separation. Qualifier **A** may be added to certain notations, thus indicating a requirement for annual survey. The detailed differences are shown in the specific requirements given in this section.

Table 1 Correlation IMO equipment classes to DNV GL class notations

IMO equipment class	*Class notations*	*Additional information*
Not applicable	**DYNPOS(AUTS)**	Even though IMO MSC/Circ.645 and IMO MSC.1/Circ.1580 does not specify any equipment class corresponding to **DYNPOS(AUTS)** this requirements level is often referred to as IMO equipment class 0.
IMO equipment class 1	**DPS(1)**	When full correlation with the technical requirements in IMO MSC.1/Circ.1580 is wanted, the following addition shall be complied with: — It shall be possible to control the thrusters manually by a common joystick in the main DP-control system.
	DYNPOS(AUT)	Additional requirements to achieve higher availability and robustness as compared to **DPS(1)** will apply.
IMO equipment class 2	**DPS(2)**	When full correlation with the technical requirements in IMO MSC.1/Circ.1580 is wanted, the following additions shall be complied with: — Single failure criteria shall include any normal static component (cables, pipes, manual valves, etc.) that may immediately affect position keeping capabilities. I.e. the arrangement of auxiliary systems shall be as per **DYNPOS(AUTR)** class notation described in [9]. — Redundant components and system shall be immediately available without needing manual intervention. I.e. in case a single stern thruster is arranged as per [4.3.2] this shall be a dual feed arrangement as per [4.3.4], or similar. — It shall be possible to control the thrusters manually by a common joystick in the main DP-control system. — The individual thruster emergency stop systems shall have a loop monitoring system. — At least one automatic power management system (PMS) shall be provided and should have redundancy according to the equipment class.
	DYNPOS(AUTR)	Additional requirements to achieve higher availability and robustness as compared to **DPS(2)** will apply.
IMO equipment class 3	**DPS(3)**	When full correlation with the technical requirements in IMO MSC.1/Circ.1580 is wanted, the following additions shall be complied with: — It shall be possible to control the thrusters manually by a common joystick in the main and back-up DP-control systems. — The individual thruster emergency stop systems shall have a loop monitoring system. — At least one automatic power management system (PMS) shall be provided and should have redundancy according to the equipment class.
	DYNPOS(AUTRO)	Additional requirements to achieve higher availability and robustness as compared to **DPS(3)** will apply.
The **DYNPOS**-series comprise the **DYNPOS(AUTS)**, **DYNPOS(AUT)**, **DYNPOS(AUTR)** and **DYNPOS(AUTRO)** notations. The **DPS**-series comprise the **DPS(1)**, **DPS(2)** and **DPS(3)** notations.		

1.4 Class notations

Vessels built and tested in compliance with the requirements in this section and the requirements of the rules for relevant main class may be assigned the relevant class notation(s) given in Table 2.

Table 2 Class notations

Notation hierarchy		*Description*
Notations not requiring redundancy	**DYNPOS(AUTS)**	Dynamic positioning system without redundancy.
	DPS(1)	Dynamic positioning system with an independent joystick system back-up and a position reference back-up.
	DYNPOS(AUT)	Dynamic positioning system with an independent joystick system back-up and a position reference back-up. Additional requirements to achieve higher availability and robustness as compared to **DPS(1)** will apply.
Notations requiring redundancy	**DPS(2)**	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up.
	DYNPOS(AUTR)	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up. Additional requirements to achieve higher availability and robustness as compared to **DPS(2)** will apply.
Notations requiring redundancy and separation of systems	**DPS(3)**	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up. Plus a back-up dynamic positioning control system in an back-up dynamic positioning control centre, designed with physical separation for components that provide redundancy.
	DYNPOS(AUTRO)	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up. Plus a back-up dynamic positioning control system in an back-up dynamic positioning control centre, designed with physical separation for components that provide redundancy. Additional requirements to achieve higher availability and robustness as compared to **DPS(3)** will apply.

1.4.1 Qualifier A

A qualifier **A** can when requested by the vessel owner be assigned to vessels with notation **DYNPOS(AUTR)** or **DYNPOS(AUTRO)** or **DPS(2)** or **DPS(3)**, which then shall undergo annual survey according to the applicable 5 yearly survey scope. This means that the scope of the annual survey shall also include the scope of the complete survey.

Guidance note:

Example of notations: **DYNPOS(AUTR, A)** or **DPS(2, A)**.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.4.2 Station keeping capability

Vessels with one of the **DYNPOS**-series class notations, except for notation **DYNPOS(AUTS)**, listed in Table 2 will be assigned DP capability numbers according to DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*. These will be entered as a register notation in the Society's register of vessels. See [10] for details.

Guidance note 1:

Upon special request DP capability numbers may also be approved and entered as a notation in the register of vessels also for vessels with the **DPS**-series notations and for the notation **DYNPOS(AUTS)**.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.5 Definitions

Table 3 Definitions

Term	*Definition*
bulkhead deck	see Pt.3 Ch.1 Sec.4 Table 7 for definition
CLE	sailing vessel entering in to class
consequence analysis	monitoring function in the DP-control system that issue an alarm if the vessel (in its current operating mode) in the current weather conditions would not be able to keep the heading and position in the case that any of the predefined worst case failures should occur **Guidance note:** For detailed information and requirements to the consequence analysis function see [6.13]. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
DP	dynamic positioning
DP-control system	all control systems and components, hardware and software necessary to dynamically position the vessel. The DP-control system consists of the following: — dynamic positioning control computer(s) — sensor system — display system — operator panels — positioning reference system — associated cabling and cable routing — UPS(s) as required by the relevant notation. **Guidance note:** The DP-control system will normally consist of one or more computers. This is often referred to as the DP system, but is only a part of the DP system by rule terminology. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Term	Definition
dynamic positioning system (DP system)	complete installation necessary for dynamically positioning a vessel comprises of the following systems: — power system — thruster system — DP-control system — independent joystick system (when required).
dynamically positioned vessel (DP vessel)	vessel which automatically maintains its position and heading (fixed location or predetermined track) exclusively by means of thruster force **Guidance note:** For the **DYNPOS**-series an intact vessel should be able to keep position and heading without contribution from transverse thrust generated by the combined use of propellers and rudders. For **DYNPOS(AUTR)** and **DYNPOS(AUTRO)** thruster force may include propulsion and steering (rudder) forces for back-up purposes only (e.g. after loss of one redundancy group), see [7]. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
failure	occurrence in a component or system causing one or both of the following effects: — loss of component or system function — deterioration of functional capability to such an extent that the safety of the vessel, personnel, or environment is significantly reduced. **Guidance note:** For vessels that should comply with **DYNPOS(AUTRO)** or **DPS(3)** requirements, the definition of single failure has no exceptions, and should include incidents of fire and flooding, and all technical break-downs of systems and components, including all electrical and mechanical parts. Loss of stability (e.g. as a result of flooding) is not a relevant failure mode. For vessels that should comply with **DYNPOS(AUTR)** or **DPS(2)** requirements, certain exceptions will be allowed in the definition of single failure. Flooding and fire should not be considered beyond main class requirements. Failure of static components, e.g. pipes, manual valves, cables etc. may not need to be considered if adequate reliability of single component can be documented, and the part is protected from mechanical damage. Specific requirements will apply as given in the following subsections of this section. Especially for **DYNPOS(AUTR)** failure of a wide range of static components will be considered as relevant single failures. See also [4]. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
FMEA	failure mode and effect analysis. See [1.6.7]
hidden failure	failure that is not immediately evident to operations and maintenance personnel **Guidance note:** Equipment that fails to perform an "on demand" function falls into this category. It is necessary that such failures are detected by monitoring and/or revealed through periodical testing/verification in order to ensure the availability of such functions. Protective functions, e.g. in power plants and switchboards, are typical examples of on demand functions where possible hidden failures should be considered. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
HMI	human machine interface encompassing user input device (UID) and/or visual display unit (VDU)
joystick	device for readily setting of vectorial thrust output including turning moment

Term	Definition
minimum time requirement	minimum required time duration for which the residual remaining capacity as defined by the worst case failure design intent shall be available **Guidance note:** The time requirement will normally be governed by the maximum time necessary to safely terminate the on-going operations after the worst case single failure, given the residual remaining capacity. All relevant operational scenarios which the vessel performs and/or participates in should be considered when determining the time requirements. This time requirement should be fulfilled by the design, and the way the vessel is technically configured (technical system configuration) and operated. In addition to the actual time necessary to terminate the operation, the minimum time requirement includes also the time necessary for detection and alarming by the system, and the time needed for the operator(s) to notice, make the appropriate decision(s), and initiate the termination process. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
operational mode	manner of control under which the DP-system may be operated, e.g.: — automatic mode (automatic position and heading control) — joystick mode (manual position control with selectable automatic or manual heading control) — manual mode (individual control of thrust, azimuth, start/stop of each thruster) — auto track mode (considered as a variant of automatic position control, with programmed movement of reference point).
position/heading keeping	maintenance of a desired position/heading within the normal excursions of the control system and the environmental conditions
positioning/heading reference system	all hardware, software and sensors that supply information and or corrections necessary to give position/heading reference, including power supply
power system	all components and systems necessary to supply the DP-system with power. The power system includes: — prime movers with necessary auxiliary systems including piping — generators — switchboards — uninterruptible power supplies (UPS) and batteries — distribution system including cabling and cable routing — for **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**: power management system (PMS).
redundancy	ability of a component or system to maintain its function when one failure has occurred. Redundancy can be achieved, for instance, by installation of multiple components, systems or alternative means of performing a function
redundancy design intent	refers to redundant component groups which constitutes the overall system design for a given system operational mode and technical system configuration
redundancy group	all components and systems that is subject to a single failure as specified in [4], for the specific notations **Guidance note:** The redundancy groups will emerge as a consequence of the worst case single failure within each group. The rules do not give requirements to the number of (beyond 2) or ratio between the defined groups. The groups should be identified in the FMEA, verified by testing and incorporated in the consequence analysis. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Term	*Definition*
reliability	ability of a component or system to perform its required function without failure during a specified time interval
station keeping	automatically maintaining a vessel position and heading within required limits
technical system configuration	includes all technical modes (and combinations of the modes) of all systems that may influence the redundancy and failure tolerance of the vessel. This will typically include but is not limited to e.g., control system modes, power plant and thruster configuration, switchboards (AC and DC) configuration and distribution setup, auxiliary systems setup, valves, breakers, pumps) **Guidance note:** The technical system configuration(s) are prerequisites for establishing the basis for an FMEA, and should be specified for all relevant configurations. One example could be that a vessel has different technical system configurations for different vessel operational modes and another example could be in case a vessel with **DYNPOS(AUTRO)** notation is intended to also to have a mode based on **DYNPOS(AUTR)** acceptance criteria, both modes should be stated, specified, analysed, and tested in the FMEA. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
thruster system	all components and systems necessary to supply the DP system with thrust force and direction. The thruster system includes: — thruster with drive units and necessary auxiliary systems including piping — thruster control — associated cabling and cable routing — main propellers and rudders if these are under the control of the DP system.
worst case failure	refers to failure modes which, after a failure, results in the largest reduction of the position and/or heading keeping capacity. This means loss of the most significant redundancy group, given the prevailing operation. Failure modes related to specific class notations are specified in [4]
worst case failure design intent	refer to the minimum remaining capacity after any relevant single failure or common cause (for a given operational mode)
zone	confined space with specified fire and flooding boundaries

1.6 Documentation requirements

1.6.1 The documentation submitted, shall include descriptions and particulars of the vessel and cover the requirements given in Table 4 and Table 5, and [1.6.6] to [1.6.9], as appropriate. These documentation requirements are in addition to the requirements for main class.

1.6.2 Vessel documentation shall be submit as required in Table 4. For vessels with the qualifiers **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** or **DPS(3)** the relevant information elements and documentation as specified in DNVGL OTG-10 *DP-classed vessels with closed bus-tie(s)* Appendix A, shall be included in the documentation listed in Table 4 or submitted separately.

Table 4 Documentation requirements - vessel

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
Positioning keeping systems	Z050 - DP Design philosophy	The document shall describe the main features of the design and identify the redundancy groups and the redundancy design intent (including the separation design intent when required), as a minimum with respect to: — thrusters, propellers and rudders — engines, generators and other power sources — main switchboard arrangement — type(s) of fuel. The worst case failure design intent shall be stated. The intended minimum time requirement shall be stated. The document shall specify the all intended technical system configuration(s) that the DP notation shall be based on, and for each of these the corresponding worst case failure design intent. As a minimum the specification should cover the above listed components. For notations requiring separation, the DP zone plan and ventilation arrangements to DP related spaces shall be described. The DP design philosophy shall be submitted early in the project. In case the DP design philosophy is not specified, documentation related to other part of the DP system may need to be put on hold since the acceptance criteria will very often be determined based on the specified DP design intent.	FI	**AUTR**, **AUTRO**	**2**, **3**

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
	I060 – Principal cable routing sketch	The cable routing layout drawing shall indicate all cables relevant to the DP system, e.g. power cables, control cables, cables used for indication etc. The documentation shall also include a list of relevant cables crossing fire zones. For the cable routing layout drawing it is recommended that colours are used to indicate the cable routes that are designed and physically arranged to provide redundancy.	AP	**AUTRO**	**3**
	Z030 – Arrangement plan	Fire and flooding separation zone plan. This shall be in form of a GA plan indicating, preferably by use of colours, which spaces that are intended to contain equipment and systems belonging to the different redundancy groups. In addition the drawings shall indicate the passive fire protection between the zones.	AP	**AUTRO**	**3**
	Z071 – Failure mode and effect analysis (FMEA)	See [1.6.7].	AP	**AUTR**, **AUTRO**	**2**, **3**
	Z253 – Test procedure for quay or sea trial	Redundancy and failure modes based on FMEA. See [1.6.8].	AP	**AUTR**, **AUTRO**	**2**, **3**
Positioning keeping systems (cont.)	Z200 – DP Station keeping capability assessment report	Report shall be according to DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*. See also [1.6.6].	AP	**AUT**, **AUTR**, **AUTRO**	Not applicable
Position keeping control centres	Z030 – Arrangement plan	For **DYNPOS(AUTRO)** and **DPS(3)** also the emergency DP-control centre shall be covered.	AP	All	All
Thrusters emergency stop systems	I150 – Circuit diagram	Individual thruster emergency stop system required at the DP control centre. This system may be part of the individual manual lever thruster control system.	AP	All	All

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
Electric power system general	E040 – Electrical load balance	Alternating current (AC) power consumption balance for dynamic positioning operation. For vessels with the qualifiers **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)** the load calculations shall also reflect the situations after failure (stop) of each redundancy group. May be a part of the power consumption balance as required in Pt.4 Ch.8 *Electrical installations*. Not applicable for class entry (CLE).	AP	All	All
Propulsion and steering arrangements Manoeuvring thruster arrangements	Z110 – Data sheet	Including: — thrust output and power input curves — response time for thrust changes — response time for direction changes — anticipated thrust reductions due to interaction effects.	FI, R*)	All	All
Internal communication system	I040 – User interface documentation		AP, R	All	All
	I050 – Power supply arrangement		AP, R	All	All
	I070 – Instrument and equipment list		AP, R	All	All
	I080 – Data sheet with environmental specifications		AP, R	All	All
	Z253 – Test procedure for quay and sea trial		AP, R	All	All
AP = For approval; FI = For information; L = Local handling; R = On request *) = Only on request, typical for novel designs and/or new manufacturers.					

1.6.3 For products required to be approved and/or certified, the manufacturer shall submit the documentation required by Table 5. For vessels with the qualifiers **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** or **DPS(3)** the relevant information elements and documentation as specified in DNVGL-OTG-10 *DP-classed vessels with closed bus-tie(s)* Appendix A, shall be included in the documentation listed in Table 5 or submitted separately.

Table 5 Documentation requirements – products required to be approved and/or certified

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
Dynamic positioning automatic control systems, main Dynamic positioning automatic control systems, back-up	I010 – Control system philosophy		AP	All	All
	I020 – Control system functional description		AP	All	All
	I030 – Block diagram		AP	All	All
	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	I140 – Software quality plan	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All
	I150 – Circuit diagram		AP	All	All
	Z071 – Failure mode and effect analysis		AP	**AUTR**, **AUTRO**	**2**, **3**
	Z252 – Test procedure at manufacturer		AP	All	All
	Z253 – Test procedure for quay and sea trial		AP	All	All
	Z161 – Operation manual	User operating manual for the control system. One copy shall be submitted to the approval centre. Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All
	Z162 – Installation manual	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All
	Z163 – Maintenance manual	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
Position keeping consequence analysis facility	I020 – Control system functional description	Required for the main DP-control system. Shall describe the functionality of the consequence analysis function for the specific project with reference to the overall redundancy intent and the worst case failure design intent (as described in the DP design philosophy document (Z050)). (see [6.13])	AP	**AUTR**, **AUTRO**	**2**, **3**
Independent joystick manual control system	I020 – Control system functional description		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I030 – Block diagram		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I040 – User interface documentation		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I050 – Power supply arrangement		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I070 – Instrument and equipment list		FI	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I080 – Data sheet with environmental specifications		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I140 – Software quality plan	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I150 – Circuit diagram		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	Z252 – Test procedure at manufacturer		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	Z253 – Test procedure for quay and sea trial		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
	Z161 – Operation manual	User operating manual for the control system. One copy shall be submitted to the approval centre. Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
Thruster control mode selection system	I020 – Control system functional description		AP	All	All
	I030 – Block diagram		AP	All	All
	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	I140 – Software quality plan	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All
	I150 – Circuit diagram	For essential hardwired circuits (for emergency stop, shutdown, interlocking, mode selection, back-up selection, etc.). Details of input and output devices and power sources for each circuit.	AP	All	All
	Z252 – Test procedure at manufacturer		AP	All	All
	Z253 – Test procedure for quay and sea trial		AP	All	All
	Z161 – Operation manual	User operating manual for the control system. One copy shall be submitted to the approval centre. Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All
Position reference systems	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All

Object	*Documentation type*	*Additional description*	*Info*	***DYNPOS*** *qualifiers*	***DPS*** *qualifiers*
	Z253 – Test procedure for quay and sea trial		AP	All	All
	Z161 – Operation manual	User operating manual for the system. One copy shall be submitted to the approval centre. Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R	All	All
Vertical reference systems Heading measurement systems Environmental monitoring systems 1)	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	Z253 – Test procedure for quay and sea trial		AP	All	All
Main electric power control and monitoring system	Z071 – Failure mode and effect analysis (FMEA)	Power management system. Not applicable for class entry (CLE).	AP	**AUTR**, **AUTRO**	**2**, **3**
AP = For approval; FI = For information; L = Local handling; R = On request					
1) Environmental monitoring systems comprise sensors for measurements of for wind and other sensors connected to DP-control, joystick and manual control systems.					

1.6.4 For general requirements to documentation, see DNVGL-CG-0550 Sec.6.

1.6.5 For a full definition of the documentation types, see DNVGL-CG-0550 Sec.5.

1.6.6 DP station keeping assessment
Calculation of the dynamic positioning (DP) station keeping capability, shall be submitted for approval for all notations in the DYNPOS-series, except for class notation **DYNPOS(AUTS)**. The calculations shall be performed according to standard: DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*, see [10]. The calculations and results shall be documented in form of a report as outlined in DNVGL-ST-0111.

1.6.7 Failure mode and effect analysis

a) For vessels with the notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** or **DPS(3)**, documentation of consequences of single failures in accordance with rule requirements is required in the form of a failure mode and effect analysis (FMEA).

b) The purpose of the FMEA shall give a description of the different failure modes of the equipment when referred to its functional task. Special attention shall be paid to the analysis of systems that may enter a number of failure modes and thus induce a number of different effects on the DP system performance. The FMEA shall include at least the information specified in item c) through j) below.

Guidance note:

Description of FMEA systematic can be found in document DNV-RP-D102 *Failure Mode and Effect Analysis (FMEA) of Redundant Systems*. Other sources for information on FMEA systematics is IEC Publication 60812 and IMO HSC Code, Annex 4.

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c) The FMEA shall identify the vessel, provide general vessel information and specify the overall acceptance criteria, i.e. class notation(s).

d) The FMEA shall clearly describe the redundancy groups, redundancy design intent(s), worst case failure design intent(s), and minimum time requirement(s). All technical system configuration(s) intended for DP operation(s) shall be described. Prerequisites for achieving the required failure tolerance and redundancy shall be included. A collected list of these prerequisites shall be presented.

e) A breakdown of the DP system, into functional blocks shall be made. The functions of each block shall be described. The breakdown shall be performed to such a level of detail that the functional interfaces between the functional blocks are shown.

f) A description of each physically and functionally independent item and the associated failure modes with their failure causes related to normal operational modes of the item shall be furnished.

g) A description of the effects of each failure mode alone on other items within the system and on the overall DP system shall be made. This shall include a closed bus-tie analysis when required.

h) When separation is required, the FMEA shall state the separation design intent and give descriptions of the installation of redundant component groups in fire and flooding protected compartments and zones. The method of separating the different zones shall be identified. The design shall be analysed and the analysis shall conclude on the whether the separation design intent is met. The minimum time requirement(s) shall also be considered when relevant. This includes all relevant systems and components, like e.g. machinery and piping, ventilation systems, electrical systems and control systems, cables and communication lines with associated equipment.

i) A redundancy and failure mode test program specifying tests to verify assumptions and conclusions shall be developed.

j) The FMEA shall summarise and conclude as a minimum the following:

— for each subsystem analysed, the conclusions shall be stated
— for the total system, an overall summary covering the main findings from the most critical subsystems
— a compliance statement referring to the acceptance criterion, and when applicable to the minimum time requirement(s), shall be stated for the FMEA.

k) After FMEA testing is performed the FMEA(s) shall be updated to reflect the actual design and the actual test results. This updating shall as a minimum include correction of mistakes, modifications done to the DP system as a consequence of findings during testing and the actual test results, findings and conclusions. The updated FMEA(s) and FMEA test program(s) shall be compiled in a FMEA report and submitted to DNV GL for information.

l) The updated FMEA(s) (and FMEA test program(s)) shall be kept on board. The FMEA(s) and FMEA test program(s) shall at all times be updated to cover alterations to the DP system hardware or software.

Guidance note:

This is not to be understood as a requirement for a FMEA for the software. However the FMEA (or other relevant documentation) should include identification of the software version(s) installed, and documentation giving this information should be updated when new versions are installed.

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1.6.8 Test procedure for sea trial (FMEA test program)

a) For vessels with the notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** or **DPS(3)** a test plan for verification of conclusions in the FMEA shall be prepared and submitted. The test plan shall support verification of the analysis and conclusions made in the FMEA including: Redundancy design intention(s), worst case failure design intention(s), single failure tolerance within the given time requirement and acceptance criteria, barriers and other compensating measures, independency and septation requirements when required. See also [3].

b) The test program shall have an introduction which as a minimum shall include: Reference to the specific FMEA document (title, version and date) and specification of (or reference to) all specified system operational modes and technical system configurations that shall be verified by testing.

c) Each test shall as a minimum contain: test identification (e.g. test number), test prerequisites and test setup for the specific test, test method and actions to be performed, expected results and acceptance criteria (including time requirements when relevant) and space/functionality for documenting actual observations, test results, and conclusions. In order to facilitate the practical testing, description of the test method should preferably include detailed locations where the physical and practical actions should be carried out. Preferably also the test intention(s) and reference to the specific part in the FMEA to be verified should be included.

d) When separation is required, a set of separation tests shall be prepared and documented. These can be supported by other verification activities such as documentation of installation procedures and inspections, in order to support the conclusions of the separation analysis.

e) After FMEA testing is performed the FMEA test program(s) shall be updated to reflect the actual design and the actual test results. This updating shall as a minimum include correction of mistakes, modifications done to the DP system as a consequence of findings during testing and the actual test results, findings and conclusions. The updated FMEA(s) and FMEA test program(s) shall be compiled in a FMEA report and submitted to DNV GL for information.

f) The updated FMEA(s) and FMEA test program(s) shall be kept on board. The FMEA(s) and FMEA test program(s) shall at all times be updated to cover alterations to the DP system hardware or software.

1.6.9 Operating manuals for control systems

1) User operating manuals according to Table 5 shall be kept on board. The manuals shall include information on the specified systems, their installation and structure as well as operation and maintenance.

Guidance note:

These manuals cover the technical systems. Manuals for DP operations are not normally included and may be produced separately, in accordance with operational requirements.

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2) User operating manuals shall at least cover the following:

— definitions of symbols and nomenclature
— functional description
— operating instructions, normal conditions
— operating instructions, failure conditions
— man and machine communication systems
— back-up systems
— monitoring
— maintenance and periodical performance test
— fault-finding procedures.

Functional description:

— different functions including back-up functions shall be explained in detail.

Operating instructions:

— description of the normal operation of the equipment, including adjustments and change of limit values, possible modes of presentation, starting and stopping systems
— description of operation of the DP system in different operational modes
— description of transition from one operational mode to another.

Fault-finding procedures:

— description of fault symptoms with explanation and recommended corrective actions
— instructions for tracing faults back to functional blocks or systems.

1.7 Certification

Products in the DP system shall be certified as required in Table 6. All objects are independent products and the certificates can hence be issued independently or as combined certificates if delivered by the same manufacturer:

Table 6 Certification requirements

Object	*Certificate type*	*Issued by*	*Certification standard**	*Additional description*
Dynamic positioning control system	PC	Society		
Independent joystick control system with auto heading	PC	Society		
Propulsion and steering control systems Manoeuvring thruster control systems	PC	Society		Control and monitoring systems for all thrust producing units and steering arrangements that are part of the dynamic positioning system.
Thruster control mode selection system	PC	Society		When specifically required as part of the approval process. Thruster control mode selection systems may be exempted from certification when type approved.
*Unless otherwise specified the certification standard is the rules.				

1.7.1 For a definition of the certificate types, see DNVGL-CG-0550 Sec.3.

Guidance note:

Additionally, components and systems should be certified according to main class requirements.

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2 Upgrades and class entries

2.1 Documentation and testing requirements

2.1.1 The requirements in this subsection apply for class entries from other classification societies to **DYNPOS**-series of notations except for the **DYNPOS(AUTS)** notation, and for upgrades to and between any DP notations. For requirements related to the class entries to **DYNPOS(AUTS)** notation, see [2.2].

2.1.2 Verification as required in [1.6] will be required for the relevant notation(s) as specified.

2.1.3 The verification shall be based on documentation review, performance testing and FMEA failure testing as described in [3]. The test shall be performed according to approved test programs.

2.1.4 Documentation is required as specified in Table 4 and Table 5. The documentation requirements can be summarized as follows:

— dynamic positioning control system including UPS(s), position reference systems and sensors
— back-up dynamic positioning control system including -UPS(s), position reference systems and sensors (for **DYNPOS(AUTRO)**)
— documentation on the independent joystick system with selectable heading control (for **DYNPOS(AUT)**, **DYNPOS(AUTR)** and **DYNPO(AUTRO)**)
— thruster, propeller and rudder configuration
— mode change systems (dynamic positioning-/joystick-/manual-control)
— ship systems FMEA, and FMEA test program (for **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**)
— thruster emergency stop system at the dynamic positioning control centre
— dynamic positioning control centre lay-out, for **DYNPOS(AUTRO)** also for the back-up dynamic positioning control centre
— for **DYNPOS(AUTRO)**, cable routing layout drawing, system arrangement plan and fire and flooding separation drawings
— dynamic DP station keeping capability assessment report, according to DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessel*, see [10].

2.1.5 Vessels to be assigned the qualifier **A** shall carry a valid FMEA, with a corresponding FMEA test program.

2.1.6 Any deviations from requirements relevant for the class entry or upgrade notation found as a result from the documentation review and testing required in [2.1.3] to [2.1.4] shall be rectified before the vessel can be assigned the relevant **DYNPOS** notation.

2.2 Class entries not requiring additional verification

2.2.1 The requirements in this subsection apply for class entries from other classification societies to **DPS**-series of notations and for the **DYNPOS(AUTS)** notation.

2.2.2 In general, the system design will be accepted based on a corresponding, valid and maintained dynamic positioning class notation, from the losing society.

Guidance note:

This implies that class entry vessels may have designs based on somewhat different requirements than those given in these rules.

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2.2.3 Documentation review, survey or testing will not be required prior to class assignment, unless the periodic dynamic positioning survey will be due or overdue (based on the date of the last survey or test from the losing society) when the vessel is taken into class.

2.2.4 Vessels to be assigned the qualifier **A** shall have an updated FMEA, with a corresponding FMEA test program.

3 Survey and test upon completion

3.1 General

3.1.1 Upon completion, the DP system shall be subjected to final tests according to approved test programs. Functional, redundancy and failure response testing of the DP system shall be performed at sea trials. The program(s) shall contain test procedures and acceptance criteria. Prior to the DP system tests, all systems and equipment included in the DP system shall be successfully commissioned and tested.

Guidance note 1:

The systems that should be tested prior to DP system tests should at least include:

— load test according to main class
— power management system(s)
— switchboard control and protection
— thruster control and transfer of thruster control
— manual override of thruster control
— emergency stops
— communication systems
— main alarm system as for main class and **E0** (if applicable)
— integrated automation systems (if applicable)
— other systems as applicable.

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Guidance note 2:

Ch.11 Sec.2 describes methods for flexible and efficient data driven verification of systems, including DP systems. Initial survey of the DP system on vessels with the optional class notation **DDV** for in-service verification of the DP system will be based on traditional, witnessed verification methods.

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3.1.2 When deemed necessary by the attending surveyor, tests additional to those specified by the test program may be required.

3.2 Measuring system

3.2.1 All DP-control systems sensors, peripheral equipment, and position reference systems shall be tested as part of the complete DP system.

3.2.2 Failures of DP-control system sensors and position reference systems shall be simulated to check the alarm system and the switching function.

3.3 Thrusters

3.3.1 Functional tests of control and alarm systems of each thruster shall be carried out.

3.3.2 All signals within the thruster control systems and signals exchanged between each thruster and the DP-control systems shall be checked.

3.3.3 The different modes of thruster control shall be tested. Proper operation of mode selection shall be verified.

3.4 UPS power supply

The capacity of the UPS batteries shall be tested, in addition to verification of the alarms required in [8].

3.5 Independent joystick control system

All functions of the independent joystick system shall be tested.

3.6 Complete DP system test

3.6.1 The complete DP system shall be tested in all operational modes, with simulation of different failure conditions, in order to try out e.g. switching modes, back-up systems, fail to safe response (e.g. thruster control system I/O) and alarm systems.

Guidance note:

Different operational modes apply to the DP-control system, the power system, thruster systems, etc.

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3.6.2 Change of command between the automatic DP-control system, independent joystick system and the individual thruster lever systems shall be demonstrated.

3.6.3 Position and heading keeping function shall be demonstrated on all possible combinations of position reference systems (PRS), and on each PRS as a single system. Position change function shall, if implemented, be demonstrated on each PRS as a single system. Selecting and de-selecting of PRS shall also be tested.

3.6.4 During sea trials the offset inputs for each position reference system and relevant sensors in the DP-control system should be verified and demonstrated to the attending surveyor by setting out the offsets on drawings. It should be verified that these fit with the actual placing of the equipment.

3.6.5 Manual override, as required by [6.6] and [7.3.2] shall be demonstrated during normal operation and failure conditions.

3.6.6 A duration test shall be carried out for at least 8 hours with the complete automatic system in operation. All failures shall be recorded and analysed.

Guidance note:

The time spent on DP functional tests may be deducted from the time required for the duration test.

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3.6.7 When specifically required a high seas trial shall be carried out with full system operation for at least 2 hours. The weather conditions shall be such that an average load level on the thrusters of 50% or more is achieved.

Guidance note:

Typically this will be required for DP systems where important parts are of novel design. The test described in [3.6.7] is dependent on weather conditions and may be omitted if satisfactory results were obtained from the test described in [3.6.6].

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3.6.8 Thruster emergency stop function shall be demonstrated.

3.6.9 For notations **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**, alarm upon loop failure as required by [7.3.7], shall be demonstrated.

3.6.10 For the **DYNPOS**-series of notations, except for **DYNPOS(AUTS)**, rudder steering gears included under DP control a test shall be carried out verifying that maximum design temperature of actuator and all other steering gear components is not exceeded when the rudder is continuously put over from border to border within the limits set by the DP-control system, until temperature is stabilized.

Guidance note:

The test should be carried out with the propeller(s) running with an average propulsion thrust of not less than 50%, unless the control system ensures that rudder operation is performed at zero propulsion thrust only, upon which the test may be carried out without the propeller(s) running. The test may be carried out in any steering gear control mode. Number of steering gear pumps connected and rotation speed should be the maximum allowed during DP operation.

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3.7 Redundancy and failure response tests

3.7.1 The requirements in this subsection apply to **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**.

3.7.2 A selection of tests within each system analysed in the FMEA shall be carried out. Specific conclusions of the FMEA for the different systems shall be verified by tests when redundancy, fail safe response, separation or independence is required. The test selection shall cover all specified technical system configurations.

Guidance note:

For **DYNPOS(AUTRO)** and **DPS(3)** this implies that loss of all systems in relevant fire zones or within watertight compartments should be tested. This will imply that all equipment and systems in the most relevant spaces are shut down simultaneously, one space at a time, to demonstrate that the separation requirements are met. Typically the following spaces should be tested: DP control centres (normally the bridge and DP back-up bridge), engine control rooms, engine rooms, switchboard rooms, and instrument rooms.

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3.7.3 The test procedure for redundancy shall be based on the simulation of failures and shall be performed under as realistic conditions as practicable.

Guidance note:

It is understood that not all failure modes in all systems are possible to simulate. For such failure modes the acceptance of the system will be based on the theoretical FMEA, and hence the documentation analysis of these failure modes should be emphasized in the FMEA.

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3.7.4 For notation **DPS(2)**: In case redundancy is based upon change-over of a single stern thruster as described in [4.3.2], then the functionality of the change over mechanism and availability of the thruster after single failure shall be demonstrated at sea-trials.

4 General arrangement

4.1 General requirements

4.1.1 The general requirements for DP system design are presented in Table 7. Comparison of the main differences between the **DPS**-series and the **DYNPOS**-series of notations are presented in Table 8.

4.1.2 For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**, the design and level of redundancy employed in system arrangements shall be to the extent that the vessel maintains the ability to keep position after worst case failure(s).

Guidance note:

In general the **DYNPOS**-series of notations are requiring a higher degree of availability and robustness as compared to the **DPS**-series of notations. The detailed differences are outlined in the specific requirements given in these rules.

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4.2 Redundancy and failure modes

4.2.1 The requirements in this subsection apply primarily to DP systems with **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)** notations. For **DYNPOS(AUTS)**, **DYNPOS(AUT)** and **DPS(1)** notations, the redundancy requirements are according to main class, unless specific requirements are stated.

4.2.2 The redundancy design intent(s) and worst case failure design intent(s) based on specified redundancy groups shall be stated, and in addition all the relevant technical system configuration(s) shall be specified. (See [1.5] and the required DP Design philosophy document.) Only redundancy design intents that are verified by approval and testing can be incorporated in the consequence analysis required by [6.13].

Guidance note:

The redundancy groups will emerge as a consequence of the worst case single failure within each group. The rules do not give requirements to the number of (beyond 2) or ratio between the defined groups. The groups should be identified in the FMEA, verified by testing and incorporated in the consequence analysis.

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4.2.3 Based on the relevant single failure definition in [4.4], [4.5] and [4.6], worst case failures shall be determined in the FMEA. The consequence of the identified worst case failure(s) in terms of reduction in position and heading keeping ability shall be used as the criterion for the consequence analysis described in [6.13].

4.2.4 In order to meet the single failure criteria in [4.4], [4.5] and [4.6], redundancy of components will be necessary as follows:

— for notation **DYNPOS(AUTR)**, redundancy of all active components and specified static components
— for notation **DPS(2)**, redundancy of all active components and specified static components, except for possible exemptions based on the requirements in [4.3.2] and [4.3.5] with guidance notes
— for notation **DYNPOS(AUTRO)** and **DPS(3)**, redundancy of all components and physical separation of the components.

4.3 Redundancy

4.3.1 For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)** and **DPS(3)**: The DP system shall be designed with redundancy. A position keeping ability shall be maintained without disruption upon any single failure.

Guidance note:

Component and system redundancy, in technical design and physical arrangement, should in principle be immediately available with the capacity required for the DP system to safely terminate the work in progress. The consequence analysis required in [6.13] will give an indication whether the position and heading can be maintained after a single failure.

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4.3.2 For **DPS(2)**: The requirement in [4.3.1] also applies to this notation, however it can be accepted that the system is dependent on change-over of a single stern thruster in order to maintain position keeping ability after loss of one redundancy group. The change over may be based on full stop and restart.

Guidance note:

A typical thruster configuration with two bow tunnel thrusters, one single stern tunnel thrusters and two pitch propellers with high-lift rudders, distributed between two redundancy groups will be accepted for **DPS(2)** notation as long as the single stern tunnel thruster is arranged for being changed over between the two redundancy groups.

When such design is chosen as basis for the redundancy the possibility for hidden failures causing loss of the change-over function and the possibility for single failures affecting more than one redundancy groups should be carefully considered in order to minimize the possibility of such failures. Adequate evaluations should be included in the FMEA required in [1.6].

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4.3.3 For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)** and **DPS(3)**: Redundancy shall be based upon running machinery. Automatic or manual intervention arranged to improve the position keeping ability after a failure can be arranged, but cannot be considered by the consequence analysis.

Guidance note:

The redundancy requirements will not be considered as complied with if based upon manual or automatic start or restart of generators thrusters or pumps, or if based upon automatic or manual reconfiguration of auxiliary systems e.g. by use of valves.

Automatic activation of equipment may be accepted as contributing to redundancy only if their reliability and simplicity of operation is satisfactory so that they can be brought into operation before position and heading keeping performance is degraded. This principle is typically only accepted for transfer of control between redundant controllers and for standby start of sea water cooling pumps for **DYNPOS(AUTR)** in systems where the seawater is not directly cooling the redundant components, but indirectly through heat exchangers.

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4.3.4 **DYNPOS(AUTR)**, **DPS(2)**, **DYNPOS(AUTRO)** and **DPS(3)**: Stop of thrusters and subsequent start-up of available thrusters will not be accepted as contributing to the redundancy. Dual feeding of thrusters from different redundancy groups may be accepted as long as all the following conditions are met:

— No failures in the thruster dual feed system shall be able to propagate to both power systems supplying the thruster. In order to mitigate the effects of hidden failures, minimum two independent barriers, both capable of isolating upon failures, shall be arranged in each supply line for **DYNPOS(AUTRO)** and **DPS(3)**. These barriers shall be outside of the common thruster space and the supply lines shall be separated by A60 partition.
— The thruster is fully ready with specified power available for DP control without disruption or manual intervention after failure. Available thrust output may be reduced to a specified level when only one supply is available.
— The thruster is separated from the failed zone and redundancy group.
— The availability of both supplies is monitored and communicated to the DP-control systems.
— Start and any necessary reset after full stop of thruster is available in DP control centre.
— Auxiliary systems are autonomous for each thruster.
— Supply to auxiliary and control systems are continuously available.
— Thruster failure or trip shall prevent automatic re-start.
— The discrimination and voltage-dip ride through capabilities shall be documented.
— For **DYNPOS(AUTRO)** and **DPS(3)**: The discrimination and voltage-dip ride through capabilities shall also be verified by live testing.

Guidance note 1:

See DNV-RP-D102 *Failure Mode and Effect Analysis (FMEA) of Redundant Systems*, Appendix D, for discussion on the subject and examples of relevant failure modes. See also [8.5.4] with guidance note.

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Guidance note 2:

For **DYNPOS(AUTRO)** and **DPS(3)** it is utmost important that the design is built and prepared for the required live testing of severe failure modes both at the new building stage and at renewal trials during the vessels entire operational life time.

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4.3.5 For **DPS(2)**: The requirement in [4.3.3] also applies to this notation; however change-over of a single stern thruster as described in [4.3.2]] can be accepted. In addition automatic change-over of redundant duty-standby pumps in accepted common piping systems will also be accepted.

4.4 Failure modes

4.4.1 For notation **DYNPOS(AUTR)** the loss of position shall not be allowed to occur in the event of a single failure in any active component or system, nor in any static components as specified in these rules. Single failure criteria for **DYNPOS(AUTR)** include:

— any active component or system
— static components as specified in the rules
— other static components which are not properly documented with respect to protection
— a single inadvertent act of operation. If such an act is reasonably probable
— systematic failures or faults that can be hidden until a new fault appears
— common cause failures when found relevant
— automatic interventions caused by external events, when found relevant.

Guidance note:

In order to reduce the probability of inadvertent acts, the following may be used:

— double action
— operation of two separate devices
— using screen based question pop-ups.

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4.4.2 For notation **DYNPOS(AUTR)** the following components/systems are also considered to fail as consequence of a single failure:

— coolers
— filters
— motorised valves
— fuel oil service tanks and appurtenant piping supplying the engine(s)
— electrical and electronic equipment (this includes all on-board equipment and systems, e.g. any safety shut-down systems (spurious shut down), vessel control systems, external force measurements, etc.
— when considering single failures of switchboards, the possibility of short-circuit of the bus-bars shall be considered.

4.4.3 For notation **DPS(2)** the single failure criteria shall be based on the same criteria as given for **DYNPOS(AUTR)** as given in [4.4.1]. However, based on proper FMEA, static components like coolers, filters and piping/tanks may be considered as not failing.

Guidance note:

See IMO MSC/Circ.645 *Guidelines for vessels with dynamic positioning systems*, dated 6 June 1994 part 2.2.2:

For equipment class 2, a loss of position is not to occur in the event of a single fault in any active component or system. Normally static components will not be considered to fail where adequate protection from damage is demonstrated, and reliability should the satisfaction of the Administration. Single failure criteria include:

1) Any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.).
2) Any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection and reliability.

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4.4.4 For class notations **DYNPOS(AUTRO)** and **DPS(3)** loss of position shall not be allowed to occur in the event of a single failure. In addition to the single failures listed under [4.4.1], the single failure criteria for **DYNPOS(AUTRO)** and **DPS(3)** include:

— any static components in the DP system
— all components in any watertight compartment, from fire and flooding
— all components in any one fire-subdivision, from fire or flooding (for cables, see also [4.6.1]).

4.5 Independence

4.5.1 Independence shall take into account all technical functions. Use of shared components may be accepted if the reliability is sufficiently high and/or the effect of failure is sufficiently low.

Guidance note:

Particular attention should be paid to the redundancy and independence of ventilation and cooling facilities for equipment where temperature problems are anticipated.

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4.6 Separation for class notations DYNPOS(AUTRO) and DPS(3)

4.6.1 Systems that form the designed redundancy intent shall be separated by bulkheads and decks, fire-insulated by A-60 class division, and in addition, watertight if below the bulk-head deck. See also [9].

Guidance note 1:

The term systems should be understood to also include single components, cabling, and piping.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

If two A-0 bulkheads are arranged in areas with low fire risk, this may be accepted based on case-by-case approval.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

For column stabilised units the watertight separation will be required below the freeboard deck.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 4:

Cabling to equipment that forms part of the designed redundancy requirement should be separated by bulkheads and decks, fire-insulated by A-60 class division. When this is practically unavoidable, cables can be separated by use of A-60 cable ducts or equivalent fire-protection. This alternative is not accepted in high fire risk areas, e.g. engine rooms and fuel treatment rooms. This, as far as practicable, also applies to piping.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 5:

On open deck, cables in separate pipes that are separately routed may be accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 6:

Suitable means should be provided to keep the ambient temperature inside of an A-60 cable duct within maximum temperature for the cables, when necessary, taking into account the temperature rise of cables under full power.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 7:

On open deck, separation of antennas, sensors and appurtenant cabling belonging to main and those belonging to the back-up DP control system should be arranged with due consideration to achieve the best practical separation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 8:

Separated power systems simultaneous supplying non DP related equipment placed in a non-separated areas or areas with lower fire segregation than A60 may be accepted, provided sufficient measures are taken in order to prevent failure consequences beyond the worst case failure design intent for the DP system. Non-separated slip-ring assemblies will not be accepted. See DNV-RP-D102 *Failure Mode and Effect Analysis (FMEA) of Redundant Systems,* Appendix D, for further discussion and details related to this issue.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.6.2 Watertight separation shall also be considered in areas above the bulk-head deck where large quantity of liquids may occur as a consequence of leakage. This will e.g. apply to engine rooms. Identification and analysis of such failure modes shall be part of the DP FMEA.

Guidance note:

Special attention should be paid to areas where leakage of flammable liquids may occur.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.6.3 Watertight doors in A60 insulated bulkheads need not to be insulated. See SOLAS Chapter. II-2 Reg. 9.4.2.4. In such cases the materials of the doors shall have melting points of not less than 950 °C and combustible materials shall be installed with a minimum distance of 450 mm from the door.

5 System arrangement

5.1 General

5.1.1 The requirements for system arrangement for the different notations **DYNPOS**-series and the **DPS**-series are summarised in Table 7. Specific requirements for each subsystem are presented under the respective section headings.

Table 7 System arrangement

Subsystem or component			*Minimum requirements for class notations*			
			DYNPOS(AUTS)	***DYNPOS(AUT)***	***DYNPOS(AUTR)***	***DYNPOS(AUTRO)***
				DPS(1)	***DPS(2)***	***DPS(3)***
Electrical power system	Electrical system		No redundancy 3)	No redundancy 3)	Redundancy in technical design	Redundancy in technical design and physical separation (separate compartments)
	Main switchboard		1 3)	1 3)	1	2 in separate compartments
	Bus-tie breaker		0 3)	0 3)	1	2, 1 breaker in each MSB
	Distribution system		Non-redundant 3)	Non-redundant 3)	Redundant	Redundant, through separate compartments
	Power management		No	No	**DYNPOS (AUTR)** :Yes **DPS(2)**: No	**DYNPOS (AUTRO)**: Yes **DPS(3)**: No
Thrusters	Arrangement of thrusters		No redundancy	No redundancy	Redundancy in technical design 4)	Redundancy in technical design and physical separation (separate compartments)
	Single levers for each thruster at main DP-control centre		Yes	Yes	Yes	Yes
Positioning control system	Automatic control: number of computer systems		1	1	2	2 + 1 in back-up control centre
	Manual control: independent joystick system with automatic heading control 2)		No	Yes	Yes	Yes
Sensors	Position reference systems		1	2	3	3 whereof 1 in back-up control centre
	External sensors	Wind	1	1	**DYNPOS (AUTR)**: 3 **DPS(2)**: 2	**DYNPOS (AUTRO)**: 3 **DPS(3)**: 2 whereof 1 connected to back-up control system
		Heading reference system 1)	1	1	3	3 whereof 1 in back-up control centre

Subsystem or component			*Minimum requirements for class notations*			
			DYNPOS(AUTS)	***DYNPOS(AUT)***	***DYNPOS(AUTR)***	***DYNPOS(AUTRO)***
				DPS(1)	***DPS(2)***	***DPS(3)***
		Vertical reference sensor (VRS)	1	1	**DYNPOS (AUTR)**: 3 **DPS(2)**: 2 5)	3 whereof 1 in back-up control centre
UPS			0	1	2	2 + 1 in back-up control centre
Printer			Yes 6)	Yes 6)	Yes 6)	Yes 6)
Back-up control centre for dynamic positioning control back-up system			No	No	No	Yes

1) The heading reference system(s) shall comply with IMO Res. A424(XI) performance standards for gyro-compasses. When three heading reference systems are required one of the three may be replaced by a heading measuring device based upon another principle, as long as this heading device is type approved as a THD (transmitting heading device) as specified in IMO Res. MSC.116(73). For notations **DYNPOS (AUTRO)** and **DPS(3)** this is not to be the gyro placed in the back-up control centre.

Heading sensors based on other principles may be accepted upon special considerations. When such considerations are made the total heading device installation shall be considered in view of redundancy, robustness and failure tolerance, both with respect to the number of heading devices installed, principles used, and the installation of the equipment with respect to signal transmission, power supply and physical installation (including separation when required).

2) The heading input may be taken from any of the required heading input devices.

3) When this is part of the ship normal electrical power system (i.e. used for normal ship systems, not only the DP system), then Pt.4 Ch.8 applies.

4) For **DPS(2)** see also [4.3.2].

5) Where necessary for the correct functioning of position reference systems, at least three vertical reference sensors shall be provided for notation **DPS(2)**. If the DP-control system can position the ship within the operating limits without VRS corrections, only 2 VRSs are required.

6) Dynamic positioning systems. The printer may be replaced by a separate electronic data logger, provided the data is stored on redundant electronic media (the DP-control system operator stations may be used as redundant storage media) and the data logger has UPS supply in compliance with [8]. The data logger shall have HMI and functionality in place for the operator to access and view the stored date in an efficient manner. The data logger shall have capacity for storage of data for minimum 7 days of operation. It shall be possible to upload to offline storage media, for data storage longer than the logger capacity. (The data logger should preferably be time synchronised with other alarm and logging systems to support performance and incident analysis.)

5.1.2 In general additional requirements to achieve higher availability and robustness will apply to the **DYNPOS**-series as compared to the **DPS**-series of notations. An overview of the main differences between the two series are summarised in Table 8 for quick reference. Specific requirements for each subsystem are presented under the respective section headings.

Table 8 Comparison table for the main differences between the DPS-series and the DYNPOS-series of notations

(Note: For complete overview of the differences the whole rule section shall be considered.)								
Technical item	*Rule reference*	*Class notations*						
		DYNPOS (AUTS)	**DPS(1)**	**DYNPOS (AUT)**	**DPS(2)**	**DYNPOS (AUTR)**	**DPS(3)**	**DYNPOS (AUTRO)**
Thruster configuration without stern thrusters, i.e. side thrust based on combination of rudders and propellers	[7.1] and [7.2]	Yes	Yes	No	No	No	No	No
Redundancy can be based upon change over of a single stern thruster	[4.3.2], [4.3.3] and [4.3.5]	NA	NA	NA	Yes	No	No	No
Redundancy can be based upon automatic change-over of redundant duty-standby pumps in accepted common piping systems	[4.3.5]	NA	NA	NA	Yes	No	No	No
Additional monitoring requirements for steering gear	Pt.4 Ch.10 Sec.1 [5.8]	No	No	Yes	No	Yes	No	Yes
Power management system required	[8.4]	No	No	No	No	Yes	No	Yes
Common static components may be accepted in redundant fuel oil, fresh water cooling and pneumatic systems	[6.4]	NA	NA	NA	Yes	No	No	No
Number of VRSs required	Table 7	1	1	1	2*)	3	3	3
Number of wind sensors required	Table 7	1	1	1	2	3	2	3
Loop monitoring of emergency stop loops	[7.3]	No	No	No	No	Yes	No**)	Yes
HMI for position reference systems required outside DP-control system operator station(s)	[6.8]	No	No	Yes	No	Yes	No	Yes
Main DP-control system shall include a joystick mode	[6.3.7]	No	No	Yes	No	Yes	No	Yes
DP capability numbers required	[1.6.6] and [10]	No	No	Yes	No	Yes	No	Yes

Class entry from other class societies will be based on corresponding valid notation from losing class society	[2.2]	Yes	Yes	No	Yes	No	Yes	No
Class entry from other class societies requires documentation approval and testing (functional and FMEA) at entry	[2.1]	No	No	Yes	No	Yes	No	Yes
NA = Not applicable *) Where necessary for the correct functioning of position reference systems, at least three vertical reference sensors shall be provided for notation **DPS(2)**. If the DP-control system can position the ship within the operating limits without VRS corrections, only 2 VRSs are required. **) Note that the **DPS(3)** integrity requirements shall be complied with for all emergency stop systems. See [5.6].								

5.2 DP control centre

5.2.1 The DP vessel shall have its DP control centre designated for DP operations, where at least the required indicators, displays, alarm panels, control panels and internal communication systems are installed. This equipment shall be arranged with easy access for the operator so that he/she does not need to change position when operating the control systems.

Guidance note 1:

Changing orientation will be accepted provided that the operator's view of the operating area will not change significantly. This implies that the operator should not be forced to turn his back to the operating area when changing between different control systems (DP-control system, manual thruster levers, and independent joystick control system).

Manual levers and the independent joystick should be easily accessible from the DP operator work station. Thruster emergency stops and mode change system should be within reach from both manual lever operator stations and DP operator stations, and easily accessible from the independent joystick operator work station. Somewhat longer distances may be accepted case by case.

When the systems/equipment are accepted split between more than one work station at the DP control centre (e.g. a manoeuvring and a ship handling station), the required automatic, joystick and manual lever control modes should be available at the work station(s) being designated for the DP operator.

In general all required VDU should be readable from DP, Joystick and manual lever operator stations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The DP control centre may be a dedicated part of the navigation bridge. System components which do not require frequent or immediate operator attention may be installed in alternate locations.

Systems that are required to be located at the DP control centre includes: DP-control and independent joystick control operator stations, required position reference systems HMI, manual thruster levers, mode change systems, thruster emergency stops, internal communications.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.2 Installed portable equipment shall have its dedicated fixed location at each work station where it is intended to be used. The orientation of levers and indicators shall be in accordance with the vessel axis at all intended locations.

Guidance note:

One typical example of such equipment is portable joystick operator stations. It is assumed that such required equipment is placed at its dedicated location the DP control centre during DP operations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.3 The location of the DP control centre shall be chosen to suit the main activity of the vessel.

5.2.4 The DP control centre shall be arranged such that the DP operator has a good view of the vessel's exterior limits and the surrounding area.

5.2.5 For vessels with **DYNPOS(AUTRO)** and **DPS(3)** notation, a back-up DP control centre shall be arranged for the location of the back-up DP-control system. This centre shall be separated from the main centre by A-60 class division, and located with easy access from the main DP control centre.

Guidance note:

The back-up DP control centre may be used if the main DP control centre is on fire. This should be considered when the location of the back-up DP control centre is chosen.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.6 The back-up DP control centre shall be arranged with similar view to the vessel's exterior limits and the surrounding area as the main DP control centre.

Guidance note:

For vessels that carry out DP operations where the DP operator's view of the working area is not considered necessary, the view from the DP back-up control centre may not be similar to the view from the main DP control centre. For such vessels it may be accepted that the view from the back-up DP control centre is provided by a sufficiently fault tolerant (all failures affecting the possibility to perform automatic DP control from main DP centre should be considered) closed circuit television (CCTV) system. This will apply e.g. for drilling units.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3 Arrangement of positioning control systems

5.3.1 Notation **DYNPOS(AUTS)** shall include an automatic control mode and an independent manual position control mode based on the control levers of each thruster.

5.3.2 Notation **DYNPOS(AUT)** and **DPS(1)** shall include:

- an automatic position control mode
- an independent joystick system with automatic heading control
- manual levers for each thruster.

Guidance note:

A joystick and a joystick mode included in the automatic positioning control system will not meet the requirement for an independent joystick system in notations **DYNPOS(AUT)**, **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(1)**, **DPS(2)** and **DPS(3)**. See also [6].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.3 Notation **DYNPOS(AUTR)** and **DPS(2)** shall include:

- an automatic position control mode consisting of at least two mutually independent control systems
- an independent joystick system with automatic heading control
- manual levers for each thruster.

5.3.4 Notation **DYNPOS(AUTRO)** and **DPS(3)** shall include:

- an automatic position control mode consisting of at least two mutually independent control systems
- an independent joystick system with automatic heading control
- manual levers for each thruster
- an automatic back-up DP positioning control system.

Guidance note:

This guidance note applies for [5.3.1] to [5.3.4]. Use of combined mechanical levers for two or more thrusters may be accepted in accordance with the following principles:. For notations not requiring redundancy (e.g. **DYNPOS(AUT)** and **DPS(1)**) where the minimum requirement is one aft thruster and one forward thruster and one longitudinal thruster:

— at least one lever for thruster(s) providing transverse thrust forward
— at least one lever for thruster(s) providing transverse thrust aft
— at least one lever for thruster(s) providing longitudinal thrust.

For notations requiring redundancy (**DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**) where the minimum requirement is two aft thrusters, two forward thrusters and two longitudinal thrusters:

— at least two levers for thrusters providing transverse thrust forward
— at least two levers for thrusters providing transverse thrust aft
— at least two levers for thrusters providing longitudinal thrust.

As an example this means that two bow tunnel thrusters for notation **DYNPOS(AUT)** can use a common HW lever. Another example is two bow tunnel thrusters and one bow azimuth thruster for **DYNPOS(AUTR)** where the two bow tunnel thrusters can use a combined lever, while the bow azimuth lever is providing the required redundancy. However, on a **DYNPOS(AUTR)** vessel where the redundancy is provided by two bow tunnel thrusters only, these cannot use a common lever.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.5 For notations **DYNPOS(AUTRO)** and **DPS(3)**: The back-up DP-control system shall include an automatic position control mode, and shall be interfaced with a position reference, VRS and heading reference system which shall be able to operate independently of the main system of [5.3.4].

5.4 Arrangement and layout of control panels

5.4.1 The information sources like displays, indicators, etc., shall provide information in a readily usable form, see Pt.4 Ch.9 Sec.6.

5.4.2 The operator shall be provided with immediate information of the effect of any actions, preferably with graphics.

5.4.3 Where applicable, feedback signals shall be displayed, not only the initial command.

5.4.4 Easy switch-over between operational modes shall be provided. Active mode shall be positively indicated.

5.4.5 Positive indications of the operational status of the different systems shall be given.

5.4.6 Indicators and controls shall be arranged in logical groups, and shall be co-ordinated with the geometry of the vessel, when this is relevant. Upon special consideration it may also be accepted to arrange controls relative to other coordinates, e.g. earth axis.

5.4.7 If control of a sub-system can be carried out from alternate control stations, positive indication of the station in charge shall be provided. Responsibility transferred from one station to another shall be indicated.

Guidance note:

For control transfer arrangements, see Pt.4 Ch.9 Sec.3.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.8 Precautions shall be taken to avoid inadvertent operation of controls if this may result in a critical situation. Such precautions may be proper location of handles, etc., recessed or covered switches, or logical requirements for operations.

5.4.9 Interlocks shall be arranged, if erroneous sequence of operation may lead to a critical situation or damage of equipment.

5.4.10 Controls and indicators placed on the navigation bridge and the DP control centre(s) shall be sufficiently illuminated to permit use at night and shall be provided with dimming facilities.

5.5 Arrangement and layout of data communication links

5.5.1 When two or more thrusters and their manual controls are using the same data communication link, this link shall be arranged with redundancy in the technical design.

5.5.2 The independent joystick may share the redundant communication link described in [5.5.1] with the manual control, but not with the DP-control system.

5.5.3 When the DP-control system uses a data communication link, this link shall be independent from the communication link(s) for manual control.

5.5.4 When units (e.g. thruster controllers) are interfaced to data communication links which are required to be independent, the interfacing to each of these networks shall be separately arranged in such a way that common mode failures (e.g. network storm) affecting both communication links are eliminated. This includes both HW and SW failures in the connected units, the interface and the communication links.

5.5.5 The communication link for the DP-control system shall be arranged with redundancy in technical design for **DYNPOS(AUTR)** and **DPS(2)**, and with redundancy in the technical design and physical separation for **DYNPOS(AUTRO)** and **DPS(3)**.

5.5.6 For **DYNPOS(AUTR)** no failure mode as specified in [4.4.1] and [4.4.2], for **DPS(2)** as specified in [4.4.3], for **DYNPOS(AUTRO)** and **DPS(3)** as specified in [4.4.4], shall have an effect on the functionality of both networks.

Guidance note:

For **DYNPOS(AUTR)** and **DPS(2)** control cables and communication links belonging to different redundancy groups should be separated as far as practically possible.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.6 Arrangement and layout of emergency stop systems

5.6.1 The requirements in this subsection apply to notations **DYNPOS(AUTR)**, **DPS(2)**, **DYNPOS(AUTRO)** and **DPS(3)**.

5.6.2 Emergency stop systems shall not violate the redundancy design intent. Single failures relevant for the given notation shall not lead to stop of DP related equipment beyond the specified redundancy groups.

5.6.3 Systems for activation of emergency stop of DP related equipment shall be so arranged that it is possible to activate emergency stop of equipment belonging to different redundancy groups separately.

Guidance note:

For requirement to emergency stop of thrusters, see [7].

For general requirements to emergency stop, see Pt.4 Ch.8 Sec.2.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.6.4 For **DYNPOS(AUTRO)** and **DPS(3)**: When systems for emergency stop are placed in a different fire zone than the system it controls or systems for emergency stop of equipment belonging to more than one zone are placed in the same fire zone, these systems shall be arranged with sufficient fire and flooding integrity in order to prevent unintended activation.

Guidance note:

Systems for emergency stop of equipment belonging to more than one redundancy group will typically be placed in the same space, e.g. thruster emergency stop on the bridge or emergency stops for auxiliary pumps located in an engine control room. When this is the case protection against unintended activation due to fire or flooding should be implemented. This includes failures of equipment and cabling including the activation buttons. The required integrity may for example be achieved by use of a combination of loop monitoring and thermal fuses which will introduce a loop failure before the activation buttons can short circuit and cause unintended stop. The thermal fuses should then be placed in close proximity to the respective activation buttons and be a part of the loop that is covered by the loop monitoring required for the **DYNPOS**-series.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.7 Internal communication

5.7.1 A two-way voice communication facility shall be provided between the DP system control centre(s) (both main and back-up centres for **DPS(3)** and **DYNPOS(AUTRO)**) and the navigation bridge, ECR and other relevant operation control centres.

5.7.2 The two-way voice communication system shall be supplied by a battery or an uninterruptible power supply as a stand-by power supply sufficient to operate the system for at least 30 minutes.

Guidance note:

Operational Control Centre (applicable to ships and offshore) is any on-board location where key members of the crew can communicate decisions in both normal and emergency situations. Operation control centres typically include, but is not limited to: the bridge; the engine control room; a cargo control station; the dynamic positioning control centre, the centralised control room [CCR], the back-up dynamic positioning centre, the driller's cabin, or any other location from where normal and emergency situations may be controlled.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6 Control systems

6.1 General requirements

The operational status of thrusters, sensors and reference systems used in DP operations shall be clearly indicated. The following information shall typically be presented:

— running
— available for DP
— in DP operation.

6.2 Independent joystick control system

6.2.1 An independent joystick system is required for notations **DYNPOS(AUT)**, **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(1)**, **DPS(2)** and **DPS(3)**.

6.2.2 It shall be possible to control the thrusters manually by a common joystick independent of the DP-control system. The independent joystick system shall include selectable automatic heading control.

6.2.3 Upon selection of independent joystick control system, the procedure for enabling the thrusters for joystick control shall be straightforward.

6.2.4 Any failure in the independent joystick control system shall initiate an alarm.

6.2.5 Any failure causing loss of control of the thrusters in the independent joystick control system shall freeze the thrust commands or set the thrust commands to zero. If the failure affects only a limited number of thrusters, the command to these affected thrusters may be set to zero, while keeping the other unaffected thrusters in joystick control.

6.3 DP-control system

6.3.1 The positioning control system shall perform self-check routines, which shall bring the system to a stop, or automatically change-over to a standby (slave) system when critical failure conditions are detected. An alarm shall be initiated in case of failure.

6.3.2 Automatic control mode shall include control of position and heading. Set points for position and heading shall be independently selectable. It shall be possible to individually enter new position and heading set points in automatic control mode.

Guidance note:

The rules do not give any specific acceptance criteria for vessel positioning performance. However, in moderate weather conditions and with a fully operational DP system the vessel should generally be able to demonstrate position keeping accuracy typically within a 3 m radius and ± 1° of heading, given sufficient accurate position and heading reference input.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.3 When stopped, either by automatic or manual means the positioning control system shall set the thrust commands to zero.

6.3.4 Loss of one or multiple position reference system input and/or one or multiple sensor inputs shall not lead to significant change in thrust output.

Guidance note:

This includes the situation when DP-control system loses the last available position reference system input or sensor input. Position or heading drive off is not accepted after such failures.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.5 Upon recovery of position and heading reference input the DP-control system shall not automatically apply the last position or heading set point (set points before loss of input) when this is significantly different from the actual vessel position and/or heading. If any other set point than the actual vessel position and/or heading is applied then it shall be operator chosen.

6.3.6 When combining position reference systems and/or sensors in one unit were more than one function or system can be lost upon one common failure, the consequence to the total system upon such a failure shall be evaluated in order to ensure that the redundancy, independency and separation requirements for the given notation(s) are complied with. See Table 7. See also [6.5.7].

Guidance note:

Unit should be understood as one piece of equipment (or one system) for each sensor and position reference system as required in Table 7. The rule is applicable when equipment/systems serving more than one such function are part of the DP system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.7 For **DYNPOS(AUT)**, **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**: It shall be possible to control the thrusters manually by a common joystick in the main DP-control system. For **DYNPOS(AUTRO)** the requirement also applies to the back-up DP-control system. The joystick mode shall include selectable automatic and manual heading control.

6.3.8 The DP control centre is the main control station for equipment in the DP-control system which requires manual operation.

6.3.9 Sensors and/or reference systems may be shared with other systems provided failure in any of the other systems cannot spread to the DP system.

6.4 Additional for DP-control systems for notation requiring redundancy

6.4.1 The requirements in this subsection apply to notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**.

6.4.2 There shall be at least two automatic positioning control systems. These systems shall be arranged such that, after the occurrence of any single failure within the DP-control system, command output to a group of thrusters able to position the ship, can still be produced. For **DYNPOS(AUTRO)** and **DPS(3)** a single automatic back-up DP positioning control system shall also be arranged, as required in [5].

6.4.3 One of the controllers in the main system shall be selected as the online controller. This selection shall be possible by manual means and by automatic action upon failure of the online controller. The other controller(s) shall be in standby mode for automatic or manual change over. Alternatively, 3 or more controllers can be arranged in an automatic majority voting system. The voting mechanism shall not jeopardize the redundancy requirements. It shall not be possible to automatically or manually select a controller which is not ready to assume command as the active controller.

6.4.4 Any failure of an online or standby positioning control system, sensor or positioning reference system selected, shall initiate an alarm.

Guidance note:

When more than two position reference systems and/or sensors inputs for the same parameters (excluding wind measurements) are used by the DP-control system then voting mechanisms should be utilised in order to identify incorrect input, take correct action upon the failure in order to minimize the consequence of failure and to alarm the operator.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.4.5 Self-monitoring and comparison between controllers shall be arranged so that alarm is released upon detection of an unexpected difference in thrust command or position or heading. This shall not jeopardise the independence of each system or risk common mode failures.

6.4.6 Automatic transfer of online responsibility shall not cause thrust changes of such magnitude that it will be detrimental to the positioning of the vessel.

6.4.7 There shall be identification of the status of the positioning control systems at the operator panel.

6.5 Additional for DP-control systems for notations requiring separation

6.5.1 The requirements in this subsection apply to notations **DYNPOS(AUTRO)** and **DPS(3)**.

6.5.2 If three positioning control computers are chosen for the main DP-control system, one of these may serve as the back-up DP-control system, provided that the necessary separation, as required for the back-up DP-control system, is achieved.

6.5.3 There shall be at least one positioning reference system and one set of sensors connected to the back-up DP positioning control system, in such a way that their operation is ensured, independent of the condition of the main system.

Guidance note:

For wind sensors, GPS antennas, etc., and belonging cabling which cannot possibly be located in the same fire zone as the back-up control centre, the independence and separation between main and back-up DP-control systems, position reference systems and sensors should be ensured by use of physical distance and separation as far as practically possible.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.4 The back-up DP positioning control system shall operate as a 'hot back-up', and shall, at all times, be ready to assume command, and maintain the position from the moment of assuming command.

6.5.5 The back-up DP positioning control system shall perform self-check routines and communicate its status to the main system. An alarm shall be initiated if it fails or is not ready to take control.

6.5.6 The back-up DP positioning control system shall be capable of being activated by the operator at the back-up DP control centre. The nature of the switching shall be such that no single failure will render the back-up inoperable together with the main system, or vice versa.

6.5.7 The requirement given in [6.3.6] applies to both the required installation on the main DP control centre and to the required installation on the back-up DP control centre separately.

6.6 Thruster control mode selection

6.6.1 The thruster control modes, i.e. manual, independent joystick and automatic, shall be selectable by a simple device located in the DP control centre. The control mode selector system may consist of a single selector switch or individual selectors for each thruster.

Guidance note:

For vessels with nautical notations, see Sec.3, Sec.4 and Sec.5.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.2 The control mode selection system shall be arranged so that it is always possible to select manual controls at the DP control centre after any single failure in the DP control mode or in the independent joystick control mode, included failures in the thruster control mode system itself. This applies also to the control mode selection system intended to be used by the operator during normal operation. The system shall also provide the required integrity between the DP-control system and the independent joystick system.

6.6.3 For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)** notations, mode selection systems shall not violate redundancy requirements.

Guidance note:

A common switch may be accepted as long as each thruster system is electrically independent.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.4 For **DYNPOS(AUTRO)** and **DPS(3)** the back-up DP-control system shall still be selectable even if the control mode selection system has failed (e.g. is damaged by a fire).

Guidance note:

The mode selector may consist of a single switch also for **DYNPOS(AUTRO)** and **DPS(3)** even if this may be damaged by a fire, or other hazards, provided that the back-up DP-control system is still selectable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7 Positioning reference systems

6.7.1 Where more than one positioning reference system is required, at least two shall be based on different principles.

Guidance note:

For **DYNPOS(AUT)** and **DPS(1)** special considerations may be given where the use of two different measuring principles would not be practicable during DP operation. This means that e.g. two DGPS systems may be accepted for these notations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.2 Monitoring of positioning reference systems shall include alarms for electrical and mechanical functions, i.e. power, pressure, temperature as relevant.

6.7.3 Positioning reference systems shall provide new position data with a refresh rate and accuracy suitable for the intended DP operations.

Guidance note 1:

Systems that only produce new position data with long intervals relative to the response time of the DP vessel, will not be considered as positioning reference systems, as required in Table 7, unless it can be demonstrated that the performance is adequate in all operational modes and operational weather conditions.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The accuracy of the position reference data shall generally be within:

— a radius of 2% of water depth for bottom-based systems
— within a radius of 3 m for surface-based systems.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

For satellite based systems, interface and necessary equipment for receiving differential correction signals shall be installed.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.4 It shall be simple for the operator to establish the operational status of all position reference systems at any time. Which systems that is in operation, with data accepted or discarded, shall be clearly identified.

6.7.5 When data from several position references are combined into a mean positioning, by filtering techniques, the reference position of each shall, be available at the operator's request.

6.7.6 When several systems are combined to provide a mean reference, the mean value used shall not change abruptly by one system being selected or deselected.

6.7.7 Failures in a positioning reference system that might give degraded quality, loss of position signal or loss of redundancy shall initiate an alarm.

6.7.8 Limit alarms shall be provided for systems, which have defined range limits.

6.7.9 If a positioning reference system can freeze or otherwise produce corrupt data output, a method shall be provided to enable rejection of the data.

6.7.10 When more than one positioning reference system is required, then each shall be independent with respect to signal transmission and interfaces.

Guidance note 1:

In order for two satellite based systems to be considered as independent it should be possible to set them up with different differential correction signals.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**,**DPS(2)** and **DPS(3)**: Interfaces to the dynamic positioning computer system shall be in accordance with the overall redundancy requirement. Systems should be equally distributed between the redundant groups, and so arranged that systems based on the same principle are equally distributed between the redundant groups.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.11 Power supply to the position reference systems shall be from UPS (except for notation **DYNPOS(AUTS)**). For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**,**DPS(2)** and **DPS(3)** arrangement of power supplies shall be in accordance with the overall redundancy requirement.

Guidance note 1:

For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**,**DPS(2)** and **DPS(3)**: Systems power supply should be equally distributed between the UPSs, and so arranged that power supply to systems based on the same principle are equally distributed between the UPSs.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Power supply to units providing correction signal to DGPSs should follow the same redundant distribution principle.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

The requirement for UPS supply for position reference systems is not applicable for parts of the systems which are not actively in use during positioning. E.g. Hydro acoustic positioning reference system transducer hoist systems or taut wire derrick control systems.

For taut wire systems, the heave compensation system need not be powered by UPS supply as long as at least one other position reference system is available and powered from UPS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.12 For **DYNPOS(AUTRO)** and **DPS(3)** at least one of the positioning reference systems shall be connected directly to the back-up DP positioning control system and separated by A-60 class division, from the other positioning reference systems. This system shall also be available for use by the main DP-control system, by connections not violating the separation requirements.

6.8 Position reference system user interface

6.8.1 The requirements in this subsection apply to the **DYNPOS**-series of notations

6.8.2 For **DYNPOS(AUT)**: At least one of the required position reference systems' HMI shall be independent of the DP-control system. This HMI shall be placed at the DP-control centre in view of the DP operator.

6.8.3 For **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**: At least two of the positioning reference systems' HMIs shall be independent of the DP-control system. These HMIs shall be placed at the main DP control centre in view of the DP operator. The two reference systems fulfilling this requirement shall have their power supply from different UPSs. For **DYNPOS(AUTRO)** the system required to be placed at the back-up DP control centre shall have HMI independent of the DP-control system.

Guidance note:

For **DYNPOS(AUTRO)**, this implies that if only one reference system placed on the main DP control centre is equipped with separate HMI, the system placed in the backup control centre should have a slave HMI on the main DP control centre.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9 Sensors

6.9.1 Sensors shall provide new data with a refresh rate and accuracy suitable for the intended DP operations.

6.9.2 When more than one sensor for a specific function is required, then each shall be independent with respect to power, signal transmission, and interfaces. For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)** arrangement of power supply shall be in accordance with the overall redundancy requirement. For notations where no or only one UPS is required power may be taken from the same distribution/UPS.

6.9.3 Monitoring of sensors shall include alarms for electrical and mechanical functions, i.e. power, pressure, temperature as relevant.

6.9.4 It shall be simple for the operator to establish the operational status of all sensors at any time. Which systems that is in operation, with data accepted or discarded, shall be clearly identified. Sensor data shall be available at the operator's request.

6.9.5 When failure of a sensor is detected, an alarm shall be initiated even if the sensor is in standby at the time of failure.

Guidance note:

During DP operations, it is important that failures of any sensor, whether it is being used or not at the time, is brought to the attention of the operator.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.6 For the notation **DYNPOS(AUTRO)** and **DPS(3)** the sensors connected directly to the back-up positioning control system shall in general be installed in the same A-60 fire zone as the back-up DP-control system.

6.10 Display units

6.10.1 The display unit shall present a position plot including the location of the vessel relative to the reference sources. The plot may be vessel relative, or a true motion presentation.

6.10.2 For positioning control systems, designed with redundancy, there shall be at least two DP-control system operator stations.

6.10.3 If the display is used for presentation of warnings or alarms, these shall have priority over other information and not be inhibited by other data currently being displayed.

6.10.4 The display units shall support the operator with necessary information in order to ensure safe operation in all modes.

6.11 Monitoring

6.11.1 The DP control centre shall receive alarms and warnings reflecting the status of the DP system.

Guidance note:

The alarms from power and thruster systems may be group alarms for each prime mover, generator, or thruster, as generated by the general alarm system of the vessel.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.11.2 An alarm shall be initiated when the vessel exceeds pre-set position and heading limits.

6.11.3 Any failure of an online or standby positioning control system, sensor or positioning reference system selected, shall initiate an alarm.

6.11.4 The alarms to be presented in the DP control centre shall be limited to functions relevant to DP operation.

6.12 Monitoring of batteries supplying DP thrusters

6.12.1 When batteries are used as source(s) of power according to the requirements in [8.3] the DP following information shall be provided by the DP-control system:

— remaining available energy in batteries based on state of charge, SOC and state of health SOH. The indication shall be given in [%] of the batteries original fully charged capacity
— remaining time to discharge based on rate of discharge
— for redundant notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**; the calculated remaining time the vessel can hold position and heading after relevant single failure(s). This means that when position and heading keeping are dependent on energy supply from batteries after failure, the time assumed by the DP-control system online consequence analysis shall be indicated. The failure mode(s) causing need for the largest power contribution from the batteries after failure shall be considered. The calculations shall be based on connected batteries and running machinery and the actual functionality of the power/energy management systems. Alternatively more conservative calculations may be accepted.

Guidance note:

For definition of and requirements related to SOC and SOH: See rules for ships Ch.2 Sec.1 *Battery power*.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.12.2 When batteries are suppling thrusters in DP mode the DP-control system shall give alarms based on available energy. It is accepted that several limits can be defined. These alarm levels may be operator set so that they can be adjusted according to the vessels operation(s), and for redundant notations also according to the corresponding minimum time requirement after failure. It shall not be possible to set the time limit below the lowest accepted minimum level. When the calculated remaining time is below 30 minutes, and in addition for notations requiring redundancy when the calculated remaining time after failure is below 30 minutes, this shall be continuously indicated at the DP operator station.

Guidance note 1:

The alarm levels should be so adjusted that it will provide sufficient time to safely terminate the ongoing operations. Any uncertainty in the accuracy of available energy should be accounted for by conservative adjustments of these alarm levels. In addition it should be carefully considered at which level of charge the battery should be considered to be discharged. It should also be considered if the termination process will result in additional energy consumption. In such a case this additional consumption needs be taken in to account.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

In case the vessel has more than one accepted minimum time requirement, the operator shall ensure that correct time limits, corresponding to the ongoing operations, are being used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.12.3 In case any power section is solely supplied by batteries then this shall be clearly and continuously indicated in the DP-control system HMI.

6.13 Consequence analysis

6.13.1 The requirements in this subsection apply to notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**.

6.13.1.1 The DP-control systems shall perform an analysis of the ability to maintain position after worst case failures. An alarm shall be initiated, with a maximum delay of 5 minutes, when a failure will cause loss of position in the prevailing weather conditions. In case the redundancy is based on limited energy sources like e.g. batteries then the duration of the delay should be considered.

Guidance note:

This analysis should verify that the thrusters remaining in operation after the worst case failure can generate the same resultant thruster force and moment as required before the failure.

The analysis should consider the average power and thrust consumption. Brief, dynamic effects should be removed by filtering techniques.

For operations which will take a long time to terminate safely, the consequence analysis should include a function which simulates the thrust and power remaining after the worst case failure, based on manual input of weather trend.

Typically, the worst case failure will be loss of one complete switchboard, one engine room, or a group of thrusters that are subject to a common failure mode.

Limitations in available power and/or thrust for the relevant worst case single failure condition(s) should be taken in to consideration by the consequence analysis.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.13.2 The consequence analysis shall be repeated automatically at pre-set intervals. The operator shall be able to monitor that the analysis is in progress.

6.13.3 When limited energy sources like e.g. batteries, are supplying power to thrust producing units, it shall be possible to set the consequence analysis in a mode where the contribution from such sources are not considered.

6.13.4 When batteries are considered as a redundant source of power to DP thrusters, the consequence analysis alarm shall also be given when the available energy after failure is insufficient for operation according to a given time limit. This limit may be set by the operator, so that it can be adjusted according to the corresponding minimum time requirement for the operation, as determined in the FMEA, or a more conservative value if chosen. However, it shall not be possible to adjust this time below the lowest accepted minimum level. The calculations shall be based on the prevailing weather conditions and experienced operating pattern, e.g. mean net power consumption for the actual operation. The failure mode(s) causing need for the largest power contribution from the batteries after failure shall be considered.

Guidance note 1:

Any uncertainty in the accuracy of available energy should be accounted for by adjusting these alarm levels. In addition it should also be considered at which level of charge the battery should be considered to be empty. It should also be considered if the termination process will result in additional energy consumption. In such a case this additional consumption needs be taken in to account as well.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

In case the vessel has more than one accepted minimum time requirement, the operator shall ensure that correct time limits, corresponding to the ongoing operations, are being used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7 Thruster systems

7.1 Rule application

7.1.1 Thrusters shall comply with main class requirements.

7.1.2 The thrusters shall be designed as dynamic positioning thrusters or propulsion thrusters according to Pt.4 Ch.5. The thruster systems shall be designed for continuous operation.

Guidance note:

Generally no restrictions should be put on the starting intervals of electrical machines. If required, the arrangement is subject to approval in each case.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.1.3 When the main propulsion propellers are included under DP control, they shall be considered as thrusters, and all relevant requirements of these rules will apply. When rudders are not included under DP control a rudder out of zero alarm shall be given at the DP control centre in case the rudder is not in zero when the vessel is under control by the DP-control system.

Guidance note:

As for rudders, this principle applies as relevant to any other units supplying thrust in the DP system, e.g. water jets.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.1.4 When the main steering system is included under DP control, the steering gear shall be designed for continuous operation.

Guidance note:

For the **DYNPOS**-series, except for notation **DYNPOS(AUTS)**: see additional requirements for steering gear under DP control in Pt.4 Ch.10.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2 Thruster configuration

7.2.1 For notations **DYNPOS(AUT)**, **DYNPOS(AUTR)** and **DYNPOS(AUTRO)** the thruster configuration shall include thrust units which together will produce, at any time, transverse and longitudinal thrust, and a yawing moment. When intact, the DP system shall be able to produce such combined forces without contribution from transverse thrust generated by the combined use of propellers and rudders.

Guidance note 1:

Transverse thrust generated by the combined use of propellers and rudders will not be considered as thrust units in this context. See the definition in [1] with corresponding guidance note.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The rules do not specify the number or size of thrusters to make up the configuration. The station holding capability resulting from a chosen configuration will be documented by the DP capability numbers, see [10].

Thrusters should be located with consideration of effects, which will reduce their efficiency, e.g. thruster-hull, and thruster-thruster interaction, and shallow-immersion effects.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.2 For notations **DYNPOS(AUTR)** and **DYNPOS(AUTRO)** a redundant thruster configuration is required, and in addition to the requirement in [7.2.1] transverse and longitudinal thrust, and yawing moment shall be available after any single failure.

Guidance note:

Transverse thrust generated by the combined use of propellers and rudders may upon special consideration, be accepted as equivalent to a side thruster for back-up purposes, and should in such cases be proven on trials.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.3 For notations **DPS(1)**, **DPS(2)**, **DPS(3)** and **DYNPOS(AUTS)** the thruster configuration shall include thrust units which together will produce, at any time, transverse and longitudinal thrust, and a yawing moment.

Guidance note 1:

In this context transverse thrust generated by the combined use of propellers and rudders may be accepted as bases for normal DP operations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The rules do not specify the number or size of thrusters to make up the configuration.

Thrusters should be located with consideration of effects, which can reduce their efficiency, e.g. thruster-hull, and thruster-thruster interaction, and shallow-immersion effects.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.4 For notations **DPS(2)** and **DPS(3)** a redundant thruster configuration is required, and in addition to the requirement in [7.2.3] transverse and longitudinal thrust and yawing moment shall be available after any relevant single failure.

Guidance note:

See [4.2].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3 Thruster control

7.3.1 Individual follow up control of each thruster unit, by separate manual levers, shall be arranged in the DP control centre. This manual control shall be independent of the DP-control system and include azimuth and thrust (e.g. pitch and/or rpm.) control, as relevant. See also [8] with corresponding guidance notes.

Guidance note:

For vessels with notation **DYNPOS(AUTRO)** or **DPS(3)**, manual control will not be required in the back-up DP control centre.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.2 Manual thruster control mode shall be available at all times, also during all failure conditions in dynamic positioning or independent joystick control systems. Manual thruster control mode is not required to be available upon failures modes where the main DP control centre needs to be evacuated.

Guidance note:

Manual thruster control mode should be understood as manual control of all thrust units, including main propulsion, dynamic positioning thrusters, water jets and rudders.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.3 A single failure in the thruster control system should neither cause significant increase in thrust output nor make the thruster rotate. A single failure in the thruster control system or in its communication lines shall not lead to failure of more than one thruster at a time.

Guidance note 1:

This also applies to rudders when the rudders are under DP-control. See Pt.4 Ch.10 Sec.1 [5.5.4]. Upon special considerations it may be accepted that a rudder moves to mid-ship position upon a failure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

It may be accepted that a thruster rotates, if at the same time the thrust output is set to zero.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.4 It shall be possible to stop each thruster individually from the main DP control centre by means independent of the positioning and thruster control systems. This emergency stop shall be arranged with separate cables for each thruster.

7.3.5 For the **DPS**-series of notations and for the notation **DYNPOS(AUTS)**: It is accepted that emergency stop of a main propeller can cause stop of other thrusters. For notations **DPS(2)** and **DPS(3)**, thrusters stopping as a consequence of emergency stop of a main propeller shall belong to the same redundancy group as this main propeller.

Guidance note:

For vessels with notation **DYNPOS(AUTRO)** or**DPS(3)**, emergency stop will not be required at the back-up DP control centre.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.6 For the **DYNPOS**-series of notations the emergency stop activation buttons at the DP control centre shall be arranged in a dedicated mimic and in accordance with the thruster location and consistent with the vessel axis and layout, or they may be arranged together with the corresponding thruster levers if these are arranged in accordance with the physical thruster layout.

Guidance note:

For the **DYNPOS**-series of class notations, except for the notation **DYNPOS(AUTS)**, this implies that power take off (PTO)-step up gears for alternators powering other thrusters in the DP system, should be arranged on the primary side of the propulsion clutch, see Figure 1.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

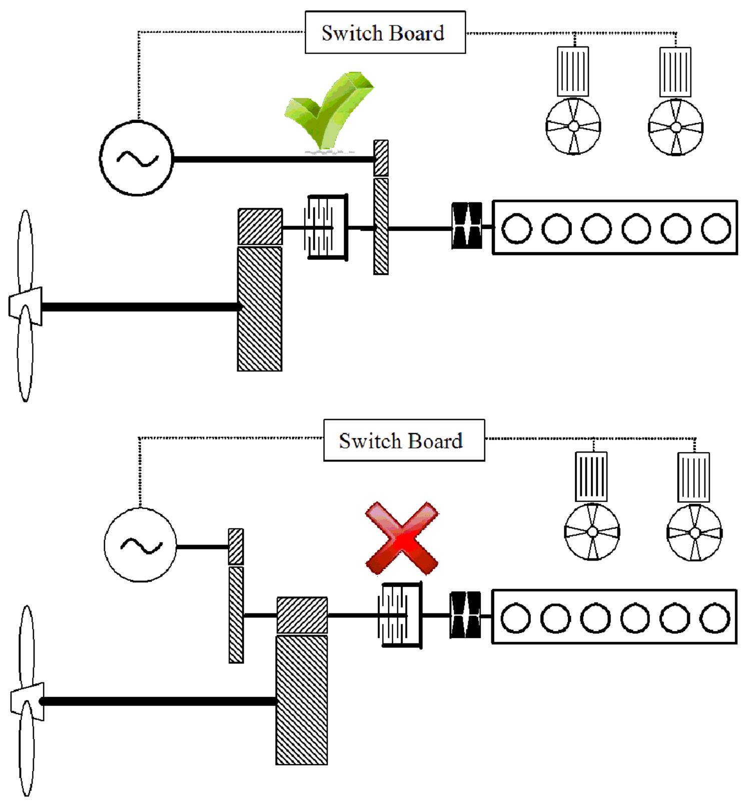

Figure 1 Acceptable and unacceptable clutch arrangement for DYNPOS-series of notations.

7.3.7 For notations **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**, an alarm shall be initiated upon loop failure, i.e. both broken connections and short-circuit, in the emergency stop system. Such failures shall not cause stop of the thruster.

Guidance note:

For emergency stop arrangement for other notations, see Pt.4 Ch.8 Sec.2.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.4 Indication

7.4.1 For each thruster, running and stop, pitch, rpm. and azimuth shall be displayed at the DP-control centre.

7.4.2 The displayed information of [7.4.1] shall be continuously visible at displays/indicators separate from the DP control and independent joystick control systems displays. At least, display of pitch, rpm. and azimuth (alternatively thrust and thrust direction), for each actuator, shall be readable from the normal position of the DP operator. Otherwise, slave displays/indicators shall be installed and be readable from the normal position of DP operator. The indication shall be arranged so that it will continue to present the real actuator values in case of any single I/O failure related to the follow up control. Hence, one single sensor can not be used for both indication and closed loop control. It can be accepted that indication is lost as a consequence of a failure as long as the follow up control is not affected.

7.4.3 For azimuth thruster used for steering, additional monitoring shall be arranged as required in Pt.4 Ch.10 Sec.1 Table 14.

8 Power systems

8.1 General

8.1.1 The power systems shall comply with the relevant rules for main class, for all class notations in this section. For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)** additional requirements will apply in regard to redundancy and with respect to maximum single failure, as specified for each notation. See [4] for the definition of a single failure.

Guidance note:

IMO MSC/Circ.645 "Guidelines for vessels with dynamic positioning systems"

Item 3.2.3:

"For equipment class 2, the power system should be divisible into two or more systems such that in the event of failure of one system at least one other system will remain in operation. The power system may be run as one system during operation, but should be arranged by bus-tie breakers to separate automatically upon failures which could be transferred from one system to another, including overloading and short-circuits."

Item 3.2.4:

"For equipment class 3, the power system should be divisible into two or more systems such that in the event of failure of one system, at least one other system will remain in operation. The divided power system should be located in different spaces separated by A-60 class division. Where the power systems are located below the operational waterline, the separation should also be watertight. Bus-tie breakers should be open during class 3 operations unless equivalent integrity of power operation can be accepted according to 3.1.3".

IMO MSC.1/Circ.1580 *"Guidelines for vessels and units with dynamic positioning (DP) systems"*,

Item 3.2.3:

"For equipment class 2, the power system should be divisible into two or more systems so that, in the event of failure of one sub-system, at least one other system will remain in operation and provide power for station keeping. The power system(s) may be run as one system during operation, but should be arranged by bus-tie breaker(s) to separate the systems automatically upon failures which could be transferred from one system to another, including, but not limited to, overloading and short-circuits."

Item 3.2.4:

"For equipment class 3, the power system should be divisible into two or more systems so that, in the event of failure of one system, at least one other system will remain in operation and provide sufficient power for station keeping. The divided power system should be located in different spaces separated by A-60 class divisions. Where the power systems are located below the operational waterline, the separation should also be watertight. Bus-tie breakers should be open during class 3 operations unless equivalent integrity of power operation can be accepted according to paragraph 3.1.4".

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8.1.2 Means shall be implemented in order to prevent overloading of the power plant, e.g. by use of interlocks, thrust limitations or other means. Means shall also be implemented to prevent reactive overload. This includes overload resulting from failures, e.g. loss of a generator or more than one generator when these are subject to common mode failures, or loss of complete switchboard sections.

8.2 Number and capacity of generators

8.2.1 For notation **DYNPOS(AUTS)**, **DYNPOS(AUT)** and **DPS(1)**, the generator capacity shall be in accordance with the main class.

Guidance note:

It is accepted that all generators are in operation to run all thrusters 100%.

Particular attention should be paid to starting conditions of thruster motors, especially with one generator out of service. The effect of voltage drop during starting periods may cause under-voltage trips of control circuits, and main class requirements should be observed. When starting thrusters on dedicated generators with no other loads connected which would be affected by voltage deviations, voltage drop in excess of 'the limits of the rules may be accepted.

The high reactive load demands, which may occur in DP thruster operation should be considered when selecting number and type of generators, further, the dynamic load variations for diesel engines should be taken into consideration.

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8.2.2 For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**, the number of generators shall comply with the redundancy requirements as defined in the single failure criteria in [4].

8.3 Batteries supplying power to DP thrusters

8.3.1 These requirements are applicable to DP systems where batteries are used as source of power to thrust producing units, hereafter named thrusters.

Guidance note:

Battery installations not used as a redundant source of power, but only used e.g. for peak shaving, handling of dynamic responses in the power system, etc., may not have to comply with these requirements.

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8.3.2 Batteries can be accepted as source(s) of power for DP thrusters, but the DP system shall be designed such that the vessel also can fulfil the relevant dynamic positioning class notation(s) requirements without the batteries.

Guidance note:

The vessels DP position keeping capacity (both before and after failure, i.e. the redundancy design intention) may vary when batteries are connected or disconnected.

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8.3.3 The vessel shall comply with Ch.2 Sec.1 *Battery power* and shall have the class notation **Battery(Power)**.

8.3.4 The battery with its battery management system (BMS) and energy management systems (EMS) shall be so arranged that the actual available energy can be determined and communicated to the DP-control system for indication and monitoring purposes. See [6.12].

8.3.5 Redundancy shall be based on connected batteries.

8.4 Power management

8.4.1 For **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**: An automatic power management system shall be arranged, operating with both open and closed bus-bar breakers. This system shall be redundant, and for **DYNPOS(AUTRO)** in addition A-60 separated, so that the functionality is maintained after a failure or, alternatively, one failure will only affect one section of the power system in accordance with the redundancy design intent. The system shall be capable of performing the following functions:

— load dependent starting of additional generators
— block starting of large consumers when there is not adequate running generator capacity, and to start up generators as required, and hence to permit requested consumer start to proceed
— it shall be possible to set a minimum number of connected generator sets in each redundancy group.

Guidance note:

Exemption from the requirement for an automatic and redundant power management system (PMS) may be granted, provided that functions for blackout prevention, tripping of non-essential consumers and block starting of large consumers are taken care of by other systems. Exemptions will be given to systems where PMS will add few or no benefits.

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8.4.2 A failure in a power management system shall not cause alteration to the power generation, and shall initiate an alarm in the main DP-control centre.

8.4.3 It shall be possible to operate the switchboards in manual as required for the main class, with the power management system disconnected.

8.4.4 Overload, e.g. caused by the stopping of one or more generators subject to common mode failures, shall not create a black-out.

Guidance note:

Reduction in thruster load, i.e. pitch or speed reductions, should be introduced to prevent blackout and enable standby generators to come online. If this function is taken care of by the positioning control system, the function should be co-ordinated with the power management system.

Load reductions should preferably be achieved through the tripping of unimportant consumers, and the requirement does not exempt such means. But, it is common that the relative load proportions will require thruster load reduction, in order to effectively reduce overload situations.

When the system is running with open bus-ties, partial black-out contained within one redundancy group (i.e. one main switchboard section), may occur in case a failure causes stop of the last connected generator set in that same redundancy group (main switchboard section).

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8.5 Technical system configurations based on closed bus-tie(s)

8.5.1 For notations **DYNPOS(AUTS)**, **DPS(1)** and **DYNPOS(AUT)**: No additional requirements apply.

8.5.2 For notations **DPS(2)**, **DYNPOS(AUTR)**: The vessel shall at least have one specified technical system configuration based upon open bus-ties between all electrical power generation system belonging to the different redundancy groups.

8.5.3 For operation with closed bus-tie(s) the power system shall be arranged with bus-tie breaker(s) to separate automatically upon failures which could be transferred from one system to another.

8.5.4 **DYNPOS(AUTR)** and **DPS(2)**: When generators in different redundancy groups are running in parallel this will introduce the possibility that a single failure may propagate between systems. In such cases it is required that protective measures are implemented in the system in order to ensure the required integrity between the redundancy groups. Analysis of relevant failure modes shall be addressed in the FMEA.

Guidance note:

Examples of failure modes that will be relevant are given below.*) The analysis and test requirements may be part of the DP FMEA and FMEA test program or other documentation. In case such verification is documented in other documentation the FMEA should give reference to this documentation, and refer/state conclusions based on this.

Failure modes:	*Minimum analysis and test requirement for **DYNPOS(AUTR)** and **DPS(2)**:*
Short circuits, earth failures	Selectivity between generator breakers and bus-tie breaker(s) on short circuit and earth failures, in form of a discrimination analysis.
Over load	Overload required to be handled by functionality in control systems (PMS, DP, Switchboard logic), control system documentation, FMEA and functional testing at DP/PMS/FMEA trials. (Can I/O failure between DP/PMS/SWB be a hidden failure?)
Governor failures	Power failure, speed pick-up failure, over-fuel, isochronous load sharing lines. Analyse and test all these.
Overvoltage and automatic voltage regulator (AVR), failure scenarios	Over excitation/excitation break-down/under excitation, to be analysed in the FMEA analysis. FMEA test requirement: loss of excitation (power or no output), loss of sense or over excitation (disconnect CT feedback or increase excitation).
Failures related to PMS and active load sharing	Analysis, functional testing. FMEA test: Power failure, network failure (disconnect), PMS I/O failure testing required as found necessary in FMEA analysis, load sharing line failure (disconnect).
Transient under voltage (short circuit ride through) (In electrical systems transient voltage dips may occur, e.g. due to short circuits and subsequent intended opening of feeder or bus-tie breakers for disconnection of the faulty equipment. In connection with operation with closed bus such transients will affect the whole connected distribution system.)	The FMEA should analyse the effect of transient voltage dips in the system and identify measures necessary to avoid problems with: — unintended tripping of frequency converters — unintended deselecting of thrusters from DP control (e.g. loss of ready signal from drives to DP-control system) — unintended tripping of motors and other important components, like auxiliary system pumps (tripping of motor starters and/or contactors) — unintended activation of under voltage protection systems — DC control power systems, e.g. dual feeding through diodes or automatic change-over. In relation with the above items, functionality should be checked in order to verify the potential effect of this failure mode. The requirement is that the equipment not belonging to the redundancy group directly affected by the failure shall ride through the transient period and be immediately available, without operator intervention, when the system voltage is re-established. It should also be evaluated if re-establishment of system voltage could cause unacceptable high voltages ('voltage over-shoot-). Measures should be implemented as found necessary through analysis. No short circuit test-requirements to verify the conclusions. For auxiliary functions which will not affect the DP system within a long time period after failure and which are starting and stopping regularly as part of their normal operation, typically systems for control of ambient room temperature, the ride through may be based upon stop and automatic restart/standby start. (Additionally, or as an alternative, verification of the above mentioned items may also be based on testing. Such testing should be based upon non-destructive methods for simulating the transient low voltage period in the system.)

*) It should be understood that this is not an exhaustive list of failure modes relevant for closed bus-tie systems. Reference is made to documents DNVGL OTG-10 *DP-classed vessels with closed bus-tie(s)* and DNV-RP-D102, *Failure Mode and Effect Analysis (FMEA) of Redundant Systems,* Appendix D, for explanation of acceptance criteria, discussion on the subject, and other examples of relevant failure modes.

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8.5.5 For notations **DYNPOS(AUTRO)** and **DPS(3)**: Technical system configurations based on closed bus-ties may be accepted based upon special considerations. See [11] Appendix A for a more detailed specification of these considerations.

Guidance note:

See [8.1.1], IMO MSC/Circ.645 *Guidelines for vessels with dynamic positioning systems* item 3.2.4 and IMO MSC.1/Circ.1580 *Guidelines for vessels and units with dynamic positioning (DP) systems* item 3.2.4: For **DYNPOS(AUTRO)** and **DPS(3)**: Bus-tie breakers providing redundancy should be open during class 3 operations.

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8.6 Main and distribution switchboards arrangement

For **DYNPOS(AUTS)**, **DYNPOS(AUT)** and **DPS(1)** notations the main class requirements are adequate.

8.7 Main and distribution switchboards arrangement for notations requiring redundancy

8.7.1 The requirements in this subsection apply to notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**.

8.7.2 The switchboard arrangement shall be such that no single failure will give a total black-out. For **DYNPOS(AUTR)** and **DPS(2)** this means equipment failures. For **DYNPOS(AUTRO)** and **DPS(3)** this means failure of all equipment in any fire and/or watertight subdivision.

8.7.3 When considering single failures of switchboards, the possibility of short-circuit of the bus-bars has to be considered.

8.7.4 A main bus-bar system consisting of at least two sections, with bus-tie breaker(s) or inter-connector breaker(s), shall be arranged. When the system is designed to be operated with closed bus-tie breaker in DP mode, this breaker shall be a circuit breaker capable of breaking the maximum short circuit current in the system, and which is selective in relation to generator breakers to avoid total loss of main power (black-out).

8.7.5 For **DYNPOS(AUTR)** and **DPS(2)** it is accepted that the bus-bar sections are arranged in one switchboard.

8.7.6 For **DYNPOS(AUTRO)** and **DPS(3)** it is required that each bus-bar section is isolated from the other(s) by watertight A-60 partitions according to [4.6]. There shall be a bus-tie breaker on each side of this partition.

8.7.7 Bus-bar control and protection systems shall be designed to work with both open and closed bus-tie breakers.

Guidance note:

This is not to be understood as a requirement for having a technical system configuration for DP based upon closed bus-tie(s), and hence with the additional requirements as specified in [8.5].

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8.7.8 The online power reserve, i.e. the difference between online power capacity and generated power at any time, shall be displayed in the main and back-up DP control centre(s). For split-bus power arrangements, indications shall be provided for individual bus sections.

8.8 Control system power supply

8.8.1 The requirements in this subsection apply to notations **DYNPOS(AUT)**, **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(1)**, **DPS(2)** and **DPS(3)**).

8.8.2 The DP controllers, operator stations, printers/data loggers and measuring systems (PRSs and sensors) shall be powered from uninterruptible power supplies, (UPS). The arrangement and number of UPS shall be in accordance with Table 7.

8.8.3 The power supply for the independent joystick system and the power supplies for the thruster control systems shall be independent of the DP-control system UPSs. In case the independent joystick main power supply is arranged in form of a battery supply or UPS, this supply shall be able to provide output power at maximum load for 30 minutes after loss of charger input power, and loss of charger input power and UPS on bypass power shall initiate an alarm in the independent joystick system.

8.8.4 The battery installed for each UPS shall be able to provide output power at maximum load for 30 minutes after loss of charger input power. Loss of charger input power and UPS on bypass power shall initiate an alarm in the DP-control system.

Guidance note:

Reference is given to main electrical rules. See Pt.4 Ch.8 Sec.7 for relevant rules for UPSs.

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8.8.5 For **DYNPOS(AUTR)** and **DPS(2)**: The input power supply to the redundant UPSs shall be derived from different redundancy groups.

8.8.6 For **DYNPOS(AUTRO)** and **DPS(3)**: The input power supply to the redundant UPSs for the main DP-control system shall be arranged so that these are supplied from different redundancy groups. Alternative supplies from within the same A60 zone as the main DP-control system may be arranged as long as these are arranged as manual change over systems. Power supply to the UPS supplying the back-up DP-control system shall not be from the same sub-distribution switchboard as the normal supply to any of the main DP-control system UPSs, and in addition arranged so that it is A60 separated from the main DP-control system.

8.8.7 Power supply to the thruster control mode selection systems shall be arranged so that the required independency, integrity and redundancy as specified in [6.6] are complied with.

8.8.8 UPS and battery supplies to other control systems relevant for DP shall be derived from the same redundancy group as the system(s) being served.

Guidance note:

When dual supply to thrusters is arranged in accordance with [4.3.4] the power supply to the control systems shall be dual feed in accordance with the main thruster supply through a selective power supply arrangement, or be branched off from the thrusters main dual feed arrangement.

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8.8.9 In general control systems and equipment shall have power supply from within the redundancy group they are serving. In case power supply is arranged from more than one redundancy group special attention shall be paid to the potential risk of propagation of failure modes due to e.g. lack of discrimination or due to under/overvoltage affecting more than one redundancy group. Selectivity/barriers for relevant failure modes shall be documented and verified when such power supply is arranged. This applies especially to **DYNPOS(AUTRO)** and **DPS(3)** systems where supplies crossing required separation barriers in general should be avoided.

9 Auxiliary systems

9.1 General

9.1.1 For **DYNPOS(AUTS)**, **DYNPOS(AUT)** and **DPS(1)** notations the main class requirements are adequate.

9.2 Additional for notations requiring redundancy

9.2.1 The requirements in this subsection apply to notations **DYNPOS(AUTR)**, **DYNPOS(AUTRO)**, **DPS(2)** and **DPS(3)**.

9.2.2 The auxiliary systems, serving machinery, thrusters, electrical components and all other systems and components necessary for supplying the DP system with power and/or thrust, shall be arranged in accordance with the redundancy and separation requirements as given for the relevant notation(s). See [4.2].

9.2.3 Failure shall be considered for all active components as specified in [4.2] for the relevant notation(s).

9.2.4 For **DYNPOS(AUTR)**: See [9.3], [9.4], [9.5] and [9.6] below for specific requirements to specific systems. When separate piping systems are required, cross-over facilities between redundancy groups can be arranged, based on that they will be kept closed in normal DP operation. Unless otherwise specified in these rules, fixed piping may be shared by components designed with redundancy. See also [4.4].

9.2.5 For **DPS(2)** the auxiliary systems shall be based on the same general principles with respect to active components. However, based on proper FMEA, static components like coolers, filters and piping/tanks may be considered as not failing, and hence common static components may be accepted in fuel oil systems, fresh water cooling systems and pneumatic systems.

Guidance note 1:

Reference is made to IMO MSC/Circ.645 *Guidelines for vessels with dynamic positioning systems*, part 2.2.2, dated 6 June 1994:

For equipment class 2, a loss of position is not to occur in the event of a single fault in any active component or system. Normally static components will not be considered to fail where adequate protection from damage is demonstrated, and reliability should the satisfaction of the Administration. Single failure criteria include:

1) Any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.).
2) Any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection and reliability.

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Guidance note 2:

See [4.2].

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Guidance note 3:

Main class requirements to auxiliary piping systems are found in Pt.4 Ch.6.

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9.2.6 For **DYNPOS(AUTRO)** and **DPS(3)**: Piping for all systems relevant for DP shall be arranged with A-60 separation, and watertight below bulkhead deck, between systems belonging to different redundancy groups. Cross-over pipes are acceptable provided these can be closed at both sides of separating bulkheads. Ventilation ducts shall not have cross-over facilities. See also [9.4] through [9.6] below.

9.3 Specific requirements for fuel oil systems

9.3.1 For **DYNPOS(AUTR)**: The fuel oil supply shall be arranged with full separation between systems providing required redundancy. There shall be at least one service tank serving each redundancy group.

9.3.2 For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)** and **DPS(3)**: If the fuel system requires heating, then the heating system shall be designed with the appropriate level of redundancy unless fuel which do not require heating, are arranged so that the requirement in [9.3.1] is fulfilled. Separation by A-60 class division is required for **DYNPOS(AUTRO)** and **DPS(3)**, see [9.2.6].

9.4 Specific requirements for fresh water cooling systems

For **DYNPOS(AUTR)**: Fresh water cooling systems providing the required redundancy shall be arranged as separated systems, in view of the risk of severe loss of water or accumulation of gas due to leakage.

Guidance note:

Redundant systems for air conditioning and control of ambient temperature, e.g. air condition units, chillers and HVAC, may share common piping for notation **DYNPOS(AUTR)**.

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9.5 Specific requirements for pneumatic systems

For **DYNPOS(AUTR)**, **DYNPOS(AUTRO)** and **DPS(3)**: Pneumatic systems in which a relevant single failure modes may compromise the required redundancy shall be arranged as separated systems for each redundancy group. Separation by A-60 class division is required for **DYNPOS(AUTRO)** and **DPS(3)**, see [9.2.6].

9.6 Specific requirements for fire dampers and quick closing valves

For **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**: Fire dampers and quick closing valves which upon activation may affect power generation and/or thrust shall be so arranged that there is separate activation for each redundancy group. As a minimum there shall be separate activation input devises and valves (in case the activation system is pneumatic) for each redundancy group. Separation by A-60 class division is required for **DYNPOS(AUTRO)**, see [9.2.6].

10 Station keeping capability

10.1 General

10.1.1 The requirements in this section apply to the notations **DYNPOS(AUT)**, **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**.

10.1.2 The position keeping ability of the vessel shall be calculated according to the DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*.

10.1.3 All ship-shaped monohull vessels shall calculate their dynamic positioning station keeping capacity according to DNVGL-ST-0111 DP capability level 1.

10.1.4 Vessels with other hull shapes than ship-shaped monohulls shall calculate their dynamic positioning station keeping capacity according to DNVGL-ST-0111 DP capability level 2. Deviations from the DP capability level 1 method shall be kept to a minimum, and shall only be related to the hull differences.

10.1.5 A given DP capability number indicates that a vessel's station keeping ability can be maintained in the corresponding DP capability number condition and all conditions below, but not in the condition specified for the next DP capability number. The DP capability numbers relates to the Beaufort scale and environmental conditions as given in table 9.

Table 9 DP capability numbers and Beaufort scale, wind speed, wave height, wave period and current speed

Beaufort(BF) number	*DP capability number*	*Beaufort description*	*Wind speed*) [m/s]*	*Significant wave height [m]*	*Peak wave period [s]*	*Current speed [m/s]*
0	0	Calm	0	0	NA	0
1	1	Light air	1,5	0,1	3,5	0,25
2	2	Light breeze	3,4	0,4	4,5	0,50
3	3	Gentle breeze	5,4	0,8	5,5	0,75
4	4	Moderate breeze	7,9	1,3	6,5	0,75
5	5	Fresh breeze	10,7	2,1	7,5	0,75
6	6	Strong breeze	13,8	3,1	8,5	0,75
7	7	Moderate gale	17,1	4,2	9,0	0,75
8	8	Gale	20,7	5,7	10,0	0,75
9	9	Strong Gale	24,4	7,4	10,5	0,75
10	10	Storm	28,4	9,5	11,5	0,75
11	11	Violent storm	32,6	12,1	12,0	0,75
12	NA	Hurricane force	NA	NA	NA	NA
*)The wind speed is the upper limit of the mean wind speed 10 m above sea level for the given DP capability number. The given peak wave periods represent the 95% confidence interval found from the world wide scatter diagram.						

10.1.6 The DP capability numbers shall be evaluated for a balance of forces while the vessel is maintaining both position and heading. Thus, there shall at the same time be a balance of forces and a balance of moments, i.e. including all moments generated by the thrusters, and those caused by environmental forces.

10.1.7 The format of the DP capability numbers shall be a series of 4 integer numbers, ranging from 0 to 11. The DP capability will be given in the DNV GL register in the following format: DP capability LX(A,B,C,D).

Where:

— X = 1 or 2 describing the DP capability level.
— A: Maximum DP capability number as specified in Table 9 where the vessel in its intact condition (no failures) can maintain station with its heading ±30° relative to the environmental forces.
— B: Maximum DP capability number as specified in Table 9 where the vessel in its intact condition (no failures) can maintain station with heading 0-360°.
— C: Maximum DP capability number as specified in Table 9 where the vessel in its worst case single failure condition relevant for the class notation can maintain station with its heading ±30° relative to the environmental forces.
— D: Maximum DP capability number as specified in Table 9 where the vessel in its worst case single failure condition relevant for the class notation can maintain station with its heading 0-360°.

10.1.8 The C and D numbers shall be the lowest numbers obtained across all the redundancy group cases (i.e. stop of one redundancy group at a time). These parameters are not applicable for non-redundant DP systems (i.e. vessels not having their redundancy verified by issuance of a redundant DP class notation), and shall be indicated as NA (not applicable) for such vessels.

11 Appendix A Technical system configurations based on closed bus-ties

11.1 Special considerations

11.1.1 This appendix apply to notations **DYNPOS(AUTRO)** and **DPS(3)** when the required integrity between redundancy groups shall be based on closed bus-ties, i.e. based on technical system configurations where generators in different redundancy groups are running in parallel.

11.1.2 Approval shall be specially agreed upon and will be considered as additional work.

11.2 General

11.2.1 The vessels shall in addition to the closed bus-ties mode have at least one specified technical system configuration based upon open bus-ties between all electrical power generation systems belonging to the different redundancy groups. The integration of functional capabilities on a system level shall be controlled and coordinated by a system integrator. The yard is responsible for this coordination. It is required, therefore, to nominate a dedicated person who has the responsibility for the complete process for gaining **DYNPOS(AUTRO)** and/or **DPS(3)** acceptance.

11.2.2 The definition of relevant single failures shall have no limitations and shall be addressed in the approval process and during testing.

11.2.3 For operation with closed bus-ties the power system shall be arranged with bus-tie breakers to separate automatically upon failures which could be transferred from one system to another.

11.2.4 The integrity level shall be comparable to a system based on open bus-ties in order to minimize the residual probability for failure propagation. Protective functions shall be installed in order to achieve the required equivalent integrity level.

11.2.5 The verification shall be based upon approval of additional documentation (as compared to systems based on open bus-ties) including, but not limited to, thorough closed bus-tie analysis, calculations and dynamic computer simulations of the power system in normal operation and during all relevant failure conditions. In addition live testing of failure modes including e.g. short circuits, earth faults, automatic voltage regulators faults, engine governor faults and other severe faults shall be performed.

Guidance note 1:

Reference is made to documents DNVGL OTG-10 *DP-classed vessels with closed bus-tie(s)* and DNV-RP-D102, *Failure Mode and Effect Analysis (FMEA) of Redundant Systems,* Appendix D, for explanation of acceptance criteria, discussion on the subject, and examples of relevant failure modes.

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Guidance note 2:

It is utmost important that the design is built and prepared for the required live testing of severe failure modes both at the new building stage and at renewal trials during the vessels entire operational life time. It should be understood that in order to achieve this, the design will require installation of additional equipment and systems including e.g. advanced protective systems for generators and switchboard.

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Guidance note 3:

The negative effects of hidden failures should be prevented. This applies both for hardware and software. Hidden failures for all components and systems should be considered, and this will require extensive use of self-diagnostics. However, self-diagnostics cannot be considered to mitigate all hidden failures, and due to this duplication and redundancy will be required.

Consequently, protection and safety systems should have back-up. This means that if the first action performed by the protection system does not remove the failure or is not performed (due to hidden failure), then the back-up system should execute alternative actions to isolate the faulty component or system. After activation of the back-up protection, the consequence of the failure should still be in line with the overall redundancy design intent.

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Guidance note 4:

More detailed information on requirements for documentation, calculations, computer simulations and testing can be provided on request.

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11.2.6 When generators in different redundancy groups are running in parallel, black-out recovery on individual switch-board sections by starting of generators and recovery of full automatic thruster control from DP shall be possible. The DP-control systems shall receive thruster ready signals within maximum 45 seconds after black-out.

SECTION 2 DYNAMIC POSITIONING SYSTEMS WITH ENHANCED RELIABILITY - DYNPOS(E,ER)

1 General

1.1 Introduction

The industry practice for redundant dynamic positioning systems has traditionally rested on an approach where the redundancy is based on running machinery, not utilising stand by units or change over mechanisms. Typical examples of standards used are the Society's class notations **DYNPOS(AUTR)** and **DYNPOS(AUTRO)**, and IMO MSC/Circ. 645 *Guidelines for vessels with dynamic positioning systems* and IMO MSC.1/Circ.1580 *Guidelines for vessels and units with dynamic positioning (DP) systems* equipment class 2 and equipment class 3.

These rules are based on somewhat different principles and philosophies which are adapted to, making it possible to better utilise the latest technology within power generation, power distribution, thruster technology and advanced integrated control systems in order to allow for flexible and efficient operation of the power and thruster plant.

These rules also allow for and set specific requirements for power plants that may be designed for running with connected power systems on specific conditions. Standby start and change over, may be used as a bases for redundancy, allowing for more flexible, economic and environmental friendly operations.

While the **DYNPOS(E)** notation does not require separation requirements in addition to main class, a new approach is taken towards separation of components and systems providing redundancy for the **DYNPOS(ER)** notation.

Hence, these rules cannot directly compare with the traditional standards for dynamic positioning systems. By applying these rules, the intention is to achieve integrity towards loss of position and heading keeping ability, which meets intentions comparable to or exceeding IMO MSC/Circ. 645 and IMO MSC.1/Circ.1580 equipment class 2 and equipment class 3 (depending on which failure mode is being evaluated). The standard which will be the most suitable for a given vessel and/or operation should therefore be evaluated on a case by case basis.

Dynamic positioning systems characterised and structured in line with the IMO MSC/Circ.645 and IMO MSC.1/Circ.1580 are described in Sec.1.

1.2 Scope

The rules in this section apply to systems for dynamic positioning. These rules do not include requirements or recommendations in regard to the vessels operation or other characteristics.

Requirements, additional to these rules may be imposed by the national authority with whom the vessel is registered and/or by the administration within whose territorial jurisdiction it is intended to operate. Where national legislative requirements exist, compliance with such regulations will also be necessary.

Note that these rules do not give guidance on the suitability of the different intended technical system configurations with respect to the vessels various industrial mission(s). Reference is made to the Society's recommended practice: DNVGL-RP-E306 *Dynamic positioning vessel design philosophy guidelines*.

The requirements in these rules are additional to the rules for main class. In particular see the relevant sections of:

— Pt.4 Ch.1 *Machinery systems, general*
— Pt.4 Ch.2 *Rotating machinery, general*
— Pt.4 Ch.3 *Rotating machinery - drivers*
— Pt.4 Ch.4 *Rotating machinery - power transmissions*
— Pt.4 Ch.5 *Rotating machinery - driven units*
— Pt.4 Ch.8 *Electrical installations*

— Pt.4 Ch.9 *Control and monitoring systems*.

1.3 Application

1.3.1 Notations

Vessels built and tested in compliance with the requirements in this section and the requirements of the rules for main class may be assigned the relevant class notation(s) given in Table 1.

Table 1 Class notations

Notation	*Description*
DYNPOS(E)	The main objectives for the **DYNPOS(E)** notation shall be to provide a dynamic positioning system with the following properties: — redundancy in technical design — independent single alternative DP-control system — operator stations for main and alternative DP-control systems placed in the same DP control centre (e.g. the bridge) — flexibility and increased availability of power and thrust by use of connected power systems, standby start and change-over.
DYNPOS(ER)	The main objectives for the **DYNPOS(ER)** notation shall be to provide a dynamic positioning system with the following properties: — all the same properties as listed for **DYNPOS(E)**, and in addition: — A-60 separation between redundancy groups in high fire risk area — A-0 separation between redundancy groups in other areas — watertight separation between redundancy groups below bulkhead deck.

A qualifier **A** can when requested by the vessel owner be assigned to vessels with notation **DYNPOS(E)** or **DYNPOS(ER)** which then shall undergo annual survey according to the applicable 5 yearly complete survey scope. This means that the scope of the annual survey shall also include the scope of the complete survey. Example of notation: **DYNPOS(ER,A)**.

1.3.2 Station keeping capability

Station keeping capability calculations shall be made for the vessel in accordance with the requirements in [10].

1.4 Definitions

Table 2 Definitions

Term	*Definition*
bulkhead deck	see Pt.3 Ch.1 Sec.4 Table 7 for definition
capability plot	graphic illustration of vessel's position and heading keeping capacity in a specified vessel condition and specified environmental condition. See [10]

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>consequence capability analysis</td><td>monitoring function in the DP-control system that issue an alarm if the vessel (in its current operating mode) in the current weather conditions would not be able to keep the heading and position in the case that any of the predefined worst case failures should occur

Guidance note:
For detailed information and requirements to the consequence analysis function see [6.11].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---</td></tr>
<tr><td>DP</td><td>dynamic positioning</td></tr>
<tr><td>DP-control system</td><td>all control systems and components, hardware and software necessary to dynamically position the vessel. The DP-control system consists of the following:
— dynamic positioning control computer(s)
— sensor system
— display system
— operator panels
— positioning reference system
— associated cabling and cable routing
— UPSs as required by the relevant notation.

Guidance note:
The DP-control system will normally consist of one or more computers. This is often referred to as the DP system, but is only a part of the DP system by rule terminology.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---</td></tr>
<tr><td>dynamic positioning system (DP system)</td><td>complete installation necessary for dynamically positioning a vessel comprises of the following systems:
— power system
— thruster system
— DP-control system
— independent joystick system (if installed).</td></tr>
<tr><td>dynamically positioned vessel (DP vessel)</td><td>vessel which automatically maintains its position and heading (fixed location or predetermined track) exclusively by means of thruster force

Guidance note:
In this context transverse force may be generated by the combined use of propellers and rudders, see [7].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---</td></tr>
<tr><td>failure</td><td>occurrence in a component or system causing one or both of the following effects:
— loss of component or system function
— deterioration of functional capability to such an extent that the safety of the vessel, personnel, or environment is significantly reduced.

Guidance note:
Certain exceptions will be allowed in the definition of single failure. See [4]. For DYNPOS(ER) single failure will include flooding below bulkhead deck and fire in high fire risk areas. Loss of stability (e.g. as a result of flooding) is not a relevant failure mode.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---</td></tr>
<tr><td>FMEA</td><td>failure mode and effect analysis, Sec.1 [1.6.7]</td></tr>
</table>

Term	*Definition*
hidden failure	failure that is not immediately evident to operations and maintenance personnel **Guidance note:** Equipment that fails to perform an 'on demand' function falls into this category. It is necessary that such failures are detected by monitoring and/or revealed through periodical testing/verification in order to ensure the availability of such functions. Protective functions, e.g. in power plants and switchboards, are typical examples of on demand functions where possible hidden failures should be considered. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
HMI	human machine interface encompassing user input device (UID) and/or visual display unit (VDU)
joystick	device for readily setting of vectorial thrust output including turning moment
minimum time requirement	minimum required time duration for which the residual remaining capacity as defined by the worst case failure design intent shall be available **Guidance note:** The time requirement will normally be governed by the maximum time necessary to safely terminate the on-going operations after the worst case single failure, given the residual remaining capacity. All relevant operational scenarios which the vessel performs and/or participates in should be considered when determining the time requirements. This time requirement should be fulfilled by the design, and the way the vessel is technically configured (technical system configuration) and operated. In addition to the actual time necessary to terminate the operation, the minimum time requirement includes also the time necessary for detection and alarming by the system, and the time needed for the operator(s) to notice, make the appropriate decision(s), and initiate the termination process. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
operational mode	manner of control under which the DP system may be operated, e.g.: — automatic mode (automatic position and heading control) — joystick mode (manual position control with selectable automatic or manual heading control) — manual mode (individual control of thrust, azimuth, start/stop of each thruster) — auto track mode (considered as a variant of automatic position control, with programmed movement of reference point).
position/heading keeping	maintenance of a desired position/heading within the normal excursions of the control system and the environmental conditions
positioning/heading reference system	all hardware, software and sensors that supply information and or corrections necessary to give position/heading reference, including power supply
power system	all components and systems necessary to supply the DP system with power. The power system includes: — prime movers with necessary auxiliary systems including piping — generators — switchboards — uninterruptible power supplies (UPS) and batteries — distribution system including cabling and cable routing — power management system (PMS).

Term	*Definition*
redundancy	ability of a component or system to maintain its function when one failure has occurred. Redundancy can be achieved, for instance, by installation of multiple components, systems or alternative means of performing a function
redundancy design intent	refers to redundant component groups which constitutes the overall system design for a given system operational mode and technical system configuration
redundancy group	all components and systems that is subject to a single failure as specified in [4.3] for the specific notations **Guidance note:** The redundancy groups will emerge as a consequence of the worst case single failure within each group. The rules do not give requirements to the number of (beyond 2) or ratio between the defined groups. The groups shall be identified in the FMEA, verified by testing and incorporated in the consequence analysis. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
reliability	ability of a component or system to perform its required function without failure during a specified time interval
station keeping	automatically maintaining a vessel position and heading within required limits
technical system configuration	includes all technical modes (and combinations of the modes) of all systems that may influence the redundancy and failure tolerance of the vessel. This will typically include but is not limited to e.g., control system modes, power plant and thruster configuration, switchboards (AC and DC) configuration and distribution setup, auxiliary systems setup, valves, breakers, pumps, etc.) **Guidance note:** The technical system configuration(s) are prerequisites for establishing the basis for an FMEA, and should be specified for all relevant configurations One example could be that a vessel has different technical system configurations for different vessel operational modes and another example could be in case a vessel with **DYNPOS(ER)** notation is intended to also to have a mode based on **DYNPOS(AUTRO)** acceptance criteria, both modes should be stated, specified, analysed, and tested in the FMEA. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
thruster system	all components and systems necessary to supply the DP system with thrust force and direction. The thruster system includes: — thruster with drive units and necessary auxiliary systems including piping — thruster control — associated cabling and cable routing — main propellers and rudders if these are under the control of the DP system.
TOCA	sailing vessel entering in to class
worst case failure	refers to failure modes which, after a failure, results in the largest reduction of the position and/or heading keeping capacity. This means loss of the most significant redundancy group, given the prevailing operation **Guidance note:** This will typically be loss of the most significant thruster group(s) and/or generator group(s) subject to common mode failure(s). Relevant failure modes are specified in [3]. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Term	Definition
worst case failure design intent	refer to the minimum remaining capacity after any relevant single failure or common cause (for a given operational mode)
zone	confined space with specified fire and flooding boundaries

1.5 Documentation

1.5.1 The documentation submitted shall include descriptions and particulars of the vessel and cover the requirements given in Table 3 and Table 4, and [1.5.6] to [1.5.10], as appropriate. These documentation requirements are in addition to the requirements for main class.

1.5.2 Vessel documentation shall be submit as required in Table 3. In addition the relevant information elements and documentation as specified in DNVGL-OTG-10 *DP-classed vessels with closed bus-tie(s)* Appendix A, shall be included in the documentation listed in Table 3 or submitted separately.

Table 3 Documentation requirements - vessel

Object	*Documentation type*	*Additional description*	*Info*
Position keeping systems	I060 – Principal cable routing sketch	The documentation shall also include a list of relevant cables crossing fire zones. For the cable routing layout drawing it is recommended that colours are used to indicate the cable routes that are designed and physically arranged to provide redundancy. The cable routing layout drawing shall indicate all cables relevant to the DP system, e.g. power cables, control cables, cables used for indication etc. Not required for **DYNPOS(E)**.	AP
	Z030 – Arrangement plan	Fire and flooding separation zone plan. This shall be in form of a GA plan indicating, preferably by use of colours, which spaces that are intended to contain equipment and systems belonging to the different redundancy groups. In addition the drawings shall indicate the passive fire protection between the zones. Not required for **DYNPOS(E)**.	AP

Object	*Documentation type*	*Additional description*	*Info*
	Z050 – Design philosophy	The document shall describe the main features of the design and identify the redundancy groups and the redundancy design intent (including the separation design intent when required),, as a minimum with respect to: — thrusters, propellers and rudders — engines, generators and other power sources — main switchboard arrangement — type(s) of fuel. The worst case failure design intent shall be stated. The intended minimum time requirement shall be stated. The document shall specify all intended technical system configuration(s) which the DP notation shall be based on, and for each of these the corresponding worst case failure design intent(s). As a minimum the specification should cover the above listed components. For notations requiring separation, the DP zone plan and ventilation arrangements to DP related spaces shall be described. The DP design philosophy shall be submitted early in the project. In case the DP design philosophy is not specified, documentation related to other part of the DP system may need to be put on hold since the acceptance criteria will very often be determined based on the specified DP design intent.	FI
	Z071 – Failure mode and effect analysis (FMEA)	See [1.5.7].	AP
	Z200 – DP Station keeping assessment report	See [1.5.6].	AP
	Z253 – Test procedure for quay or sea trial	Redundancy and failure modes based on FMEA. See also [3], Survey and test upon completion and [1.5.8].	AP
Position keeping control centres	Z030 – Arrangement plan	Showing the physical arrangement and location of all key components in the DP control centre, see [5] for definition of key components.	AP
Thrusters emergency stop systems	I150 – Circuit diagram	Individual thruster emergency stop system required at the DP control centre. This system may be part of the individual manual lever thruster control system.	AP
Object	E040 – Electrical load balance	For dynamic positioning operation. The load calculations shall also reflect the situations after failure (stop) of each redundancy group. May be a part of the power consumption balance as required in Pt.4 Ch.8 *Electrical installations*.	AP

Object	Documentation type	Additional description	Info
	Position keeping systems	Description of protection, discrimination, interlocks, starting arrangements, magnetising arrangements, operation modes, under voltage ride through capability, change-over arrangements, etc., as applicable.	AP
	Z265 - Calculation report	Dynamic computer simulations of the power system in normal operation and during all relevant failure conditions. See [1.5.9].	FI, R
Manoeuvring thruster arrangements	Z110 – Data sheet	Including: — thrust output and power input curves — response time for thrust changes — response time for direction changes — anticipated thrust reductions due to interaction effects.	FI, R*)
	Z060 – Functional description	Systems for re-start and change-over. Time for re-start. Auxiliary systems required for re-start and operation.	AP
Internal communication system	I040 – User interface documentation		AP, R
	I050 – Power supply arrangement		AP, R
	I070 – Instrument and equipment list		AP, R
	I080 – Data sheet with environmental specifications		AP, R
	Z253 – Test procedure for quay and sea trial		AP, R
AP = For approval; FI = For information; L = Local handling; R = On request *): Only on request, typical for novel designs and/or new manufacturers.			

1.5.3 For products required to be approved and/or certified, the manufacturer shall submit the documentation required by Table 4. In addition the relevant information elements and documentation as specified in DNVGL-OTG-10 *DP-classed vessels with closed bus-tie(s)* Appendix A, shall be included in the documentation listed in Table 4 or submitted separately.

Table 4 Documentation requirements – products required to be approved and/or certified.

Object	Documentation type	Additional description	Info
Dynamic positioning automatic control systems, main Dynamic positioning automatic control systems, alternative	I010 – Control system philosophy		AP
	I020 – Control system functional description		AP
	I030 – System block diagram (topology)		AP
	I040 – User interface documentation		AP
	I050 – Power supply arrangement		AP
	I070 – Instrument and equipment list		FI

Object	*Documentation type*	*Additional description*	*Info*
	I080 – Data sheet with environmental specifications		AP
	I140 – Software quality plan	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R
	I150 – Circuit diagram		AP
	Z071 – Failure mode and effect analysis (FMEA)		AP
	Z252 – Test procedure at manufacturer		AP
	Z253 – Test procedure for quay and sea trial	See also [3] *Survey and test upon completion*.	AP
	Z161 – Operation manual	User operating manual for the control system shall be available during certification and trials. See also [1.5.10] and Pt.4 Ch.9. One copy shall be submitted to the approval centre.	FI, R
	Z162 – Installation manual	Shall be available during certification and trials. See also [1.5.9] and Pt.4 Ch.9.	FI, R
	Z163 – Maintenance manual	Shall be available during certification and trials. See also [1.5.10] and Pt.4 Ch.9.	FI, R
Position keeping consequence analysis facility	I020 – Control system functional description	Shall describe the functionality for the specific project with reference to the overall redundancy intent and the worst case failure design intent (as described in the DP design philosophy document (Z050)). See also [6.11].	AP
Independent joystick manual control system (If installed.)	I020 – Control system functional description		AP
	I030 – System block diagram (topology)		AP
	I040 – User interface documentation		AP
	I050 – Power supply arrangement		AP
	I070 – Instrument and equipment list		FI
	I080 – Data sheet with environmental specifications		AP
	I140 – Software quality plan	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R
	I150 – Circuit diagram		AP
	Z252 – Test procedure at manufacturer		AP
	Z253 – Test procedure for quay and sea trial	See also [3] *Survey and test upon completion.*	AP

Object	*Documentation type*	*Additional description*	*Info*
	Z161 – Operation manual	User operating manual for the control system. Shall be available during certification and trials. See also [1.5.10] and Pt.4 Ch.9. One copy shall be submitted to the approval centre.	FI, R
Thruster control mode selection system	I020 – Control system functional description		AP
	I030 – System block diagram (topology)		AP
	I040 – User interface documentation		AP
	I050 – Power supply arrangement		AP
	I070 – Instrument and equipment list		FI
	I080 – Data sheet with environmental specifications		AP
	I140 – Software quality plan	Shall be available during certification and trials. See also Pt.4 Ch.9.	FI, R
	I150 – Circuit diagram		AP
	Z252 – Test procedure at manufacturer		AP
	Z253 – Test procedure for quay and sea trial	See also [3] *Survey and test upon completion*.	AP
	Z161 – Operation manual	User operating manual for the control system. Shall be available during certification and trials. See also [1.5.10] and Pt.4 Ch.9. One copy shall be submitted to the approval centre.	FI, R
Position reference systems	I040 – User interface documentation		AP
	I050 – Power supply arrangement		AP
	I070 – Instrument and equipment list		FI
	I080 – Data sheet with environmental specifications		AP
	Z253 – Test procedure for quay and sea trial	See also [3] *Survey and Test upon Completion*.	AP
	Z161 – Operation manual	User operating manual for the control system. Shall be available during certification and trials. See also [1.5.10] and Pt.4 Ch.9. One copy shall be submitted to the approval centre.	FI, R

Object	Documentation type	Additional description	Info
Vertical reference systems Heading measurement systems Environmental monitoring systems [1)]	I040 – User interface documentation		AP
	I050 – Power supply arrangement		AP
	I070 – Instrument and equipment list		FI
	I080 – Data sheet with environmental specifications		AP
	Z253 – Test procedure for quay and sea trial	See also [3] *Survey and test upon completion*.	AP
Main electric power control and monitoring system	Z071 – Failure mode and effect analysis (FMEA)	Power management system.	AP
AP = For approval; FI = For information; L = Local handling; R = On request			
1)Environmental monitoring systems comprises sensors for measurements of for wind and other sensors connected to DP-control, joystick and manual control systems.			

1.5.4 For general requirements to documentation, including definition of the info codes, see DNVGL-CG-0550 Sec.6.

1.5.5 For a full definition of the documentation types, see DNVGL-CG-0550 Sec.5.

1.5.6 DP station keeping assessment

Calculation of the dynamic positioning (DP) station keeping capability shall be submitted in accordance with the standard: DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*, see [10]. The calculations and results shall be documented in form of a report as outlined in DNVGL-ST-0111.

1.5.7 Failure mode and effect analysis

a) Documentation of consequences of single failures in accordance with rule requirements is required in the form of a failure mode and effect analysis (FMEA).
b) The purpose of the FMEA is to give a description of the different failure modes of the equipment when referred to its functional task. Special attention shall be paid to the analysis of systems that may enter a number of failure modes and thus induce a number of different effects on the dynamic positioning system performance. The FMEA shall include at least the information specified in items c) through j) below.
c) The FMEA shall identify the vessel and provide general vessel information and specify the overall acceptance criteria, i.e. class notation(s).
d) The FMEA shall clearly describe the redundancy groups, design intent(s), worst case failure design intent(s), and minimum time requirement(s). All technical system configuration(s) intended for DP operation(s) shall be described and prerequisites for achieving the required failure tolerance and redundancy shall be included. A collected list of the considered prerequisites shall be presented.
e) A breakdown of the dynamic positioning system, into functional blocks shall be made. The functions of each block shall be described. The breakdown shall be performed to such a level of detail that the functional interfaces between the functional blocks are shown.
f) A description of each physically and functionally independent item and the associated failure modes with their failure causes related to normal operational modes of the item shall be furnished.

g) A description of the effects of each failure mode alone, on other items within the system and on the overall dynamic positioning system shall be made. This shall include a closed bus-tie analysis.

Guidance note:

Description of FMEA systematic may be found in document DNV-RP-D102 *Failure mode and effect analysis (FMEA) of redundant systems*, IEC Publication 60812 and IMO HSC Code, Annex 4.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

h) When separation is required, the FMEA shall state the separation design intent and give descriptions of the installation of redundant component groups in fire and flooding protected compartments and zones. The method of separating the different zones shall be identified. The design shall be analysed and the analysis shall conclude on the whether the separation design intent is met. The minimum time requirement(s) shall also be considered when relevant. This includes all relevant systems and components, like e.g. machinery and piping, ventilation systems, electrical systems and control systems, cables and communication lines with associated equipment.

i) A redundancy and failure mode test program specifying tests to verify assumptions and conclusions shall be developed.

j) The FMEA shall summarise and conclude as a minimum the following:

— for each subsystem analysed, the conclusions shall be stated
— for the total system, an overall summary covering the main findings from the most critical subsystems
— a compliance statement referring to the acceptance criterion, and when applicable to the minimum time requirement(s), shall be stated for the FMEA.

k) After FMEA testing is performed the FMEA(s) shall be updated to reflect the actual design and the actual test results. This updating shall as a minimum include correction of mistakes, modifications done to the DP system as a consequence of findings during testing and the actual test results, findings and conclusions. The updated FMEA(s) and FMEA test program(s) shall be compiled in a FMEA report and submitted to DNV GL for information.

l) The updated FMEA(s) and FMEA test program(s) shall be kept on board. The FMEA(s) and FMEA test program(s) shall at all times be updated to cover alterations to the DP system hardware or software.

Guidance note:

This is not to be understood as a requirement for an FMEA for the software. However the FMEA (or other relevant documentation) should include identification of the software version(s) installed, and documentation giving this information should be updated when new versions are installed.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.5.8 Test procedure for quay or sea trial (FMEA test program)

a) A test plan for verification of conclusions in the FMEA shall be prepared and submitted. The test plan shall support verification of the analysis and conclusions made in the FMEA including: Redundancy design intention(s), worst case failure design intention(s), single failure tolerance within the given time requirement and acceptance criteria, barriers and other compensating measures, independency and septation requirements when required. See also Sec.1 [3].

b) The test program shall have an introduction which as a minimum shall include: Reference to the specific FMEA document (title, version and date) and specification of (or reference to) all specified system operational modes and technical system configurations that shall be verified by testing.

c) Each test shall as a minimum contain: Test identification (e.g. test number), test prerequisites and test setup for the specific test, test method and actions to be performed, expected results and acceptance criteria (including time requirements when relevant) and space/functionality for documenting actual observations, test results, and conclusions. In order to facilitate the practical testing, description of the test method should preferably include detailed locations where the physical and practical actions should be carried out. Preferably also the test intention(s) and reference to the specific part in the FMEA to be verified should be included.

d) When separation is required, a set of separation tests shall be prepared and documented. These can be supported by other verification activities such as documentation of installation procedures and inspections, in order to support the conclusions of the separation analysis.
e) After FMEA testing is performed the FMEA test program(s) shall be updated to reflect the actual design and the actual test results. This updating shall as a minimum include correction of mistakes, modifications done to the DP system as a consequence of findings during testing and the actual test results, findings and conclusions. The updated FMEA(s) and FMEA test program(s) shall be compiled in a FMEA report and submitted to DNV GL for information.
f) The updated FMEA(s) and FMEA test program(s) shall be kept on board. The FMEA(s) and FMEA test program(s) shall at all times be updated to cover alterations to the DP system hardware or software.

1.5.9 Computer simulations

Dynamic computer simulations of the power system in normal operation and during all relevant failure conditions shall also be used for documenting the required failure response. Simulations shall be detailed enough in order to allow for documentation of transient conditions, e.g. failure modes like voltage dip ride through as a consequence of a short circuit, synchronising faults, etc.

1.5.10 Operating manuals for control systems

a) User operating manuals according to Table 4 shall be kept on board. The manuals shall include information on the specified systems, their installation and structure as well as operation and maintenance.

Guidance note:

These manuals cover the technical systems. Manuals for DP operations are not normally included and may be produced separately, in accordance with operational requirements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

b) User operation manuals shall at least cover the following:

— definitions of symbols and nomenclature
— functional description
— operating instructions, normal conditions
— operating instructions, failure conditions
— man and machine communication systems
— back-up systems
— monitoring
— maintenance and periodical performance test
— fault-finding procedures.

Functional description

— different functions including back-up, change-over and stand-by start functions shall be explained in detail.

Operating instructions

— description of the normal operation of the equipment, including adjustments and change of limit values, possible modes of presentation, starting and stopping systems
— description of operation of the DP system in different operational modes
— description of transition from one operational mode to another.

Fault-finding procedures

— description of fault symptoms with explanation and recommended corrective actions
— instructions for tracing faults back to functional blocks or systems.

1.6 Certification requirements

Products in the DP system shall be certified as required in Table 5. All objects are independent products and the certificates can hence be issued independently or as combined certificates if delivered by the same manufacturer:

Table 5 Certification required

Object	*Certificate type*	*Issued by*	*Certification standard**	*Additional description*
Dynamic positioning automatic control systems, main Dynamic positioning automatic control systems, alternative	PC	Society		
Independent joystick control system with auto heading	PC	Society		
Propulsion and steering control systems Manoeuvring thruster control systems	PC	Society		Control and monitoring systems for all thrust producing units and steering arrangements that are part of the dynamic positioning system.
Thruster control mode selection system	PC	Society		When specifically required as part of the approval process. Thruster control mode selection systems may be exempted from certification when type approved.
*Unless otherwise specified the certification standard is the rules.				

For a definition of the certificate types, see DNVGL-CG-0550 Sec.3.

Guidance note:

Additionally, components and systems should be certified according to main class requirements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2 Upgrades and class entries

2.1

For class entries and upgrades to **DYNPOS** enhanced reliability notations verification towards the relevant class notation shall be based on documentation review, performance testing and FMEA failure testing as described in [3]. The test shall be performed according to approved test programs.

2.2

Documentation is required as basis for the documentation review as specified in Table 3 and Table 4.

2.3

Vessels to be assigned the qualifier **A** shall have a valid FMEA, with a corresponding FMEA test program.

2.4

Any deviations from requirements relevant for the class entry found as a result from the documentation review and testing required in [2.1] shall be rectified before the vessel can be assigned the relevant **DYNPOS** enhanced reliability notation.

3 Survey and test upon completion

3.1 General

3.1.1 Upon completion, the dynamic positioning system shall be subjected to final tests according to approved test programs. Functional, redundancy and failure response testing of the DP system shall be performed at sea trials. The program shall contain test procedures and acceptance criteria. Prior to the DP system tests, all systems and equipment included in the DP system shall be successfully commissioned and tested.

Guidance note 1:

The systems that should be tested prior to DP system tests should at least include:

— load test according to main class
— power management system(s)
— communication systems
— thruster control and transfer of thruster control
— main alarm system as for main class and **E0** (if applicable)
— switchboard control and protection
— emergency stops
— safety, control and automation system for power generation, thrusters, steering and propulsion, including their auxiliaries
— other systems as applicable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Ch.11 Sec.2 describes methods for flexible and efficient data driven verification of systems, including DP systems. Initial survey of the DP system on vessels with the optional class notation **DDV** for in-service verification of the DP system will be based on traditional, witnessed verification methods.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.1.2 When deemed necessary by the attending surveyor, tests additional to those specified by the test program may be required.

3.2 Measuring system

All DP-control system sensors, peripheral equipment, and position reference systems shall be tested as part of the complete DP system. Failures of DP-control system sensors and position reference systems shall be simulated to check the alarm system and the switching function.

3.3 Thrusters

The following shall be tested:

— functional tests of control and alarm systems of each thruster
— check all signals exchanged between each thruster and the DP-control systems, including thruster ready signals

— manual override of thruster control
— transfer of thruster control (mode selection)
— function test and loop monitoring alarms for emergency stop
— failure in thruster command/feedback signals
— check different control modes
— any possible change-over arrangements
— thruster emergency stop function.

3.4 Thruster mode selection

The following shall be tested:

— functional tests
— alarms (if applicable)
— failure simulation.

3.5 UPS power supply

The following shall be tested:

— capacity of the UPS batteries
— alarms.

3.6 Complete DP system test

3.6.1 The complete DP system shall be tested in all operational modes, with simulation of different failure conditions, in order to try out e.g. switching modes, back-up systems, fail to safe response (e.g. thruster control system I/O) and alarm systems.

Guidance note:

Different operational modes apply to the DP-control system, the power system, thruster systems, etc.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.6.2 Change of command between the automatic DP-control systems, independent joystick system (if installed) and the individual thruster lever systems shall be demonstrated.

3.6.3 Position and heading keeping function shall be demonstrated on all possible combinations of position reference systems (PRS), and on each PRS as a single system. Position change function shall be demonstrated on each PRS as a single system. Selecting and de-selecting of PRS shall also be tested.

3.6.4 During sea trials the offset inputs for each position reference system and relevant sensors in the dynamic position control system shall be verified and demonstrated to the attending surveyor by setting out the offsets on drawings. It shall be verified that these fit with the actual placing of the equipment.

3.6.5 Manual override, as required by [6.5] and [7.3.3] shall be demonstrated during normal operation and failure conditions.

3.6.6 A duration test shall be carried out for at least 8 hours with the complete automatic system in operation. All failures shall be recorded and analysed.

Guidance note:

The time spent on DP operational tests may be deducted from the time required for the duration test.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.6.7 A high seas trial shall be required with full system operation for at least 2 hours. The weather conditions shall be such that an average load level on the thrusters of 50% or more is achieved.

Guidance note:

The test described in [3.6.7] is dependent on weather conditions and may be omitted if satisfactory results were obtained from the test described in [3.6.6]. Typically this will be required for DP-control systems of novel design.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.6.8 For rudder steering gears included under DP control a test shall be carried out verifying that maximum design temperature of actuator and all other steering gear components is not exceeded when the rudder is continuously put over from border to border within the limits set by the DP-control system, until temperature is stabilized.

Guidance note:

The test should be carried out with the propeller(s) running with an average propulsion thrust of not less than 50%, unless the control system ensures that rudder operation is performed at zero propulsion thrust only, upon which the test may be carried out without the propeller(s) running. Number of steering gear pumps connected and rotation speed should be the maximum allowed during DP operation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.6.9 If an independent joystick system is installed then all functions in it shall be tested.

3.7 Redundancy and failure response tests

3.7.1 A selection of tests within each system analysed in the FMEA shall be carried out. Specific conclusions of the FMEA for the different systems shall be verified by tests when redundancy, fail safe response, separation, or independence is required. The tests shall include test to verify proper functionality of the power management system (PMS) generator protection system (GP), detection systems to prevent hidden failures, back-up protection functions, stand-by start and change-over functionality and other systems that might affect the integrity of the DP system. The test selection shall cover all specified technical system configurations.

Guidance note:

For **DYNPOS(ER)** this implies that loss of all systems in relevant fire zones or within watertight compartments should be tested. This will imply that all equipment and systems in the most relevant spaces are shut down simultaneously, one space at a time, to demonstrate that the separation requirements are met. Typically the following spaces should be tested: DP control centre(s) (normally the bridge, note that operator stations for both the main and alternative DP control system will normally be located in the same space), engine control rooms, engine rooms, switchboard rooms, and instrument rooms.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.7.2 The test procedure for redundancy shall be based on the simulation of failures and shall be performed under as realistic conditions as practicable.

3.7.3 When redundancy is based upon change-over and/or stand-by start, then the functionality and availability of these mechanisms after failure shall be demonstrated at sea-trials.

4 General arrangement

4.1 General requirements

4.1.1 The general requirements for DP system design are presented in Table 6.

4.1.2 The design and level of redundancy employed in system arrangements shall be to the extent that the vessel maintains the ability to keep position after worst case failure(s).

Guidance note:

Table 6 gives general requirements only, detailed requirements are given in [6], [7], and [8].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2 Redundancy

4.2.1 The DP system shall be designed with redundancy. A position keeping ability shall be maintained without disruption upon any single failure.

4.2.2 The DP system shall in general be based on redundancy groups consisting of two or more equally sized generator sets, and with equal number of generator sets in each group. Other arrangements might be accepted on special request and will be subject to case-by-case evaluation.

4.2.3 The redundancy design intent(s) and worst case failure design intent(s) based on specified redundancy groups shall be stated, and in addition all the relevant technical system configuration(s) shall be specified. Only redundancy design intents that are verified by approval and testing can be incorporated in the consequence analysis required by [6.11].

Guidance note:

The redundancy groups will emerge as a consequence of the worst case single failure within each group. The rules does not give requirements to the number of (beyond 2) or ratio between the defined groups. The groups should be identified in the FMEA, verified by testing and incorporated in the consequence analysis.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4 Automatic start of equipment may be accepted as contributing to redundancy if their reliability and simplicity of operation is satisfactory so that they can be brought automatically into operation before position and heading keeping performance is degraded. Monitoring of availability of standby start functions shall be implemented for the most probable failures for the relevant system, e.g. power failure, wrong mode, loop failures, etc. Software based systems shall have self-diagnostics.

4.2.5 Full stop of thrusters and subsequent start-up of available thrusters will not be accepted as contributing to the redundancy. Dual power supply arrangements thrusters from different redundancy groups can be accepted as long as all the following conditions are met:

- The thruster is fully ready with specified power available for DP control without disruption or manual intervention. Available thrust output may be reduced to a specified level after failure of one supply.
- The availability of both supplies is monitored and communicated to the DP-control systems.
- The common thruster space is separated from the redundancy groups as required by the relevant notation(s).
- No failures in the system shall be able to propagate to both power systems supplying the thruster. In order to mitigate the effects of hidden failures, minimum two independent barriers, both capable of isolating upon failures, shall be arranged in each supply line. For **DYNPOS-ER** these barriers shall be outside of the common thruster space and the supply lines shall be separated by A0 partition.
- Any situation when available thrust is reduced due to any control system action is communicated to the DP-control systems.
- Start and any necessary reset after full stop of thruster is available in DP control centre.
- Auxiliary systems are autonomous for each thruster according to [9.1.6] and [9.3].
- Supply to auxiliary and control systems are autonomous and continuously available.
- Thruster failure or trip shall prevent automatic re-start.

4.2.6 Stand-by start or change-over of generators can be accepted to contribute to the redundancy as long as all the following conditions are met:

- Start and connection is automatic.
- Ready for stand-by start and/or ready for change-over signal is communicated to the DP-control systems.
- Single failure does not cause total black-out, full black-out and subsequent standby start is not accepted as bases for redundancy.
- Generator is connected fast enough in order to be able to maintain position and heading keeping ability as required by the operation. If no specific time can be documented the maximum allowed is 45 seconds after the need for more power appeared. Auxiliary systems is autonomous according to [9.1.6] and [9.3].
- Supply to generator and prime mover control systems are autonomous and continuously available.
- In case of any failure it is assumed that any one of the available stand-by generators may not start. This means that the power contribution from stand-by generators shall be based on the total number of available stand-by generators after failure minus one (n-1 principle). This includes also the stand-by generator giving the largest contribution to the position keeping ability. This shall be incorporated in the consequence analysis.

Guidance note 1:

For specific designs and specific technical system configurations failure of standby-generators to start upon request (n-1 principle) may not have to be considered consecutive to:

- an engine room fire (in another redundancy group)
- busbar-failures (in another redundancy group) in switch-boards with high integrity towards short-circuit
- failure of non-active components in sea-water systems which are not directly cooling generator and/or prime mover.

This will apply for systems with autonomous generating sets where only these limited number of failures modes will lead to loss of more than one generator. For generating sets to be considered autonomous, single failures in auxiliary systems shall only affect one generating set. This includes typically, but not limited to, the following auxiliary systems: Fresh water cooling, compressed air, exhaust systems, crank case ventilation, fuel systems, lubrication, starting air, power supply to these services, etc.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

It can be accepted that generator sets within the same redundancy group share auxiliary system, however this will reduce the number of stand-by generator sets that can be considered available by the consequence analysis. This implies that when a redundancy group (containing running and stand-by generator sets) become unavailable due to a single failure, then it should also be considered that any other stand-by generator set, or group of stand-by generator sets subject to a common mode failure, may not be available due to a hidden failure. This implies that the possibility to utilize stand-by generator sets as part of the redundancy will be significantly reduced compared with a system with fully autonomous generator sets. In the consequence analysis the n-1 principle has to consider the largest group of generator sets subject to a common mode failure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

Component and system redundancy, in technical design and physical arrangement, should be available with the capacity required for the DP system to safely terminate the work in progress. The consequence analysis required in [6.11] will give an indication whether the position and heading can be maintained after a single failure.

The transfer to components or systems designed and arranged to provide redundancy, shall be automatic and operator intervention should be avoided.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 4:

Switch-boards with high integrity towards short-circuits may be achieved by use of e.g. insulated bus-bars or SF_6 insulated systems.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.7 In case change over is arranged the arrangement shall be so that neither:

- a single failure in one redundancy group, nor
- a single failure in the change over arrangement it selves, nor
- a single failure in a common power or control system connection, nor
- a single failure in the system or component being changed over,

can cause failure of more than one redundancy group

4.2.8 Stand-by start shall also be arranged so that it will not cause failure of the redundancy group it is being connected to.

4.3 Failure modes

4.3.1 Loss of position shall not be allowed to occur in the event of a single failure. Single failure criteria include:

For **DYNPOS(E)**:

— any active component or system
— all static components
— a single inadvertent act of operation. If such an act is reasonably probable
— systematic failures or faults that can be hidden until a new fault appears
— common cause failures when found relevant
— automatic interventions caused by external events, when found relevant.

For **DYNPOS(ER)**:

— all single failure criteria as listed for **DYNPOS(E)**, and in addition:
— all components within any fire zone and/or watertight compartment as given in [4.5], (not on the bridge/ DP control centre).

Guidance note 1:

In order to reduce the probability of inadvertent acts, the following may be used:

— double action
— operation of two separate devices
— using screen based question pop-ups.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

In these rules the following are also considered active:

— coolers
— filters
— motorised valves
— fuel oil, fuel oil service tanks and appurtenant piping supplying the engine(s)
— electrical and electronic equipment (this includes all onboard equipment and systems, e.g. any safety shut-down systems (spurious shut down), vessel control systems, external force measurements, etc.)

when considering single failures of switchboards, the possibility of short-circuit of the bus-bars has to be considered.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

The **DYNPOS(E)** and **DYNPOS(ER)** notations aims for a very high reliability and integrity between redundant groups. In the FMEA special attention should be given to verification of integrity where common mode failures between redundant groups may exist. Examples of such systems may be, but are not limited to:

— operation with closed bus-tie breakers
— redundancy is based on change-over and/or stand-by start of thrusters and/or generators
— redundancy and/or separation is based on discrimination
— power management systems.

See DNV-RP-D102 *Failure Mode and Effect Analysis (FMEA) of Redundant Systems,* Appendix D, for discussion on the subject of operation with closed bus-tie breakers and examples of relevant failure modes.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.2 Based on the single failure definition, worst case failures shall be determined in the FMEA. The consequence of the identified worst case failure(s) in terms of reduction in position and heading keeping ability shall be used as the criterion for the consequence analysis described in [6.10] and [6.11].

Guidance note:

For detailed information and requirements to the consequence analysis function, see [6.10] and [6.11].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.3 In order to meet the single failure criteria, redundancy of components will be necessary for all components affecting station keeping and physical separation of these components as required in [4.5].

4.4 Independence

Independence shall take into account all technical functions. Use of shared components can be accepted only if specifically mentioned.

4.5 Separation for notation DYNPOS(ER)

4.5.1 Systems that form the designed redundancy requirement shall be separated by bulkheads and decks fire insulated by at least A-0 class division. In high fire risk areas A-60 class division is required between the redundancy groups.

Guidance note 1:

Definition of high fire risk areas: See SOLAS Chapter II-2 Reg. 3.31 Machinery spaces of category A, and MODU Code Chapter 1.3.34.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The term systems should be understood to also include components, cabling, and piping.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

Cables should be routed and equipment installed such that the risk of failure due to heat exposure of cables and equipment belonging to different redundancy groups is reduced in case of fire in one space.

Equipment and cables should generally not be mounted directly on bulkheads separating redundant groups nor should equipment or cables belonging to more than one group be mounted directly on bulkheads to a common adjacent space.

On open deck, cables in separate pipes that are separately routed may be accepted.

On open deck, separation of antennas, sensors and appurtenant cabling belonging to main and those belonging to the back-up DP control system should be arranged with due consideration to achieve the best practical separation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.5.2 It will be accepted that cables from separated power systems supplying the same component may enter a common space as long as discrimination is in place for both feeders so that the worst case failure design intent is not compromised. Non-separated slip-ring assemblies will generally not be accepted.

4.5.3 Systems that form the designed redundancy requirement shall be separated by watertight bulkheads if located below the bulk-head deck.

Guidance note:

For column stabilised units watertight separation will be required below the freeboard deck.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.5.4 Watertight separation shall also be provided in other areas where large quantity of liquids may occur as a consequence of leakage. This will e.g. apply to engine rooms. Identification and analysis of such failure modes shall be part of the DP FMEA.

Guidance note:

Special attention should be paid to areas where leakage of flammable liquids is possible.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.5.5 Watertight doors in A-60 insulated bulkheads need not to be insulated. See SOLAS Chapter. II-2 Reg. 9.4.2.4. In such cases the materials of the doors shall have melting points of not less than 950 °C and combustible materials shall be installed with a minimum distance of 450 mm from the door.

4.5.6 In the DP control centre separation with bulkheads is not required. Physical separation between main and alternative DP-control systems shall be provided by installation in separate cabinets and cables installed on separate cable trays.

4.5.7 The main controllers for the main DP-control system shall neither be located in the DP control centre nor in the same space as the main controller for the alternative DP-control system. The separation shall be bulkheads and decks of at least A-0 class. (Location of DP operator stations, see [4.5.8] and [5.2].)

Guidance note:

Cabinets installed on raised floor with openings down to a common cable space will be accepted in line with main class requirements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.5.8 Levers, operator stations, HMI and other such equipment necessary for the operator shall be installed in the DP control centre. Other parts of the DP system shall be installed in accordance with the requirement in [4.5.1].

Guidance note:

As an example this means that the thruster controllers and appurtenant cabling shall be distributed and separated in accordance with the redundancy groups as required in [4.5.1].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.6 Gas in non-hazardous areas

On vessels where gas release is a possible scenario, air intakes for combustion air shall be separate from other ventilation systems. The air intakes for separate engine rooms shall be separated as far as practicable. It shall be possible to operate machinery long enough to safely terminate the operation after shut down of machinery room ventilation.

Guidance note:

This requirement will typically apply to drilling and production units.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5 System arrangement

5.1 General

5.1.1 The requirements for system arrangement is summarised in Table 6. Specific requirements for each subsystem are presented under the respective section headings.

Table 6 System arrangement

Subsystem or component		*Fundamentals for class notations*	
Power system	Generators and prime movers	Redundant in technical design. Additional for **DYNPOS(ER)**: Physical separation. A-60 between machinery spaces of category A. Watertight below bulkhead deck.	
	Auxiliaries	Autonomous systems within each redundancy group.	
	Main switchboard	Minimum 2 switchboards. Additional for **DYNPOS(ER)**: A-0 between redundant switchboards. Watertight below bulkhead deck.	
	Bus-tie breaker	2, 1 in each switchboard.	
	Distribution system and thruster groups	Redundant in technical design. Additional for **DYNPOS(ER)**: Physically separated with A-0 division. Watertight below bulkhead deck.	
	Power management	Yes.	
Thrusters	Arrangement	Redundant. Additional for **DYNPOS(ER)**: A-0 and water tight separation.	
	Auxiliaries	Autonomous systems within each thruster group.	
Manual thruster control	Individual control levers for each thruster	Yes.	
DP control		Main DP Control system*)	Alternative DP Control system
Controllers and -operator stations	Automatic control - number of computers (see also [4.5.7])	2	1
	Automatic control - Number of operator stations (see also [5.2.2])	2	1
Position reference systems and sensors	Position reference system	3	1*)
	External wind sensors	3	1*)
	Vertical reference sensor (VRS)	3	1*)
	Heading reference sensor***)	3	1*)
	Electronic data logger	1**)	**)

Subsystem or component		*Fundamentals for class notations*	
Power supply	Uninterruptible power supply (UPS) for DP-control systems	2	1

*)The main DP-control system shall be able to read also the sensors belonging to the alternative DP Control system.

**)The data logger for the main DP-control system shall also log the alternative DP-control system, alternatively two logger systems will be accepted.

***)The heading reference system(s) shall comply with IMO Res. A424(XI) performance standards for gyro-compasses. One of the three required heading reference systems may be replaced by a heading measuring device based upon another principle, as long as this heading device is type approved as a THD (Transmitting Heading Device) as specified in IMO Res. MSC.116 (73).

Heading sensors based on other principles may be accepted upon special considerations. When such considerations are made the total heading device installation shall be considered in view of redundancy, robustness and failure tolerance both with respect to the number of heading devices installed, principles used, and the installation of the equipment with respect to signal transmission, power supply and physical installation (including separation when required).

5.2 DP control centre

5.2.1 The DP vessel shall have its DP control centre designated for DP operations, where at least the required indicators, displays, alarm panels, control panels and internal communication systems are installed. This equipment shall be arranged with easy access for the operator so that he does not need to change position when operating the control systems.

5.2.2 The operator stations for the main DP-control system shall be located in the DP control centre. The operator station for the alternative DP-control system shall be in the same space.

Guidance note 1:

Changing orientation may be accepted provided that the operator's view of the operating area will not change significantly. This implies that the operator should not be forced to turn his back to the operating area when changing between main DP-control system and manual thrusters' levers. The operator station for the alternative DP-control system and any possible independent joystick system may be installed with different orientation.

Manual levers and the independent joystick should be easily accessible from the DP operator work station. Thruster emergency stops and mode change system should be within reach from both manual lever operator stations and DP operator stations.

When the systems/equipment are accepted split between more than one work station at the DP control centre (e.g. a manoeuvring and a ship handling station), the required main automatic, alternative automatic and manual lever control modes shall be available at the work station(s) being designated for the DP operator.

In general all required VDU should be readable from DP and manual lever operator stations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The DP control centre may be a dedicated part of the navigation bridge. System components which do not require frequent or immediate operator attention may be installed in alternate locations.

Systems that are normally required to be located at the DP control centre includes: Main DP control operator stations, required position reference systems HMI, manual thruster levers, mode change systems, thruster emergency stops, internal communications.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.3 The location of the DP control centre shall be chosen to suit the main activity of the vessel.

5.2.4 The DP control centre shall be arranged such that the DP operator has a good view of the vessel's exterior limits and the surrounding area.

Guidance note:

If physical arrangements make it difficult to get direct view to all required areas from one location, camera systems may be used to compensate for lack of direct view to some areas. At least one monitor should be located at and controlled from the DP control centre.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3 Arrangement and layout of control panels

5.3.1 The information sources like displays, indicators, etc., shall provide information in a readily usable form.

5.3.2 The operator shall be provided with immediate information of the effect of any actions, preferably with graphics.

5.3.3 Where applicable, feedback signals shall be displayed, not only the initial command.

5.3.4 Easy switch-over between operational modes shall be provided. Active mode shall be positively indicated.

5.3.5 Positive indications of the operational status of the different systems shall be given.

5.3.6 Indicators and controls shall be arranged in logical groups, and shall be co-ordinated with the geometry of the vessel, when this is relevant. Upon special consideration it may also be accepted to arrange indicators and controls relative to other coordinates, e.g. earth axis.

5.3.7 If control of a sub-system can be carried out from alternate control stations, positive indication of the station in charge shall be provided. Responsibility transferred from one station to another shall be indicated.

Guidance note:

For control transfer arrangements, see Pt.4 Ch.9 Sec.3.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.8 Precautions shall be taken to avoid inadvertent operation of controls if this may result in a critical situation. Such precautions may be proper location of handles etc, recessed or covered switches, or logical requirements for operations.

5.3.9 Interlocks shall be arranged, if erroneous sequence of operation may lead to a critical situation or damage of equipment.

5.3.10 Controls and indicators placed on the navigation bridge and the DP control centre shall be sufficiently illuminated to permit use at night and be provided with dimming facilities.

5.4 Arrangement and layout of data communication links

5.4.1 When the main DP-control system uses a data communication link, this link shall neither be common with the communication link(s) for manual control nor the communication link(s) for alternative DP-control system.

5.4.2 The communication link for the main DP-control system shall be arranged with redundancy in the technical design and physical separation as specified in [4.5].

5.4.3 When two or more thrusters and their manual controls are using the same data communication link, this link shall be arranged with redundancy in technical design and physical separation as required for the communication link for the main DP-control system.

5.4.4 The alternative DP-control system may share a redundant communication link with the manual thruster control and/or indication, but not with the main DP-control system.

5.4.5 When units (e.g. thruster controllers) are interfaced to data communication links which are required to be independent, the interfacing to each of these networks shall be separately arranged in such a way that common mode failures (e.g. network storm) affecting both communication links are eliminated. This includes both HW and SW failures in all the connected units, the interface and the communication links.

5.5 Arrangement and layout of emergency stop systems

5.5.1 Emergency stop systems shall not violate the redundancy design intent. Single failures shall not lead to stop of DP related equipment beyond the specified redundancy groups.

5.5.2 Systems for activation of emergency stop of DP related equipment shall be so arranged that it is possible to activate emergency stop of equipment belonging to different redundancy groups separately.

Guidance note:

For requirement to emergency stop of thrusters, see [7].

For general requirements to emergency stop, see Pt.4 Ch.8 Sec.2.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.3 For **DYNPOS(ER)**: When systems for emergency stop are placed in a different fire zone than the system it controls or systems for emergency stop of equipment belonging to more than one zone is placed in the same fire zone, these systems shall be arranged with sufficient fire and flooding integrity in order to prevent unintended activation.

Guidance note:

Systems for emergency stop of equipment belonging to more than one redundancy group will typically be placed in the same space, e.g. thruster emergency stop on the bridge or emergency stops for auxiliary pumps located in an engine control room. When this is the case protection against unintended activation due to fire or flooding should be implemented. This includes failures of equipment and cabling including the activation buttons. The required integrity may for example be achieved by use of a combination of loop monitoring and thermal fuses which will introduce a loop failure before the activation buttons can short circuit and cause unintended stop. The thermal fuses should then be placed in close proximity to the respective activation buttons and be a part of the loop that is covered by the loop monitoring.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.6 Internal communication

For internal communication requirements, see Sec.1 [5.7].

6 Control systems

6.1 General requirements

The operational status of thrusters, sensors and reference systems used in DP operations shall be clearly indicated. The following information shall typically be presented:

— running
— available for DP
— in DP operation.

6.2 Automatic control systems

6.2.1 Unless otherwise specified, all requirements in this section apply both to the main and to the alternative DP-control system.

6.2.2 The positioning control systems shall perform self-check routines. An alarm shall be initiated in case of failure.

6.2.3 Automatic control mode shall include control of position and heading. Set points for control of position and heading shall be independently selectable. It shall be possible to individually enter new position and heading set points in automatic control mode.

Guidance note:

The rules does not give any specific acceptance criteria for positioning performance. However, in moderate weather conditions and with a fully operational DP system the vessel should generally be able to demonstrate position keeping accuracy with a 3 meter radius and ±1° of heading.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.4 It shall be possible to control the thrusters manually by a common joystick at all DP operator stations. The joystick mode shall include selectable automatic and manual heading control.

6.2.5 It shall be possible to select any combination of manual (joystick and/or heading wheel) and automatic control of surge, sway and yaw.

6.2.6 When stopped, either by automatic or manual means the positioning control system shall set the thrust commands to zero.

6.2.7 Loss of one or multiple position reference system input and/or one or multiple sensor inputs shall not lead to significant change in thrust output.

Guidance note:

This includes the situation when DP-control system loses the last available position reference system input or sensor input. Position or heading drive off is not accepted after such failures.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.8 Upon recovery of position and heading reference input the DP-control system shall not automatically apply the last position or heading set point (set points before loss of input) when this is significantly different from the actual vessel position and/or heading. If any other set point than the actual vessel position and/or heading is applied then it shall be operator chosen.

6.2.9 When combining position reference systems and/or sensors in one unit were more than one function or system can be lost upon one common failure, the consequence to the total system upon such a failure shall be evaluated in order to ensure that the redundancy, independency and separation requirements for the given notation(s) are complied with. See Table 6.

Guidance note:

Unit should be understood as one piece of equipment (or one system) for each sensor and position reference system as required in Table 6. The rule is applicable when equipment/systems serving more than one such function are part of the DP system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.10 When more than two position reference systems and/or sensors are inputs are used by the DP-control system then voting mechanisms shall be utilised in order to: identify incorrect input, take correct action upon the failure in order to minimize the consequence of failure and alarm the operator.

6.3 Main DP-control system

6.3.1 The main DP-control system shall be arranged with redundancy such that, after the occurrence of any single failure within the DP-control system, command output to a defined group of thrusters able to control position and heading of the vessel, can still be produced without disruption. Changeover between redundant controllers shall be automatic and bump less.

6.3.2 One of the controllers in the main system shall be selected as the online controller. This selection shall be possible by manual means and by automatic action upon failure of the online controller. The other controller(s) shall be ready for automatic or manual change over. Alternatively, 3 or more controllers can be arranged in an automatic majority voting system. The voting mechanism shall not jeopardize the redundancy requirements. It shall not be possible to automatically or manually select a controller which is not ready to assume command as the active controller.

6.3.3 Self-monitoring and comparison between controllers shall be arranged so that alarm is released upon detection of an unexpected difference in thrust command or position or heading. This shall not jeopardise the independence of each system or risk common mode failures.

6.3.4 The automatic transfer of online responsibility shall not cause thrust changes of such magnitude that it will be detrimental to the positioning of the vessel.

6.3.5 All required positioning reference system and sensors connected to the alternative DP-control system shall also be available to the main DP-control system.

6.4 Alternative DP-control system

6.4.1 The alternative DP-control system shall be able to operate independently of the main system.

6.4.2 There shall be at least one positioning reference system and one set of sensors connected to the alternative DP-control system.

Guidance note:

This system should have high availability and be easily available, typically DGPS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.4.3 The alternative DP-control system shall at all times be ready to assume command, and maintain the position from the moment of assuming command.

6.4.4 The alternative DP-control system shall perform self check routines and communicate its status to the main DP-control system. An alarm shall be initiated in the main DP-control system if the alternative DP-control system fails or is not ready to take control.

6.5 Thruster control mode selection

6.5.1 The thruster control mode, i.e. manual, main DP and alternative DP, shall be selectable at the DP control centre. The control mode selector system shall be intuitive and simple to operate. It shall only be possible to select one automatic system at a time. Combined automatic and manual control of individual thrusters is acceptable.

Guidance note:

For vessels with nautical notations, see Sec.3, Sec.4 and Sec.5.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.2 The control mode selector shall be arranged so that it is always possible to select manual controls after any single failure in the automatic DP control mode or in the independent joystick control mode (if installed).

6.5.3 The mode selector shall not violate redundancy or independency requirements.

Guidance note:

A common switch will be accepted, but each system should be electrically independent.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.4 The main and alternative DP-control systems shall be capable of being activated by the operator. The nature of the switching shall be such that no single failure will render the alternative DP-control system inoperable together with the main system.

6.6 Positioning reference system

6.6.1 At least four position reference systems are required. These shall be based on at least two different principles and maximum two of the required systems shall be based on the same principle.

Guidance note:

This should be understood so that four separate systems based on two different principles will be accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.2 In order for two satellite based systems to be considered as separate units it shall be possible to set them up with different differential correction signals.

6.6.3 When more than one satellite based system is installed, at least one system shall be able to utilise a different satellite system than the others, e.g. one DGPS system is also able to utilise GLONASS, and in addition at least one shall be a dual frequency receiver.

6.6.4 Position reference systems can be utilised by both the main and alternative DP-control system provided that the independence requirements between the main and alternative DP-control systems is not compromised.

6.6.5 Position reference systems shall be independent with respect to signal transmission, and shall be interfaced to the DP-control systems in accordance with the overall redundancy requirement. Systems shall be distributed between the redundant groups, and so arranged that systems based on the same principle are distributed between the redundant groups.

6.6.6 Power supply to the position reference systems shall be from UPS. Arrangement of power supply shall be in accordance with the overall redundancy requirement.

Guidance note 1:

Power supplies should be equally distributed between the UPSs, and so arranged that power supply to systems based on the same principle are equally distributed between the UPSs.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Power supply to units providing correction signal to DGPSs shall follow the same redundant distribution principle.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

The requirement for UPS supply for position reference systems is not applicable for parts of the systems which are not actively in use during positioning. E.g. Hydro acoustic positioning reference system transducer hoist system or taut wire derrick control systems. For taut wire systems, the heave compensation system need not be powered by UPS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.7 Positioning reference systems shall comply with the relevant main class rules for electrical, mechanical, and hydraulic components and subsystems.

6.6.8 Monitoring of positioning reference systems shall include alarms for electrical and mechanical functions, i.e. power, pressure, temperature as relevant.

6.6.9 Positioning reference systems shall provide new position data with a refresh rate and accuracy suitable for the intended DP operations.

Guidance note 1:

Systems that only produce new position data with long intervals relative to the response time of DP vessels, will not be considered as positioning reference systems, as required in Table 6 and [6.6.1], unless it can be demonstrated that the performance is adequate in all operational modes and operational weather conditions.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The accuracy of the position reference data shall generally be within:

— a radius of 2% of water depth for bottom-based systems,

— a radius of 3 m for surface-based systems.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

For satellite based systems, interface and necessary equipment for receiving differential correction signals shall be installed.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.10 It shall be simple for the operator to establish the operational status of all position reference systems at any time. Which systems that is in operation, with data accepted or discarded, shall be clearly identified.

6.6.11 When data from several position references are combined into a mean positioning, by filtering techniques, the reference position of each shall, be available at the operator's request.

6.6.12 When several systems are combined to provide a mean reference, the mean value used shall not change abruptly by one system being selected or deselected.

6.6.13 Failures in a positioning reference system that might give degraded quality, loss of position signal or loss of redundancy shall initiate an alarm.

6.6.14 Limit alarms shall be provided for systems, which have defined range limits.

6.6.15 If a positioning reference system can freeze or otherwise produce corrupt data output, a method shall be provided to enable rejection of the data.

6.6.16 The DP control centre is the main control station for position reference systems. All position reference systems connected to the main DP-control system shall have HMI independent of the DP-control systems.

Guidance note:

Exemption may be given to systems in excess of the minimum requirements if no separate HMI is available in the market.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.17 At least one position reference system connected to alternative DP controller shall have HMI independent of the DP-control systems.

6.7 Sensors

6.7.1 Sensors for the same service shall be independent with respect to power, signal transmission, and interfaces.

6.7.2 Power supply to the sensors shall be from UPS. Arrangement of power supply shall be in accordance with the overall redundancy requirement, i.e. sensors for the same service shall be from three different UPSs.

6.7.3 Sensors can be utilised by both the main and alternative DP-control system provided that the independence requirements between the main and alternative DP-control systems is not compromised.

6.7.4 For redundant sensors the possibility for common mode failures shall be minimised.

Guidance note:

Use of all of the same principle should as far as practical be avoided. Examples of sensors that should not all be based on the same principle is wind sensors and heading reference systems.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.5 Monitoring of sensors shall include alarms for electrical and mechanical functions, i.e. power, pressure, temperature as relevant.

6.7.6 When failure of a sensor is detected during a DP operation, an alarm shall be released even if the sensor is in standby at the time of failure.

Guidance note:

During DP operations, it is important that permanent failures of any sensor, whether it is being used or not at the time, is brought to the attention of the operator. Temporary trouble of an operational nature, e.g. disturbance of acoustic systems, out of range warnings, in standby sensors do not need to initiate an alarm.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.7 Sensors and/or reference systems may be shared with other systems provided failure in any of the other systems cannot spread to the DP system.

Guidance note:

Sensors and reference systems that are separated electrically are regarded as fulfilling the requirement in [6.7.4].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.8 The DP control centre is the main control station for sensors in the DP-control system which requires manual operation.

Guidance note:

Equipment and cables located outdoor should be installed with suitable physical distance in order to reduce the risk of common failure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8 Display and indication

6.8.1 The display unit shall present a position plot including the location of the vessel relative to the reference sources. The plot may be vessel relative, or a true motion presentation.

6.8.2 For positioning control systems, designed with redundancy, there shall be at least two DP-control system operator stations.

6.8.3 If the display is used for presentation of warnings or alarms, these shall have priority over other information and not be inhibited by other data currently being displayed.

6.8.4 As a minimum the following information shall be available to the operator on the main and alternative DP-control systems operator station(s):

Continuously available:

— actual or wanted position and heading
— deviation from set points as applicable: e.g. position and heading deviation from position and heading set point
— operator station in command
— latest unacknowledged alarm
— the presence of any active alarm shall be continuously indicated
— active mode
— thrusters and position reference systems in use
— running status of consequence analysis *).

On request (may be in separate or combined display views):

— vessel mimic with selected positioning reference point for the vessel
— vessel mimic showing thruster location and actual forces and direction for each thruster
— resultant thruster force, direction and turning moment
— thruster allocation mode
— thruster set point and feedback
— position plot including the location of the vessel relative to the reference sources. The plot may be vessel relative, or a true motion presentation
— power generation mimic including: Generators, main bus-bars, thrusters, breakers status, consumed and available power. For split-bus power arrangements, indications shall be provided for individual bus sections
— selectable trace line of position movement, minimum 30 minutes storage
— online capability plots; shall be able to indicate the online capability as well as drift off simulation and simulation of the most relevant failure modes, i.e. loss of redundancy groups*)
— alarm list
— possibility to trend the most important parameters*)
— status and value of all position reference systems and sensors, including weighting if implemented
— supporting mimics and indication required for safe operation in all functional modes implemented in the system
— system status, e.g. controller in command, network status
— system information; e.g. SW version.

*) Is not required to be available in the alternative DP-control system.

Guidance note:

Requirements for indication of thrusters are given in [7].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9 Monitoring

6.9.1 The DP control centre shall receive alarms and warnings reflecting the status of the DP system.

Guidance note:

The alarms from power and thruster systems may be group alarms for each prime mover, generator, or thruster, as generated by the general alarm system of the vessel.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.2 The alarms to be presented in the DP control centre shall normally be limited to functions relevant to DP operation.

6.9.3 An alarm shall be initiated when the vessel exceeds pre-set position and heading limits.

6.9.4 Any failure of an online or standby positioning control system, sensor or positioning reference system selected, shall initiate an alarm.

6.9.5 The following data shall be continuously recorded by a separate data logger:

— operational status of the main and alternative DP-control system
— all manual input to main and alternative DP-control system
— all automatic input and output to/from main and alternative DP-control system.

6.9.6 The data logger shall have capacity for storage of data for minimum 7 days of operation. The data shall be accessible for the operator. It shall be possible to upload to offline storage media, for data storage longer than the logger capacity.

Guidance note:

The data logger should preferably be time synchronised with other alarm and logging systems to support performance and incident analysis.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.10 Monitoring of batteries supplying power to DP thrusters

6.10.1 When batteries are used as source(s) of power according to the requirements in [8.3] the following information shall be provided by the DP-control system:

— remaining available energy in batteries based on state of charge, SOC and state of health, SOH. The indication shall be given in [%] of the batteries original fully charged capacity
— remaining time to discharge based on rate of discharge
— the calculated remaining time the vessel can hold position and heading after failure(s). This means that when position and heading keeping are dependent on energy supply from batteries after failure, the time assumed by the DP-control system online consequence analysis shall be indicated. The failure mode(s) causing need for the largest power contribution from the batteries after failure shall be considered. The calculations shall be based on connected batteries and the actual functionality of the power/energy management systems. Alternatively more conservative calculations may be accepted.

Guidance note:

For definition of and requirements related to SOC and SOH, see rules for ships Ch.2 Sec.1 Battery power.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.10.2 When batteries are suppling thrusters in DP mode the DP-control system shall give alarms based on available energy. It is accepted that several limits can be defined. These alarm levels may be operator set so that they can be adjusted according to the vessels operation(s), and for redundant notations also according to the corresponding minimum time requirement after failure. It shall not be possible to set the time limit below the lowest accepted minimum level. When the calculated remaining time is below 30 minutes, and in addition for notations requiring redundancy when the calculated remaining time after failure is below 30 minutes, this shall be continuously indicated at the DP operator station.

Guidance note 1:

The alarm levels should be so adjusted that it will provide sufficient time to safely terminate the ongoing operations. Any uncertainty in the accuracy of available energy should be accounted for by conservative adjustments of these alarm levels. In addition it should be carefully considered at which level of charge the battery should be considered to be discharged. It should also be considered if the termination process will result in additional energy consumption. In such a case this additional consumption needs be taken in to account.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

In case the vessel has more than one accepted minimum time requirement, the operator shall ensure that correct time limits, corresponding to the ongoing operations, are being used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.10.3 In case any power section is solely supplied by batteries then this shall be clearly and continuously indicated in the DP-control system HMI.

6.11 Consequence analysis

6.11.1 The dynamic positioning control systems shall perform an analysis of the ability to maintain position after worst case failures. An alarm shall be initiated, with a maximum delay of 5 minutes, when a failure will cause loss of position in the prevailing weather conditions. In case the redundancy is based on limited energy sources like e.g. batteries then the duration of the delay should be considered.

Guidance note:

This analysis should verify that the thrusters and generators remaining in operation after the worst case failure can generate the same resultant thruster force and moment as required before the failure.

The analysis should consider the average power and thrust consumption. Brief, dynamic effects should be removed by filtering techniques.

Systems for load shedding or tripping may be accepted as contributing to the available power after failure if verified to be reliable and fast enough.

For operations which will take a long time to terminate safely, the consequence analysis should include a function which simulates the thrust and power remaining after the worst case failure, based on manual input of weather trend.

Typically, the worst case failure will be loss of one complete switchboard, one engine room, or a group of thrusters that are subject to a common failure mode.

Limitations in available power and/or thrust for the relevant worst case single failure condition(s) should be taken in to consideration by the consequence analysis.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.11.2 The consequence analysis shall be repeated automatically at pre-set intervals. The operator shall be able to monitor that the analysis is in progress.

6.11.3 When limited energy sources like e.g. batteries, are supplying power to thrust producing units, it shall be possible to set the consequence analysis in a mode where the contribution from such sources are not considered.

6.11.4 If stand-by start is accepted as contributing to redundancy according to [4.2.6] this shall be included in the consequence analysis. This means that the consequence analysis can consider the contribution from stand-by generators available after failure as long as the conditions outlined in [4.2.6] are taken in to consideration. The number of stand-by generator sets to be considered available (n-1 principle) shall be according to the principles set out in [4.2.6] with explanatory guidance notes.

Guidance note:

Failure of all generator sets in one A-60 enclosed engine room space should always be considered. In case each generator set are fully autonomous the failure to start upon request (n-1 principle) of stand-by generator set belonging to other groups may not need to be considered simultaneously.

When generator sets have other common failure modes than listed in [4.2.6] guidance note the (n-1) principle will always apply and in such a way that (n-1) compromises the failure to start upon request for any one groups of stand-by generator sets with such a common mode failure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.11.5 The consequence analysis can consider the contribution from change over of thrusters after a failure as long as the conditions outlined in [4.2.5] are taken in to consideration.

6.11.6 When batteries are considered as a redundant source of power to DP thrusters, the consequence analysis alarm shall also be given when the available energy after failure is insufficient for operation according to a given time limit. This limit may be set by the operator, so that it can be adjusted according to the corresponding minimum time requirement for the operation, as determined in the FMEA, or a more conservative value if chosen. However, it shall not be possible to adjust this time below the lowest accepted minimum level. The calculations shall be based on the prevailing weather conditions and experienced operating pattern, e.g. mean net power consumption for the actual operation. The failure mode(s) causing need for the largest power contribution from the batteries after failure shall be considered.

Guidance note 1:

Any uncertainty in the accuracy of available energy should be accounted for by adjusting these alarm levels. In addition it should also be considered at which level of charge the battery should be considered to be empty. It should also be considered if the termination process will result in additional energy consumption. In such a case this additional consumption needs be taken in to account as well.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

In case the vessel has more than one accepted minimum time requirement, the operator shall ensure that correct time limits, corresponding to the ongoing operations, are being used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7 Thruster systems

7.1 General requirements

7.1.1 Thrusters shall comply with main class requirements.

7.1.2 The thrusters shall be designed as dynamic positioning thrusters or propulsion thrusters according to Pt.4 Ch.5. The thruster systems shall be designed for continuous operation.

Guidance note:

Generally no restrictions should be put on the starting intervals of electrical machines. If required, the arrangement is subject to approval in each case.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.1.3 When the main propulsion propellers are included under DP control, they shall be considered as thrusters, and all relevant requirements of these rules will apply. When rudders are not included under DP control a rudder out of zero alarm shall be given at the DP control centre in case the rudder is not in zero when the vessel is under control by the DP-control system.

Guidance note:

As for rudders, this principle applies as relevant to any other units supplying thrust in the DP system, e.g. water jets.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.1.4 When the main steering system is included under DP control, the steering gear shall be designed for continuous operation.

Guidance note:

For requirements for steering gear under DP control, see Pt.4 Ch.10.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2 Thruster configuration

7.2.1 The thruster configuration shall include redundant thrust units so that after any single failure relevant for the applicable notation; the remaining thrusters in operation together will simultaneously produce transverse and longitudinal thrust, and a yawing moment.

Guidance note 1:

See the definition of dynamic positioning vessel (DP vessel) in Table 2 with corresponding guidance note.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

The rules do not specify the number or size of thrusters to make up the configuration. The station holding capability resulting from a chosen configuration will be indicated by DP capability numbers as required in [10].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3 Thruster control

7.3.1 In the DP control centre, it shall be possible to manually control the thrusters individually by use of a separate lever for each thruster. This manual mode shall be a closed loop (follow up) control system. The manual control intended for normal DP manual control shall be independent of the DP-control system and include azimuth and thrust (e.g. pitch and/or rpm.) control, as relevant.

7.3.2 This manual control shall be independent of the main DP-control system and shall include the ability to start/stop the prime mover, azimuth and pitch or rpm. control.

Guidance note:

It may be accepted for two or more thrusters to use the same mechanical lever provided that after failure of any one lever, as a minimum, manual thruster control is available in accordance with the designed redundancy intent for the vessel.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.3 Manual thruster control shall be available at all times, also during all failure conditions in the main DP-control system.

Guidance note:

Manual thruster control should be understood as manual control of main propulsion, auxiliary thrusters and rudders.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.4 A single failure in the thruster control system shall neither cause significant increase in thrust output nor make the thruster rotate. The intention is that the thruster shall fail to safe so that the vessel does not lose heading or position.

Guidance note 1:

This also applies to rudders when the rudders are under DP control. See Pt.4 Ch.10 Sec.1 [5.5.4].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

It may be accepted that a thruster rotates, if at the same time the thrust output is set to zero.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5 It shall be possible to stop the thrusters individually from the main DP control centre by means independent of the positioning and thruster control systems. This emergency stop shall be arranged with separate cables for each thruster.

7.3.6 An alarm shall be initiated upon loop failure, i.e. both broken connections and short-circuit, in the emergency stop system. Such failures shall not cause stop of the thruster.

7.3.7 The emergency stop activation buttons shall be placed in a dedicated mimic representing the thruster location and which is consistent with the vessel axis and layout, or they may be arranged together with the corresponding thruster levers if these are arranged in accordance with the physical thruster layout.

Guidance note:

This implies that power take off (PTO)-step up gears for alternators powering other thrusters in the DP system, should be arranged on the primary side of the propulsion clutch, see Figure 1.

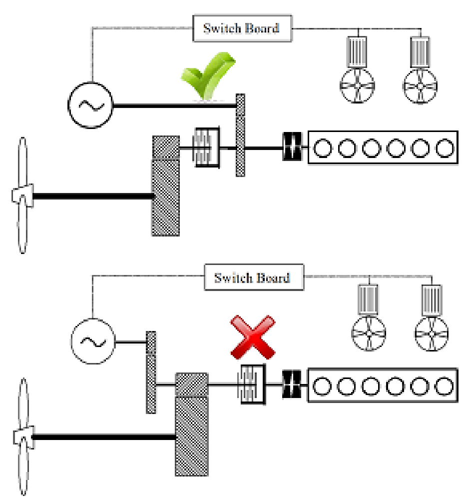

Figure 1 Acceptable and unacceptable clutch arrangement

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.4 Indication

7.4.1 For each thruster, running and stop, pitch and rpm. and azimuth shall be displayed at the DP control centre.

7.4.2 The displayed information of [7.4.1] shall be continuously visible at displays/indicators separate from the DP control and independent joystick control systems displays. At least, display of pitch, rpm. and azimuth (alternatively thrust and thrust direction), for each actuator, shall be readable from the normal position of the DP operator. Otherwise, slave displays/indicators shall be installed and be readable from the normal position of DP operator. The indication shall be arranged so that it will continue to present the real actuator values in case of any single I/O failure related to the follow up control. Hence, one single sensor can not be used for both indication and closed loop control. It can be accepted that indication is lost as a consequence of a failure as long as the follow up control is not affected.

7.4.3 For azimuth thruster used for steering, additional monitoring shall be arranged as required in Pt.4 Ch.10 Sec.1 Table 14.

7.4.4 Feedback to main and alternative DP-control systems shall not be common with the feedback used by the closed-loop thruster control system, unless voting is arranged in the closed-loop thruster control system.

8 Power systems

8.1 General

8.1.1 The power systems shall comply with the relevant rules for main class. Additional requirements will apply in regard to redundancy and with respect to maximum single failure. See [4] for the definition of a single failure.

8.1.2 The power system shall be divisible into two or more systems such that in the event of failure of one system at least one other system will remain in operation. The power system shall be prepared for being run both with open and closed bus-ties between power systems belonging to different redundancy groups. For operation with closed bus-ties, it shall be arranged with bus-tie breakers, to separate automatically upon failures which could be transferred from one system to another.

Guidance note 1:

In this context, failures are not limited to only overloading and short circuit, but should include all possible system and component failures. This means that for any system, all identified possible system and component failure should be analysed in the FMEA, and all failures should be concluded with an acceptable integrity level.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Note that these rules do not give guidance on the suitability of the different intended technical system configurations with respect to the vessels various industrial mission(s). Reference is made to the Society's recommended practice document: DNVGL-RP-E306 *Dynamic positioning vessel design philosophy guidelines*.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.1.3 When redundancy and/or separation are depending on discrimination (e.g. when a component or system has two or more power supplies originating from redundant systems) special attention shall be paid to the design in order to ensure that the discrimination is in place upon any relevant failure mode.

Guidance note:

Examples of typical failure modes are transient under voltages (e.g. as a result of a short circuit affecting both power supplies) or other common failures like e.g. voltage spikes.

Discrimination is important to maintain integrity between redundant groups when power supplies are entering the same fire zone. The physical installation should as far as possible limit the possibility for a failure to affect both systems.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.2 Number and capacity of generators

8.2.1 The number of generators shall comply with the redundancy requirements as defined in the single failure criteria in [4].

Guidance note:

These rules give no specific requirements with respect to the capacity.

Particular attention should be paid to starting conditions of thruster motors, especially with one generator out of service. Thrusters should have arrangements to prevent large start currents and voltage drop during the start sequence. The effect of voltage drop during starting periods may cause under-voltage trips of control circuits, and main class requirements should be observed. When starting thrusters on dedicated generators with no other loads connected which would be affected by voltage deviations, voltage drop in excess of the limits of the rules may be accepted.

The high reactive load demands, which may occur in DP thruster operation should be considered when selecting number and type of generators, further, the dynamic load variations for diesel engines should be taken into consideration.

Attention should also be paid to connection of large transformers where the inrush currents may make it difficult to maintain discrimination in the power distribution system. Large transformers should have pre-magnetising system or other equivalent arrangements to prevent large inrush currents.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.3 Batteries supplying power to DP thrusters

8.3.1 These requirements are applicable to DP systems where batteries are used as source of power to thrust producing units, hereafter named thrusters.

Guidance note:

Battery installations not used as a redundant source of power, but only used e.g. for peak shaving, handling of dynamic responses in the power system, etc., may not have to comply with these requirements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.3.2 Batteries can be accepted as source(s) of power for DP thrusters, but the DP system shall be designed such that the vessel also can fulfil the relevant dynamic positioning class notation(s) requirements without the batteries.

Guidance note:

The vessels DP position keeping capacity (both before and after failure, i.e. the redundancy design intention) may vary when batteries are connected or disconnected.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.3.3 The vessel shall comply with rules for ships Ch.2 Sec.1 Battery power and shall have the class notation **Battery(Power)**.

8.3.4 The battery with its battery management system (BMS) and energy management systems (EMS) shall be so arranged that the actual available energy can be determined and communicated to the DP-control system for indication and monitoring purposes. See [6.8].

8.3.5 Redundancy shall be based on connected batteries.

8.3.6 When batteries are used in combination with standby-start of generator sets, the battery power and energy shall in general be so that the DP system in all intended technical system configurations, immediately after failure of any combination of generators/batteries subject to a relevant single failure (i.e. before any standby-start), can produce minimum 1/3 of the power available before failure. The system shall, without considering contribution from standby start, be able to deliver this power level in a time period equal to the specified minimum time requirement.

Guidance note:

The 1/3 requirement is based on a standard system with 2 equally sized generator sets in each redundancy group, where a 2+1 mode will result in 1/3 available power in case of failure of the two generator sets belonging to the same group. Based on a case by case evaluation other system arrangements and battery sizes (power and/or energy) may be accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.4 Power management

8.4.1 An automatic power management system shall be arranged, operating with both open and closed bus-tie breakers. This system shall be redundant, and for **DYNPOS(ER)** in addition separated, so that the functionality is maintained after a failure or, alternatively, one failure will only affect one section of the power system in accordance with the redundancy design intent.

8.4.2 This system shall be capable of performing the following automatic functions:

— load dependent starting of additional generators
— block starting of large consumers when there is not adequate running generator capacity, and to start up generators as required, and hence to permit requested consumer start to proceed
— it shall be possible to set a minimum number of connected generator sets in each redundancy group
— black-out recovery on individual switch-board sections by starting of generators and recovery of full automatic thruster control from DP within 45 seconds after black-out. This means that the DP-control systems shall receive ready signal within 45 seconds.

8.4.3 A failure in the power management system shall not cause alteration to the power generation, and shall initiate an alarm in the DP control centre.

Guidance note:

Special attention should be paid to ensure redundant distribution of I/O signals so that effects of single failures in the PMS system will be in accordance with the overall redundancy requirements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.4.4 It shall be possible to operate the switchboards in manual as required for the main class, with the power management system disconnected.

8.4.5 Means shall be implemented in order to prevent overloading of the power plant, e.g. by use of interlocks, thrust limitations or other means. Means shall also be implemented to prevent reactive overload. In case trust is reduced by any other system than the DP-control system this shall be communicated to the DP-control system.

8.4.6 Overload, caused by the stopping of one or more generators subject to common mode failure, shall not create a black-out. Reduction in load, e.g. thruster pitch or speed reduction shall be introduced to prevent blackout and enable standby generators to come online.

Guidance note:

Load reductions should preferably be achieved through the tripping of unimportant consumers, and the requirement does not exempt such means. But, it is common that the relative load proportions will require thruster load reduction, in order to effectively reduce overload situations.

The functions for tripping and load reduction in various control systems should be co-ordinated, e.g. between power management system, DP-control system, thruster control system, drilling control system, etc.

During load recovery the voltage and frequency variations should be kept within acceptable limits. Maximum allowed variations is specified in Pt.4 Ch.8.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.4.7 When generators are running in parallel there shall be protection systems able to detect failures that may result in a full or partial black-out situation and effectuate actions to prevent such incidents. The effectuated actions shall be so that the consequence of the failure is minimized. This means that for failures where the system has sufficient time the faulty component shall be tripped before a full or partial black-out situation occurs. Such protection systems shall be independent from automatic voltage regulators (AVRs) and engine governors.

Guidance note:

These requirements will be in addition to main class requirements. Typically, but not limited to, this means that the protection system needs to have the following functionality:

— trip generators upon governor failure
— trip generators upon AVR failure.

Other examples of failure modes that need to be considered are:

— under voltage e.g. as a consequence of short circuit (and system 'ride through' capability)
— overvoltage, including transients
— short circuits and over-current
— earth failures
— negative sequence
— high harmonic distortion (THD)
— failures related to load sharing (active and reactive load, reverse power, communication, I/O…)
— failures in the power management system.

See DNV-RP-D102 *Failure Mode and Effect Analysis (FMEA) of Redundant Systems,* Appendix D, for discussion on the subject of operation with closed bus-tie breakers and more examples of relevant failure modes.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.4.8 When the system is operating with closed bus-tie breakers between switchboards belonging to different redundancy groups and the first action performed by the protection system does not remove the failure, or it is not performed (e.g. due to hidden failure), the protection system shall be able to execute alternative actions to isolate the faulty component or system before the failure effect could propagate from one system to another.

Guidance note:

A typical example should open bus-tie breakers if the faulty generator does not trip or if the failure is still present after tripping one generator.
Separation of redundant switchboard sections should be performed by opening of both bus-tie breakers in series.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.5 Main and distribution switchboards arrangement

8.5.1 The switchboard arrangement shall be such that no single failure will give a total black-out.

8.5.2 When considering single failures of switchboards, the possibility of short-circuit of the bus-bars has to be considered.

8.5.3 The main switchboard system shall consist of at least two sections located in separate spaces. It shall be possible to connect the switchboards with bus-tie breakers or inter-connector breakers.

8.5.4 The system shall be designed to operate with closed bus-tie breakers in DP mode, these breakers shall be circuit breakers which:

— are capable of breaking the maximum short circuit current in the system, and
— provides discrimination towards the generator breakers in case of short circuit, and
— shall be arranged to open automatically upon failures which could be transferred from one system to another.

8.5.5 For **DYNPOS(ER)** it is required that each bus-bar section is isolated from the other(s) by A-0 partitions and in addition watertight if below the bulkhead deck. There shall be a bus-tie breaker on each side of this partition.

Guidance note:

As part of the separation requirement the possibility of leakage of other liquids such as fuel, cooling medium, fire water, etc., has to be considered.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.5.6 Bus-bar control and protection systems shall be designed to work with both open and closed bus-tie breakers.

8.5.7 The online power reserve, i.e. the difference between online power capacity and generated power at any time, shall be displayed in the DP control centre. For split-bus power arrangements, indications shall be provided for individual bus sections.

8.6 Control system power supply

8.6.1 The DP-control systems shall be powered from uninterruptible power supplies, (UPS). The arrangement and number of UPS shall be in accordance with Table 6.

8.6.2 The UPSs for the main DP-control system shall not be located in the same space as the UPS for the alternative DP-control system, nor shall the cables supplying the main and alternative systems be routed through the same spaces.

8.6.3 The alternative DP-control system and its sensors and reference systems shall be fed from the dedicated UPS only. Dual feeding from a main system UPS is not allowed.

8.6.4 Power supply to the thruster control system shall not be from the either of the DP-control systems (main and alternative) UPSs.

8.6.5 Power supply to the thruster control mode selection systems shall be arranged so that the required independency, integrity and redundancy as specified in [6.5] are complied with.

8.6.6 The battery installed for each UPS shall be able to provide output power at maximum load for 30 minutes after loss of charger input power. Loss of charger input power and UPS on bypass power shall initiate an alarm in the DP-control system it serves.

8.6.7 The input power supply to the redundant UPSs for the main DP-control system shall be derived from different redundancy groups.

Guidance note:

The intention with the battery backup in UPS and battery distributions should provide continued supply during voltage drop and black-outs.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.6.8 UPS and battery supplies to other systems relevant for DP shall be derived from the same redundancy group as the system(s) being served.

8.6.9 In general control systems and equipment shall have power supply from within the redundancy group they are serving. In case power supply is arranged from more than one redundancy group special attention shall be paid to the potential risk of propagation of failure modes due to e.g. lack of discrimination or under/overvoltage. Due to such risks supply crossing required separation barriers shall be avoided for **DYNPOS(ER)**.

9 Auxiliary systems

9.1 General

9.1.1 All auxiliary systems that are part of the DP system (machinery, thrusters, electrical components and all other systems and components necessary for supplying the DP system with power and/or thrust) shall be arranged in accordance with the redundancy requirements, and failures shall be considered as given in [4.2].

9.1.2 Piping shall not be shared between the redundancy groups. Cross-over pipes with minimum one separation valve are acceptable for **DYNPOS(E)**. Separating valves may be manual or remote controlled as long as these fail to safe position. Cross over pipes are acceptable also for **DYNPOS(ER)**, except in ventilation ducts, provided these can be closed by valves placed at both sides of separating bulkheads.

Guidance note:

These includes at least, but not limited to, the following systems: Sea and fresh water cooling, other cooling systems, ventilation and HVAC, compressed air, combustion air, exhaust systems, crank case ventilation, pneumatic and hydraulic systems, fuel systems, lubrication, etc.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

9.1.3 In addition to the requirement in [9.1.1], pumps within each redundancy group shall be arranged with redundancy such that a failure of one pump will not result in stop of more than one:

— prime mover, or
— generator set, or
— transformer, or
— power converter, or
— thruster,

when these components are parts of the DP system. For such non-autonomous systems the redundancy shall be so arranged that the normal full capacity is not reduced after a single pump failure.

9.1.4 When dual pumps are required they shall be arranged with automatic duty-standby functionality. The duty pump shall be fed from within the same redundancy group as the component or system it serves.

9.1.5 In any space where components, as listed above (in [9.1.3]), serving more than one thruster and/or generator set are located, ventilation fans and/or air temperature control systems shall be arranged with redundancy so that acceptable temperature can be maintained after any single failure in active components. This requirement also applies for switchboard rooms and instrument rooms containing components that are parts of the DP system.

9.1.6 When redundancy shall be based upon stand-by start or change-over of generator sets and/or thrusters, auxiliary systems that are connected directly on/to the engine, generator or thruster shall be autonomous for each generator set and for each thruster. See [4.2.5] and [4.2.6]. This applies between generator sets and between thrusters that are considered as stand-by, by the consequence analysis.

Guidance note:

These means that generator sets/thrusters that are sharing auxiliary systems should not be considered as stand-by for each other by the consequence analysis. This includes typically, but not limited to, the following systems: Fresh water cooling, compressed air, exhaust systems, crank case ventilation, fuel systems, lubrication, starting air, power supply to these services, etc.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

9.1.7 Fire dampers and quick closing valves which upon activation may affect power generation and/or thrust shall be so arranged that there is separate activation for each redundancy group. As a minimum there shall be separate activation input devises and valves (in case the activation system is pneumatic) for each redundancy group. Separation by A-0 class division is required for **DYNPOS(ER)**.

9.2 Additional requirements for fuel oil systems

9.2.1 There shall be at least one service tank serving each redundancy group. For **DYNPOS(ER)** service tanks belonging to different redundancy groups shall be in A60 separated compartments. Cross-over facilities may be arranged according to [9.1.2], but shall, if arranged, be kept closed in normal operation.

9.2.2 Fuel oil quick closing valves shall be so arranged that there are separate activation for each redundancy group. As a minimum there shall as a minimum be separate activation input devises and valves (in case the system is pneumatic) for each redundancy group.

9.2.3 If the fuel system requires heating, then the heating system shall be designed with the appropriate level of redundancy unless diesel oil tanks, which do not require heating, are arranged as required in [9.1.1].

9.3 Power supply to auxiliary systems

9.3.1 Power shall be taken from within the redundancy group.

9.3.2 When redundancy shall be based upon stand-by start or change-over of generator sets and/or thrusters the power arrangement shall be so that power failure to one switchboard (except the main switchboard) will not cause simultaneous failure of generator sets or simultaneous failure of thrusters which are intended to be able to operate as stand-by/redundancy for each other:

— power to auxiliary function required to be autonomous by [9.1.6] shall be likewise autonomously arranged, with separate distribution switchboard per generator set and/or thruster, i.e. taken directly from the main switchboard level or from a dedicated switchboard supplied directly from it. This dedicated switchboard shall have an additional alternative back-up supply. Alternatively these functions can be engine driven.
— power to auxiliary functions which are not required to be autonomous by [9.1.6] but which are required to be arranged with redundant active components (e.g. a seawater cooling system with redundant pumps serving multiple generator sets in one redundancy group), shall be arranged directly from the main switchboard level within the corresponding redundancy group, or from different switchboards supplied from this main switchboard level.

The switchboards serving autonomous auxiliary functions may also serve the auxiliary functions which are not required to be autonomous as long as the above conditions are met.

10 Station keeping capability

10.1 General

10.1.1 The position keeping ability of the vessel shall be calculated according to the DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*.

10.1.2 All ship-shaped monohull vessels shall calculate their dynamic positioning station keeping capacity according to DNVGL-ST-0111 DP capability level 1.

10.1.3 Vessels with other hull shapes than ship-shaped monohulls shall calculate their dynamic positioning station keeping capacity according to DNVGL-ST-0111 DP capability level 2. Deviations from the DP capability level 1 method shall be kept to a minimum, and shall in general only be related to the hull differences.

10.1.4 A given DP capability number indicates that a vessel's station keeping ability can be maintained in the corresponding DP capability number condition and all conditions below, but not in the condition specified for the next DP capability number. The DP capability numbers relates to the Beaufort scale and environmental conditions as given in Table 7.

Table 7 DP capability numbers and Beaufort scale, wind speed, wave height, wave period and current speed

Beaufort(BF) number	*DP capability number*	*Beaufort description*	*Wind speed*) [m/s]*	*Significant wave height [m]*	*Peak wave period [s]*	*Current speed [m/s]*
0	0	Calm	0	0	NA	0
1	1	Light air	1,5	0,1	3,5	0,25
2	2	Light breeze	3,4	0,4	4,5	0,50
3	3	Gentle breeze	5,4	0,8	5,5	0,75
4	4	Moderate breeze	7,9	1,3	6,5	0,75
5	5	Fresh breeze	10,7	2,1	7,5	0,75
6	6	Strong breeze	13,8	3,1	8,5	0,75
7	7	Moderate gale	17,1	4,2	9,0	0,75
8	8	Gale	20,7	5,7	10,0	0,75
9	9	Strong gale	24,4	7,4	10,5	0,75
10	10	Storm	28,4	9,5	11,5	0,75
11	11	Violent storm	32,6	12,1	12,0	0,75
12	NA	Hurricane force	NA	NA	NA	NA
*)The wind speed is the upper limit of the mean wind speed 10 m above sea level for the given DP capability number. The given peak wave periods represent the 95% confidence interval found from the world wide scatter diagram.						

10.1.5 The DP capability numbers shall be evaluated for a balance of forces while the vessel is maintaining both position and heading. Thus there shall at the same time be a balance of forces and a balance of moments, i.e. including all moments generated by the thrusters, and those caused by environmental forces.

10.1.6 The format of the DP capability numbers shall be a series of 4 integer numbers, ranging from 0 to 11. The DP capability will be given in the DNV GL register in the following format: DP capability LX(A,B,C,D).

Where:

— X = 1 or 2 describing the DP capability level.

— A: Maximum DP capability number as specified in Table 7 where the vessel in its intact condition (no failures) can maintain station with its heading ±30° relative to the environmental forces.

— B: Maximum DP capability number as specified in Table 7 where the vessel in its intact condition (no failures) can maintain station with heading 0-360°.

— C: Maximum DP capability number as specified in Table 7 where the vessel in its worst case single failure condition relevant for the class notation can maintain station with its heading ±30° relative to the environmental forces.

— D: Maximum DP capability number as specified in Table 7 where the vessel in its worst case single failure condition relevant for the class notation can maintain station with its heading 0-360°.

10.1.7 The C and D numbers shall be the lowest numbers obtained across all the redundancy group cases (i.e. stop of one redundancy group at a time). These parameters are not applicable for non-redundant DP systems (i.e. vessels not having their redundancy verified by issuance of a redundant DP class notation) , and shall be indicated as NA (not applicable) for such vessels.

SECTION 3 NAUTICAL SAFETY - NAUT(OC) AND NAUT(AW)

1 General

1.1 Introduction

The additional class notations **NAUT(OC)** and **NAUT(AW)** set requirements for bridge design, workstation arrangement, installation of navigational equipment and provision of manoeuvring documentation in seagoing vessels; thereby reducing the risk of collision, grounding and heavy weather damage. The bridge system, in the context of the rules in this section, comprises of four essential elements: technical (system), human (operator), human (machine interface) and operational (procedures). In order to reduce the risk of malfunction in the bridge system, it is necessary to regulate the factors affecting the safe performance of the bridge system and ensure reliability, in various modes of operation under different sea-going conditions.

1.2 Scope

The scope for additional class notations **NAUT(OC)** and **NAUT(AW)** adds a level of safety in reducing the risk of collision, grounding and heavy weather damage through enhancement of the reliability of the bridge system. The requirements in this section have been established on the supposition that the regulations of international conventions and the rules for main class have been complied with. Within the operational limits of the applicable class notation, these rules aim to safeguard that the officer of the navigational watch has full control of all the primary functions he/she is responsible for, including the look-out function required by COLREG 72, [single-handed]. Moreover, the rules acknowledge that the modes of operation and the manning of the bridge varies in accordance with internal and external conditions as, for example; availability of technical systems, types of water (ocean, coastal, open), traffic density and weather conditions. These rules therefore aim to provide a bridge arrangement suitable for an augmented bridge team, when required by operational or legislative conditions.

1.3 Application

The additional class notations **NAUT(OC)** and **NAUT(AW)** are applicable to vessels operating in ocean, coastal and open waters, where the requirement for an enhanced bridge design, workstation arrangement, installation of navigational equipment and provision of manoeuvring documentation, related to safety of navigation, is based on the main class rules and the rules in this section. Ships built and tested in compliance with the requirements of this section, Sec.4 or Sec.5, and with the requirements of the rules for main class, may be assigned class notation **NAUT** with following qualifiers: **NAV**, **OC**, **AW**, **OSV**, **INS+**, detailed in Table 1.

1.4 Classification

1.4.1 Objective

1.4.1.1 The objective of the rules for nautical safety is to reduce the risk of collision, grounding and heavy weather damage through enhancement of the reliability of the bridge system.

1.4.2 The bridge system

1.4.2.1 The bridge system in the context of the rules comprises four essential elements:

— the technical system, which shall deduce and present information as well as enable the proper setting of course and speed
— the human operators, who shall evaluate available information, decide on the actions to be taken and execute the decisions

— the human-machine interface, which shall safeguard that the technical system is designed with due regard to human abilities
— the procedures, which shall ensure that the bridge system performs satisfactorily under different operating conditions.

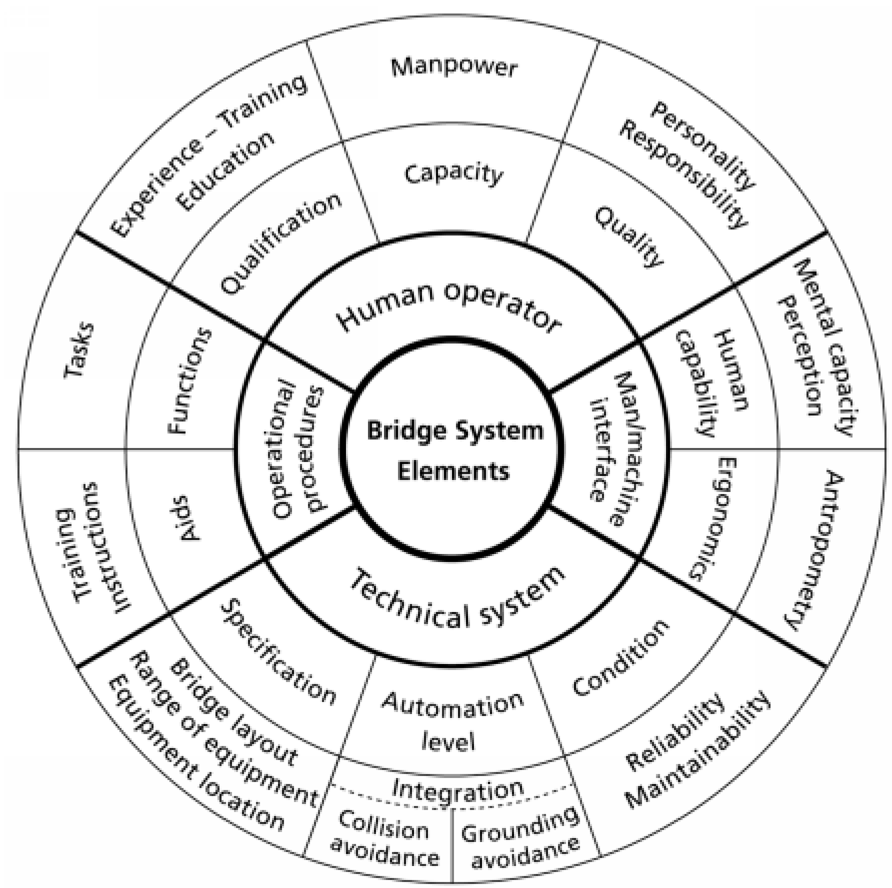

Figure 1 The bridge system

1.4.2.2 Degradation of one element of the bridge system affects the performance of the other elements. In order to reduce the risk of malfunction of the bridge system, the rule requirements aim to regulate the factors affecting the safe performance of the bridge system to ensure system reliability in various modes of operation under different operating conditions.

1.4.2.3 The main attributes of the four elements of the bridge system are considered to comprise, (see Figure 1):

— qualifications, capacity and quality of the human operator in relation to the functions to be carried out
— specification, automation level and condition of the technical system in relation to information needs, workloads and reliability
— physical abilities and information processing capacity of the human operator in relation to working conditions and the technical systems he is to operate
— tasks to be performed and technical aids available under various operating conditions as basis for establishing working routines and operating procedures.

1.4.2.4 With the exception of operator qualifications and quality, which are considered to be a matter of selection of personnel, the attributes mentioned in [1.1.3.3] forms the basis of these rule requirements. It is recognized that improvements of the attributes mentioned will have a positive effect on the performance of the human element.

1.4.3 Class notation and qualifiers

1.4.3.1 Ships built and tested in compliance with the requirements of this section, Sec.4 or Sec.5 and the requirements of the rules for main class may be assigned class notation **NAUT** and qualifiers as given in Table 1.

1.4.3.2 The **NAUT** notation has the five qualifiers **NAV**, **OC**, **AW**, **OSV**, and **INS+** in order to offer classification that meets the individual needs of ship operators, related to different types and trades of ships.

Table 1 Class notations and qualifiers

<table>
<tr><th>Class notation</th><th>Description</th><th>Qualifier</th><th>Description</th><th>Design requirements, rule reference</th><th>Survey requirements, rule reference</th></tr>
<tr><td rowspan="5">NAUT</td><td rowspan="5">Requirements within bridge design, bridge instrumentation, and workstation arrangement. Vessels with NAUT-notation will comply with the principles and aims of SOLAS V/15 and IMO MSC/ Circ.982.</td><td>NAV</td><td>Basic requirements.</td><td>Sec.4</td><td rowspan="5">Pt.7 Ch.1 Sec.6</td></tr>
<tr><td>OC</td><td>Enhanced requirements targeting ships largely operating on the high seas.</td><td>[1] to [6] and [10]</td></tr>
<tr><td>AW</td><td>— Enhanced requirements targeting vessels largely operating in coastal and narrow waters.
— Augmented requirements for bridge configuration, instrumentation and automation and including detailed documentation of the manoeuvring characteristics of the vessel.</td><td>[1] to [6], [8]and [10]</td></tr>
<tr><td>OSV</td><td>— Fundamental requirements targeting ships operating as service vessels for the offshore industry.</td><td>Sec.5</td></tr>
<tr><td>INS+</td><td>A multifunction workstation arrangement supporting the navigational functions of other qualifiers to the NAUT notation by means of network technology.</td><td>[7]</td></tr>
</table>

Guidance note:

Example of notation with qualifiers: **NAUT(OC, INS+)**.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.4.3.3 Ships which have waived one or more of the requirements recognized by the rules as being applicable for ships in world wide trade only shall have the following additional text entered in the appendix to the classification certificate:

— the class notation has been granted on the said agreement that the ship will only operate in <insert the area/waters to be traded and any other conditions of the waiver>.

Guidance note:

Example: The class notation has been granted on the said agreement that the vessel will only operate in European waters fully covered by ENC.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.4.4 Class assignment

1.4.4.1 The ship will be assigned class notation **NAUT(OC)** when the relevant requirements given in [1] to [6] and [10] are complied with.

1.4.4.2 The ship will be assigned class notation **NAUT(AW)** when the relevant requirements given in [1] to [6] and [8] and [10] are complied with.

1.4.4.3 The class notation may upon request be extended with a qualifier **INS+** when the requirements in [7] are complied with.

1.4.5 Structure of the rules

1.4.5.1 The rule structure establishes functional requirements to the greatest extent possible and gives guidance as to how a functional requirement can be met in the course of a technical solution.

1.4.5.2 A functional requirement is as far as possible expressed without quantification. The functional requirements have a principle status and will only be adjusted if the functions to be carried out on the bridge are altered.

1.5 Definitions

1.5.1 Terms and abbreviations

Table 2 Terms and abbreviations

Term	*Definition*
abnormal operating conditions	when malfunction of technical system(s) requires operation of backup systems on the bridge, or if malfunction occurs during an irregular operating condition, or when the officer of the watch becomes unfit to perform his duties and has not yet been replaced by another qualified officer
accommodation	those spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, game and hobby rooms, barber shops, pantries containing no cooking appliances and similar spaces
active function	navigational function/application in operation performing in accordance with applicable standards

Term	Definition
additional bridge functions	functions related to ship operations which shall be carried out on the bridge in addition to primary functions, and whether or not the officer in charge of the navigational watch (OOW) is responsible for the allocated tasks. Examples of such functions are: — extended communication functions — monitoring and control of ballasting and cargo operations — monitoring and control of machinery — monitoring and control of domestic systems.
AES	advanced encryption standard
alarm	an alarm is a high priority alert. Condition requiring immediate attention and action by the bridge team, to maintain the safe navigation of the ship
alert	alerts are announcing abnormal situations and conditions requiring attention. Alerts are divided in four priorities: — emergency alarms — alarms — warnings — cautions.
assigned function	navigational function/application installed on the task station (irrespective of status)
back-up navigator	a navigational officer who has been designated by the ship's master to be on call if assistance is needed on the bridge
BAM	bridge alert management. Overall concept for management, handling and harmonized presentation of alerts on the bridge
blackout period	the period suffering loss of electric power from the main and emergency generating plants
blind sector	an obstruction of the sea surface situated within a required field of vision sector
BNWAS	bridge navigational watch alarm system
bridge	the area from which the navigation and control of the ship are exercised, comprising the wheelhouse and the bridge wings.
bridge system	the total system governing the performance of bridge functions, comprising bridge personnel, technical systems, human-machine interface and procedures
bridge wing	the part of the bridge on each side of the wheelhouse, which extends towards the ship's side
CAM	central alert management. Functionality for the management of the presentation of alerts on the CAM-HMI, the communication of alert states between CAM-HMI and navigational systemsand sensors. (The function(s) may be centralized or partly centralized in subsystems and interconnected via a standardized alert-related communication)
CAM-HMI	human machine interface for presentation and handling of alerts on the bridge
catwalk	a narrow, usually elevated platform arrangement outside the wheelhouse allowing a person safe access to windows along the front bulkhead(s)
CCRP	consistent common reference point
CCRS	consistent common reference system

Term	*Definition*
coastal waters	deep unobstructed waters along a coastline that is extending an equivalent distance of not less than 30 minutes sailing at the relevant speed in all directions to one side of the course line (opposite the coastline)
COG	course over ground. Ship’s course measured relative to earth surface
collision avoidance functions	monitoring surrounding traffic and other objects visually and by all appropriate means to determine dangers of collisions, pertinent responsibilities in accordance with COLREG, and execute measures to steer clear of the danger
commanding view	view without obstructions, which could interfere with the navigator’s ability to perform his main tasks, at least covering the field of vision required for safe performance of collision avoidance functions
conning information display	a screen-based information system centralizing ship’s control state parameters, system set/ order values and voyage plan data
conning station or position	place in the wheelhouse with a commanding view providing the necessary information for conning, and which is used by navigators, including pilots, when monitoring and directing the ship’s movements
DMZ	demilitarized zone
docking operations	manoeuvring the ship alongside a berth and supervising the mooring operations
easily accessible	being both perceptible from and located within 5 m distance from the relevant working position
easily readable	see [2.4.2.3]
ECDIS	electronic chart display and information system. A navigation information system, which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulation 19 of SOLAS Chapter V, and be accepted as meeting the chart carriage requirements of SOLAS Chapter V, as amended by Res. MSC.99(73), by displaying selected information from a system electronic nautical chart (SENC)
EPFS	electronic position fixing system
emergency call	a function that immediately initate BNWAS second stage alert and subsequently third, stage remote audible alarms
emergency situations	when incidents affect regular operating conditions and priorities due to grave threats against the ship’s safety, integrity or security
ergonomics	the scientific discipline concerned with designing according to the human needs, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance
FMEA	failure modes and effects analysis. An engineering method of analysis of potential failure modes within a system to determine the impact that failures, errors and defects in components on sub-system level may have on the larger system
field of vision	angular size of scenery being observable from a position within the ship’s bridge
forwarder	receives data from INS and retransmit the information to another network
gateway	network node that serves as an access point to another network
grounding avoidance function	monitor the ship’s position in relation to the voyage plan, and determine and execute course alterations to make the ship follow the planned track

Term	*Definition*
helmsman	designated person who actuates the rudder and control the heading of the ship under way
HMI	human machine interface
INS	integrated navigation system compliant with IMO Res. MSC.252(83)
INS+	integrated navigation system qualifier for NAUT-notations. Based on INS with additional requirements
irregular operating conditions	when external conditions cause excessive operator workloads
MAC address	media access control address of INS node
manoeuvring	operation of steering and propulsion machinery, as required to alter the ship’s heading, speed and/or directional movement.
MFD	multi-function-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
MKD (AIS)	AIS minimum keyboard and display
module	entity supporting either a network communication manager or an application software
monitoring	act of constantly checking information from instrument displays and environment in order to detect any irregularities
narrow waters	waters with restricted freedom of course setting and where pilotage conventionally is the foremost navigational method
navigation	the process of planning, reading, and controlling the movement of a ship from one place to another
node	device (data point) in the LAN
normal crew working spaces	includes spaces where routine maintenance tasks or local control of machinery operated at sea are undertaken and includes special category spaces like ro-ro spaces and vehicle spaces as defined in SOLAS II on all types of ship that carry vehicles
normal operating conditions	when all shipboard systems and equipment related to primary bridge functions operate within design limits, and weather conditions or traffic, do not cause excessive operator workloads
ocean areas	waters that encompass navigation beyond the outer limits of coastal waters. Ocean areas do not restrict the freedom of course setting in any direction for a distance equivalent to 30 minutes of sailing with the relevant ship speed
ONF	other network function
OOW	officer of the navigational watch. Person responsible for the safety of navigation and bridge operations

Term	Definition
primary bridge functions	functions related to determination, execution and maintenance of safe course, speed and position of the ship in relation to the waters, traffic and weather conditions. Such functions are: — 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.
SF	function block identified by a unique ID(SFI) in accordance with IEC61162-450
SOG	speed over ground. Ship's real time speed measured relative earth surface
STW	speed through water. Ship's real time speed measured relative water surface
superstructure	decked structure, not including funnels, which is on or above the freeboard deck
topology	the way each node is physically connected to the network
UID	user input device; (example: keyboard, tiller, joystick, helm, pushbutton, etc.)
voyage plan	a comprehensive, berth to berth guide, developed and used by the vessel's bridge team to determine the most favourable passage, to identify hazards along the track, and to make out the bridge team management to ensure the vessel's safe passage
voyage planning	gathering information relevant to the contemplated voyage; the plotting of course lines and turn radii of the intended voyage in appropriate charts: indication of areas of danger, existing ships' routeing and reporting systems, vessel traffic services, areas involving marine environmental protection considerations and safe speed
VPN	virtual private network
wheelhouse	enclosed area of the bridge
wheel-over-line	the line parallel to the next course line that is passing through the point where the rudder order has to be initiated for the ship to accurately follow a curved track with a fixed radius
wheel-over-point	the point where the ship has to initiate a rudder order in order to accurately follow a curved track, taking into consideration the distance required for the ship to build up the necessary turn rate
within reach	see [2.4.2]
workstation	a workplace at which one or several tasks constituting a particular activity are carried out, designed, arranged and located as required to provide the information, systems and equipment required for safe and efficient performance of dedicated tasks and bridge team co-operations

Guidance note:

Additional terms and definitions may be found in IMO resolution A.918(22) *IMO Standard Marine Communication Phrases*

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1.6 Documentation

1.6.1 General

1.6.1.1 The builder shall submit the documentation as required by Table 3. The configuration and arrangement drawings submitted for approval shall be shown to scale. All symbols and abbreviations used shall come with a clarification.

Table 3 Documentation requirements

Object	*Documentation type*	*Additional description*	*Information*
NAUT(OC) and **NAUT(AW)**			
Navigation bridge	N011 – Bridge design drawing, extended		AP
	N021 – Vertical field of vision drawing, extended		AP
	N031 – Horizontal field of vision drawing, extended		AP
	N040 – Nautical workstation arrangement plan		AP
	N050 – Navigation bridge windows framing arrangement plan		AP
	Z030 – Arrangement plan	Window wipers, fresh water wash, sunscreens and de-misting/de-icing system (heating) on the bridge windows.	AP
	M130 – Colour specification	Interior colours for bulkheads, deckheads, framing of windows and consoles indicated by using international standards for colour reference.	AP
Navigation systems	Z090 – Equipment list		AP
	E230 – Power supply arrangement	Including wheelhouse distribution board.	AP
	I030 – System block diagram (topology)	Showing inter-connections between all sensors, equipment and systems including their power supply.	AP
	I040 – User interface documentation	Drawings/photos.	R
	I090 – Schematic description of input and output circuits		R
	Z253 – Test procedure for quay and sea trial	Specifying the test procedure and check items for all the navigational equipment.	AP
	Z161 – Operation manual		R

Object	*Documentation type*	*Additional description*	*Information*
	Z162 – Installation manual		R
Bridge alert management	I030 – System block diagram (topology)		AP
	I040 – User interface description	CAM-HMI alert list.	AP
	I220 – Interface description	For equipment not compliant with IEC 61162-1.	AP
Bridge navigational watch alarm system	I030 – System block diagram (topology)		AP
Steering control and monitoring system	I020 – Control system functional description	Steering mode selection.	AP
Navigation bridge lighting	Z030 – Arrangement plan	Red and white lighting in wheelhouse and all adjacent corridors, stairways and rooms.	AP
Ventilation systems	Z030 – Arrangement plan	For wheelhouse, including capacity specification.	AP
External communication systems	T030 – Antennae arrangement plan		AP
Public address system	E170 – Electrical schematic drawing	Cable diagram and power supply arrangement.	AP
	T010 – Functional description		AP, TA
	T060 – Data sheets with environmental specifications		AP, TA
	Z030 – Arrangement plan	Location of centrals, call stations and all loudspeakers.	AP
Automatic telephone system	E170 – Electrical schematic drawing		AP
	Z030 – Arrangement plan	Location of centrals and all subunits.	AP
Back-up telephone system	E170 – Electrical schematic drawing		AP
	Z030 – Arrangement plan	Location of centrals and all subunits.	AP
Ultra high frequency (UHF) telephone system	Z090 – Equipment list		AP
NAUT(AW)			

Object	*Documentation type*	*Additional description*	*Information*
Navigation systems	Z071 – Failure mode and effect analysis	A document analysing how single failures in components and sub-system of the Integrated navigation System (INS) will propagate and how essential systems will operate during failure. Guidance: Example of FMEA worksheet matrix that covers the items specified above (and guidance for the use of FMEA) can be found in IEC 60812.	AP
Manoeuvring	N060 – Manoeuvring booklet	A document showing the result of all the individual manoeuvring trials. Including information on equipment (model) and applied corrections.	AP
	N070 – Wheelhouse poster		FI
	N080 – Pilot card		FI
	Z253 – Test procedure for quay and sea trial	Manoeuvring trial test program specifying the test procedure for all trials.	AP
NAUT(OC, INS+), **NAUT(AW, INS+)**, **NAUT(NAV, INS+)**, **NAUT(OSV, INS+)**			
Integrated navigation system	I030 – System block diagram (topology)	— topology and network specification — description of interfaces and network components including data protocol — description of power supply arrangement(s).	AP
	Z080 – Reliability and availability analysis	— identification of sensors, network components, nodes, computers and controllers both connected to the **INS+** and being parts of the **INS+** — possible failures, performance degradations and their causes for each individual equipment — the local effect displayed on the individual equipment and transmitted via the interface — the resulting effect on the functions being processed on the **INS+** system level — method of failure detection on the **INS+** system level including related alarms, warnings and indications — system related corrective action including fall-back mode(s) of operation (as applicable) and associated indications	AP

Object	Documentation type	Additional description	Information
	Z160 – Operation manual	Including: — an overall drawing and description of the system and its components — description of the redundancy concept and the availability of the system's functions — a description of possible failures and their effects on the system — guidance for the adjustment of limits for alarms and warning indications — the implications of using different reference locations — details of the integrity monitoring provided and the required settings — details of the mechanism for marking valid, doubtful and invalid data — details of devices used in the reversionary mode.	R
Integrated navigation system (cont.)	Z162 – Installation manual	Including: — specification of sensors, components and the interconnecting equipment forming the system — details of the interfaces and connections for data broadcasting and — interconnection diagrams and interfacing details for external parts of the INS and for devices to be connected to the network — details of the power supply arrangements required — recommendations on the physical layout of the system.	R
	AP = For approval; FI = For information; R = On request; TA = Covered by type approval		

1.6.1.2 For general requirements to documentation, see DNVGL-CG-0550 Sec.6.

1.6.1.3 For a full definition of the documentation types, see DNVGL-CG-0550 Sec.5.

1.6.1.4 For navigation equipment and other equipment installed in the wheelhouse, and in the vicinity of the wheelhouse, certification is required.
Certification documentation shall be submitted as required by Table 4:

Table 4 Certification requirements

Object	Certificate type	Issued by*	Certification standard**	Additional description
Integrated navigation system (INS) (if provided)	Type approval certificate (TA)	Society		
Radar equipment	Type approval certificate (TA)	Society		

Object	*Certificate type*	*Issued by**	*Certification standard***	*Additional description*
ECDIS equipment	Type approval certificate (TA)	Society		
Position system	Type approval certificate (TA)	Society		
Gyro/heading system	Type approval certificate (TA)	Society		
Speed measuring system	Type approval certificate (TA)	Society		
Depth measuring system	Type approval certificate (TA)	Society		
Bridge navigation watch alarm system (BNWAS)	Type approval certificate (TA)	Society		
Central alert management system (CAS)	Type approval certificate (TA)	Society		
Automatic identification system (AIS)	Type approval certificate (TA)	Society		
Wiper system	Type approval certificate (TA)	Society		
Conning display system	Type approval certificate (TA)	Society		
Heading control system (autopilot)	Type approval certificate (TA)	Society		
Track control system (TCS) (if provided)	Type approval certificate (TA)	Society		
Sound reception system	Type approval certificate (TA)	Society		
Internal communication	Type approval certificate (TA)	Society		
External communication (including GMDSS)	Type approval certificate (TA)	Society		
*Type approval or MED certificates issued by others showing that the equipment complies with the rule requirements may be accepted after a case-by-case evaluation ** Unless otherwise specified the certification standard is the rules				

1.7 Tests

1.7.1 General

1.7.1.1 All tests shall be carried out according to test programs approved by the Society.

1.7.1.2 The tests and visual examinations shall verify that all relevant rule requirements are met. The tests shall cover requirements given by these rules and applicable IMO performance standards. The test programs shall specify in detail how the various functions shall be tested and what shall be observed during the tests.

Guidance note:

Reference is made to [10] for further information.

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1.7.2 Testing of network integrity- qualifier (INS+)

1.7.2.1 Testing in accordance with [7.6]. shall be carried out at the manufacturer's works as far as practical in order to limit the necessary testing on board to a minimum.

1.7.3 Onboard testing

1.7.3.1 The testing to be completed during installation and commissioning shall include:

a) verification of proper interfacing and data protocol of individual equipment
b) establishment of correct parameters for filters, integrity monitoring, alarm limits, control parameters (time constants, set points, lengths, heights, etc.)
c) verification of correct functionality of system applications and integration of components, including the ability of the integrated navigation system to keep any controlled process within the specified tolerances
d) verification of fall-back-modes and emergency operation of essential navigational functions.

1.7.3.2 The tests shall demonstrate that the essential navigational functions are available and operable on designated back-up means in a situation where the normal navigational system configuration is disabled as far as practical.

1.7.4 Manoeuvring trials - NAUT(AW)

1.7.4.1 Tests and trials as required to establish and document the ship's manoeuvring characteristics shall be carried out.

2 Design of workplace

2.1 General

2.1.1 Scope

2.1.1.1 This section specifies the requirements for bridge design, including field of vision, -wheelhouse arrangement, -workstation configuration and location of equipment within workstations.

2.1.2 Application

2.1.2.1 Ships requesting class notation **NAUT(OC)** shall comply with the basic rules in [2.2] to [2.5].

2.1.2.2 Ships requesting class notation **NAUT(AW)** shall comply with the basic rules in [2.2] to [2.5] and additionally the requirements specifically addressing **NAUT(AW)** in these subsections.

Guidance note:

A requirement being specific for **NAUT(AW)** only is identified by inclusion of the notation in the head line as follows:

— Workstations for navigating and manoeuvring – vertical view **NAUT(AW)**.

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2.1.2.3 The requirements being applicable for **NAUT(AW)** only is additionally gathered in [6] for easy overview.

2.2 Bridge design

2.2.1 Principal requirements

2.2.1.1 The ship's navigation bridge shall enable the officer in charge of the navigational watch (OOW) to perform navigational duties unassisted at all times during normal operating conditions. He shall be able to 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 full appraisal of the situation and the risk of collision, grounding and other hazards to navigation.

2.2.1.2 The ship's navigation bridge shall additionally be designed and arranged with the aim of:

— facilitating the tasks to be performed by the bridge team including a pilot in making full appraisal of the situation and in navigating the ship safely under all operational conditions
— promoting effective and safe bridge resource management
— allowing for expeditious, continuous and effective information processing and decision-making by the bridge team
— preventing or minimizing excessive or unnecessary work and any condition or distraction on the bridge which may cause fatigue or interfere with the vigilance of the bridge team.

2.2.1.3 The bridge design shall meet the terms of all relevant regulations of applicable IMO conventions.

Guidance note:

Applicable conventions in this respect are the International Convention for Safety Of Life At Sea, the International Convention for Preventing Collisions at Sea and the International Convention on Standards of Training, Certification and Watch-keeping for Seafarers, as amended.

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2.2.2 Field-of-vision from within the wheelhouse

2.2.2.1 When designing the bridge, the main factors to be considered are the overall view required from the inside of the wheelhouse and the field of vision required from each workstation.

2.2.2.2 Every effort shall be made to place the bridge above all other decked superstructures in order to obtain the best possible field of vision for safe navigation and manoeuvring of the ship.

2.2.2.3 A horizontal field of vision (FOV) to the horizon of 360° shall be obtained by using not more than 2 positions within the confines of the wheelhouse on either side of the workstation for navigating and manoeuvring and being not more than 15 m apart, see Figure 2. The 360° view shall as a minimum be attained 1 nautical mile from the observer's position.

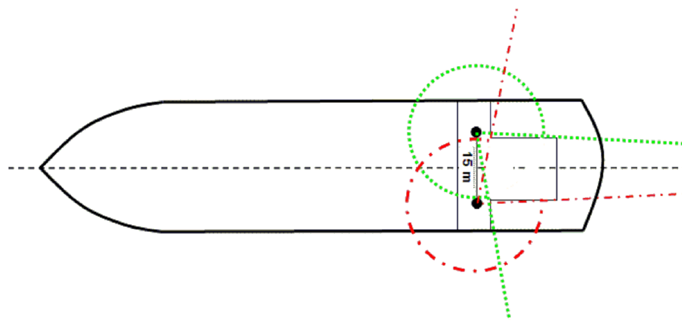

Figure 2 Two positions combined provide ≥ 360° field of vision from inside the wheelhouse

Guidance note:

The maximum distance of 15 m between the two positions inside the wheelhouse may be extended, provided the following conditions are fulfilled:

— suitable cameras are installed capable of viewing the sector(s) astern not being visible within the required 15 meter and pertinent displays/monitors are installed being viewable from the workstation for navigating and manoeuvring

— the workstations for docking are equipped with appropriate means for course and speed alterations, and

— the FOV sectors should overlap with at least 0.5°.

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2.2.2.4 It shall be possible to observe all external objects of interest for safe navigation, such as ships, buoys and lighthouses in any direction from inside the wheelhouse when the ship is pitching and rolling (eye height 1800 mm).

Guidance note:

Irrespective of helicopter decks or other structures placed on top of the wheelhouse a vertical angle of view of not less than 5° above a horizontal line extending from eye height in standing position should be available all through the 360º horizontal field of vision when positioned adjacent the windows. The eye height in a standing position is considered to be at least 1800 mm above the deck surface for this purpose.

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2.2.3 Field-of-vision from workstations

2.2.3.1 Workstations for monitoring and navigating and manoeuvring –forward vertical view

The view of the sea surface for a person positioned at the workstations for monitoring and navigating and manoeuvring 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, under all conditions of draught, trim and deck cargo (eye height 1500 mm). Figure 3.

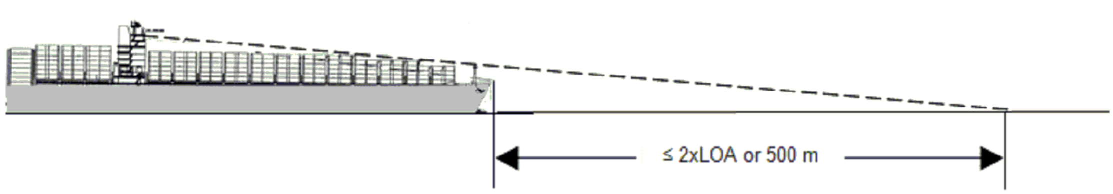

Figure 3 View of sea surface forward of bow

2.2.3.2 Workstations for monitoring and navigating and manoeuvring - horizontal field of vision

The horizontal field of vision from the workstations for monitoring and navigating and manoeuvring shall enable the officer of the navigational watch to carry out his functions in compliance with the International Regulations for Preventing Collisions at Sea and shall extend over an arc of not less than 225°, that is from dead ahead to not less than 22.5° abaft the beam on either side of the ship. Figure 4.

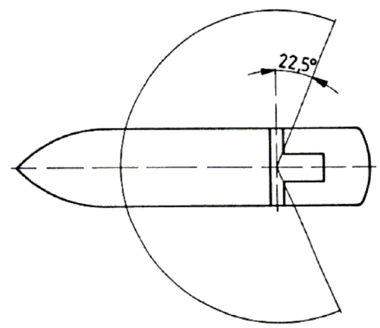

Figure 4 Horizontal field of vision from the workstations for monitoring and navigating and manoeuvring

2.2.3.3 Workstations for navigating and manoeuvring – vertical view

a) Above horizontal plane: A vertical angle of view of not less than 5° above a horizontal line, extending from eye height in forward direction, shall be provided irrespective of helicopter decks or other structures placed on top of the wheelhouse (eye height 1500 mm).
b) Below horizontal plane: Within the 180º sector forward of athwart ship any elevated ship structure or cargo obstructing the sea surface close to the ship in excess of ½ nm is considered to be a blind sector and shall be included in the blind sector calculation (eye height 1500 mm).

Guidance note:

Reference is made to the blind sector calculation required by Table 2, N020/N030. The location of elevated structures obstructing the view of the sea surface may only be acceptable on the provision that [2.2.4.1] is complied with.

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2.2.3.4 Workstations for navigating and manoeuvring – vertical view NAUT(AW)

To be able to view objects and river banks in the proximity of the ship, a person standing at the workstation for navigating and manoeuvring shall be able to observe the sea surface at a distance of no more than 500 m from the hull within the sectors from 10º on either side of the bow to 90° on both sides, under all conditions of draught, trim and deck cargo (eye height 1500 mm*).*Figure 5.

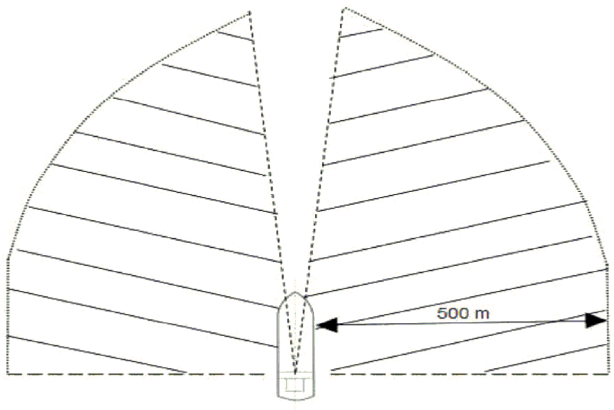

Figure 5 NAUT(AW): Obstruction of sea surface fwd of athwart ship

Guidance note:

Any deck house, superstructure or cargo obstructing the sea surface by more than 500 m should be included in the horizontal blind sector calculation and may only be acknowledged if the total blind sector requirement of [2.2.4.1] is complied with.

The eye height in standing position is considered to be not more than 1500 mm above the deck surface for the purpose of vertical view below the horizontal plane (Note: the 50% percentile of South East Asia population is 1520 mm).

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2.2.3.5 Workstations for navigating and manoeuvring - horizontal view astern NAUT(AW)

The navigator shall be able to employ leading lights and marks astern of the ship as visual reference for grounding avoidance, while seated at the workstation for navigating and manoeuvring. A field of vision sector astern shall be available and extend over an arc from dead astern to at least 5º on each side. No blind sectors shall occur within this 10º field of vision sector.

Guidance note:

Adequate camera(s) may be accepted for the purpose of achieving the required field of vision astern. The camera system and arrangement should be approved by the Society prior to the installation.

Note: Leading lights (or range lights) consist of two lights, separated in distance and elevation, so that when lined up vertically, with one behind the other, they provide a bearing to be used for positioning of the vessel in fairways.

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2.2.3.6 Workstations for navigating and manoeuvring - vertical view astern - NAUT(AW)

The vertical view through the aft window pane(s), seen from the workstation for navigating and manoeuvring, shall enable the navigator to view the sea surface in the wake of the ship at a distance not more than 2000 m abaft the stern.

The upper edge of the window(s) shall not be less than 2000 mm above bridge deck surface.

The maximum height from deck to the lower edge of the window(s) shall be 1000 mm or at least fulfil the following condition:

— the lower part of the window panes shall disclose all obtainable sea surfaces aft of the vessel when viewed from the navigating and manoeuvring workstation. Only the superstructure/-deck may be concealed when viewed from normal operating position at this workstation (eye height 1500 mm).

2.2.3.7 Workstation for conning

The horizontal field of vision from the workstation for conning shall offer a commanding view.

The vertical field of view shall enable the conning officer (pilot) to monitor the ship's relative position and leeway in the course of a marked fairway or channel.

2.2.3.8 Workstation for docking operations

In order to enable the navigator(s) to manoeuvre the ship safely alongside a berth and supervise the mooring of the ship, the horizontal field of vision from each workstation on the bridge wings shall extend over an arc of not less than 225º, that is from at least 45º on the opposite bow through to right astern from the working position. Figure 6.

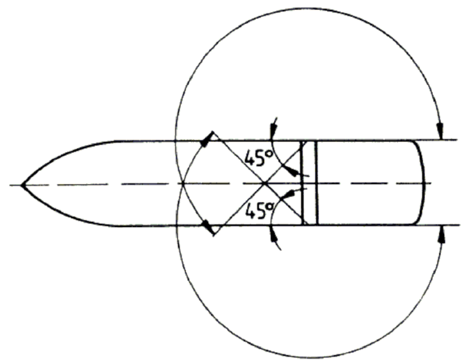

Figure 6 Field of vision from workstations for docking operations

2.2.3.9 The vertical view shall enable the navigators to monitor the ship’s position relative to the berth including observation of the accurate distance from the hull side to the quayside (jetty) at sea level from the docking workstation.

Guidance note:

If [2.2.7.1] cannot be fully satisfied, adequate cameras may be accepted for the purpose of achieving the required vertical view. The camera system and arrangement should be approved by the Society prior to the installation.

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2.2.3.10 Workstation for docking operations - vertical view **NAUT(AW)**

The vertical view from the docking workstation shall enable the navigator(s) to observe the parallel hull side of both fore ship and stern ship from a standing position besides the console while operating the UIDs on hand for manoeuvring of the ship. The hull’s side plates shall be visible over a total length of not less than L/2 (eye height 1500 mm). Figure 7.

Guidance note:

Windows should be arranged in the lower part of the bulwark and deck as appropriate to obtain the required vertical view.

Alternatively, adequate cameras may be accepted. The camera system and arrangement should be approved by the Society prior to the installation.

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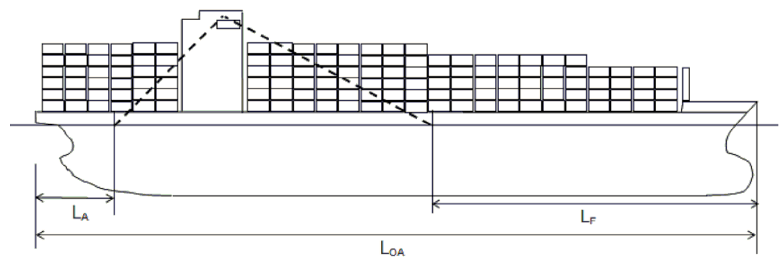

Figure 7 NAUT(AW): View from docking station (L_A+L_F) ≥ ½L_{OA}

2.2.3.11 Workstation for manual steering

In order to enable the helmsman to steer the ship safely in narrow channels, the horizontal field of vision from the workstation for manual steering shall extend over an arc from dead ahead to at least 60º on each side. Figure 8.

The vertical view shall enable the helmsman to observe steering references in the fore ship (if provided) while standing at the normal working position.

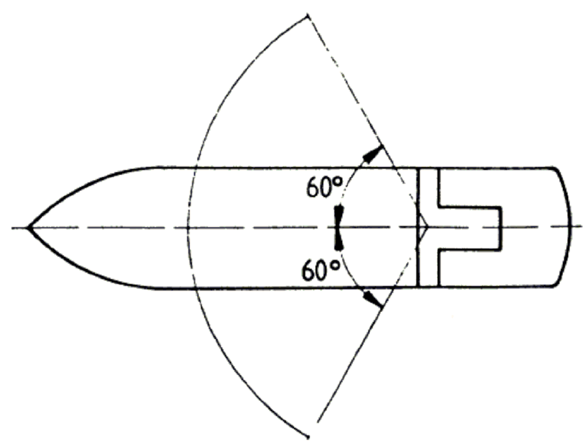

Figure 8 The field of vision from workstation for manual steering

2.2.3.12 Workstations for GMDSS and additional functions

In order to enable the OOW to operate workstations for safety monitoring, GMDSS equipment and additional bridge functions for short periods of time, the horizontal field of vision from these workstations shall extend at least over an arc from 90° on port bow, through forward, to 22.5° abaft the beam on starboard. Figure 9.

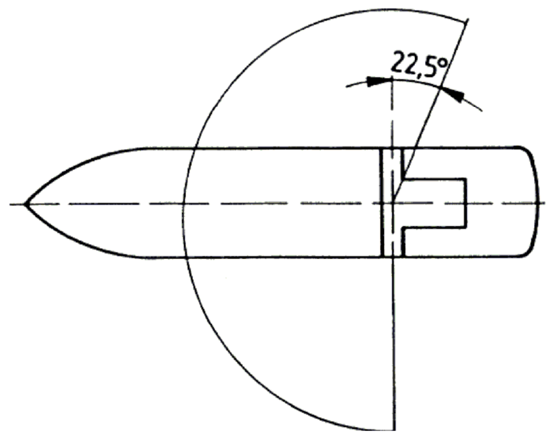

Figure 9 The field of vision from the GMDSS workstation or additional workstations

2.2.4 Blind sectors

2.2.4.1 Workstations for monitoring and navigating and manoeuvring

Blind sectors caused by cargo, cargo gear, divisions between windows and other obstructions appearing within the required field of vision of 225°, shall be as few and as small as possible, and in no way hamper a safe lookout from the workstations for monitoring and navigating and manoeuvring. The total arc of blind sectors within this field of vision shall not exceed 30°.

Guidance note:

Ref. SOLAS V reg. 22.1.2. No blind sector caused by cargo, cargo gear or other obstructions outside of the wheelhouse forward of the beam which obstructs the view of the sea surface as seen from the conning position, should exceed 10 degrees. The total arc of blind sectors should not exceed 20 degrees. The clear sectors between blind sectors should be at least 5 degrees. However, in the view described in reg. 22.1.1, each individual blind sector should not exceed 5 degrees.

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2.2.4.2 In order to reduce blind sectors within the required field of vision every effort shall be made to align the front bulkhead and bridge wings with the line-of-sight from the working positions (eye height 1500 mm) at the monitoring and navigating and manoeuvring workstations to port and starboard respectively. Figure 10.

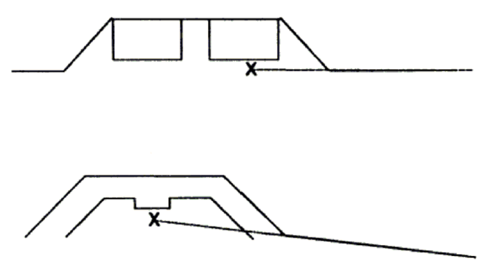

Figure 10 Front bulkhead and bridge wing bulwark in the line of sight from the workstation

2.2.4.3 Over an arc from dead ahead to at least 10° on each side of the bow, the total blind sector shall not exceed 5°. Elsewhere, each individual blind sector within the required field of vision shall not exceed 10°.

2.2.4.4 The clear sector between two blind sectors caused by obstructions outside of the wheelhouse shall be at least 5°.

The clear sector between two blind sectors caused by division between bridge windows shall not be less than the size of the broadest blind sector on either side of the clear sector.

A clear sector shall be provided from 22.5° abaft the beam and forward on both sides of the ship seen from the monitoring and navigating and manoeuvring workstations.

2.2.4.5 Divisions between windows shall be kept to a minimum and not placed in front of any working position for operation of steering and manoeuvring UIDs or in front of the radars.

2.2.4.6 Workstations for GMDSS and additional functions

A sustainable lookout shall be possible for shorter periods from the workstations for GMDSS and other functions allocated to the OOW. Additional blind sectors, caused by deck supports and other obstructions located inside or outside of the wheelhouse shall be minimized. Each individual blind sector caused by any obstruction whether inside or outside the wheelhouse shall not exceed 10º.

Guidance note:

If curtains are installed, the curtains should be stored in the after part of the console to avoid reducing the FOV, and eventually creating a blind sector from the workstation for GMDSS.

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2.2.5 Bridge windows

2.2.5.1 Window height - general

The minimum height of the upper edge of bridge window panes above the bridge deck surface shall be 2000 mm in order to provide a view of the horizon for a person in a standing position at the relevant working positions.

The maximum height of the lower edge of bridge window panes above the bridge deck shall be 1000 mm in order to provide view of the nearby sea surface for a person in a sitting position at the workstations.

Guidance note:

The maximum height of 1000 mm may be extended, provided the following condition is fulfilled:

— the lower part of the window panes should disclose all obtainable sea surface when viewed from a sitting position at the most distant workstation (*working position*). I.e. that only part of the superstructure or deck may be concealed by the extended height as viewed from the most distant workstation (eye height 1500 mm).

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2.2.5.2 Lower edge of front windows

The navigator shall obtain a good view of the sea surface in the proximity of the ship from dead ahead to 90° on either side of the workstations for navigating and manoeuvring.

When the distance between the windows and the viewing point (350 mm aft of the consoles) in sitting position at the workstations is more than 2300 mm, the height of the lower edge of the windows in the sector from 10° to 90° on each side shall be decreased sufficiently to maintain the line of sight. Figure 11.

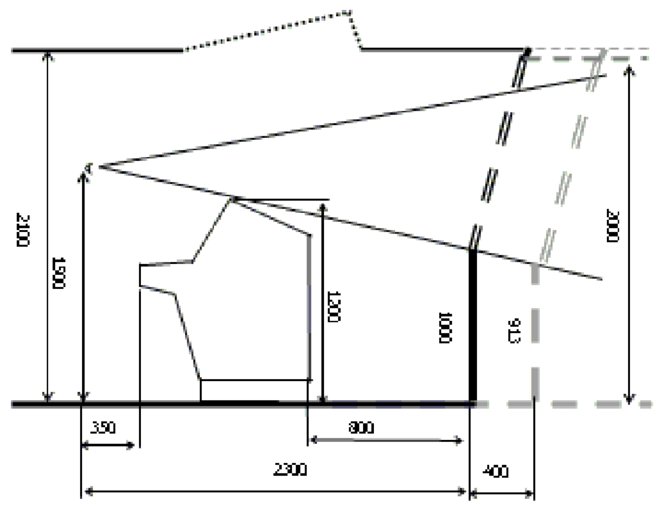

Figure 11 The height of the lower edge of windows to be decreased when the distance to front bulkhead exceeds 2300 mm

2.2.5.3 Lower edge of front windows - **NAUT(AW)**

When the distance between the windows and the viewing point 350 mm aft of the consoles in sitting positions at the workstations for monitoring and navigating and manoeuvring is more than 1500 mm, the height of the lower edge of the windows in the sector from 10° to 90° on each side shall be decreased sufficiently to maintain the line of sight. Figure 12.

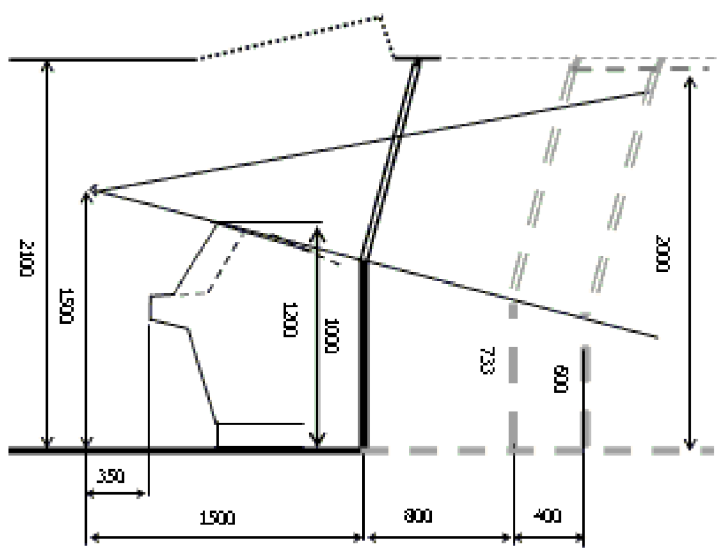

Figure 12 NAUT(AW): The height of the lower edge of windows to be decreased (lower than 1000 mm) when the distance to front bulkhead exceeds 1500 mm

2.2.5.4 Window breadth

Bridge windows should be as large as practicable to sustain a safe lookout and not less than 1200 mm wide within the field of vision required from the workstations unless otherwise is stated.

Guidance note:

The width of the window directly forward of the centre console may be less than 1200 mm in order to avoid divisions/stiffeners being located in front of any workstations.

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2.2.5.5 Window inclination

Glare in bridge windows caused by internal light sources shall be avoided and not impair the view required for conducting a proper lookout. To help avoid reflection (glare) from lights inside the wheelhouse, the bridge front windows shall be inclined from the vertical plane top out, at an angle of not less than 15° and not more than 25°. Light sources, which may cause reflection in the front windows inclined in accordance with this requirement, shall be avoided.

2.2.5.6 Side and rear windows shall be inclined from the vertical plane top out at an angle not less than 4°~5° as required to avoid glare and specular reflections from instruments and other light sources at the workstations.

Guidance note:

Vertical windows may be accepted provided that the installed equipment, lamps etc. do not cause any glare and reflection in the windows.

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2.2.5.7 Enclosed bridge wing windows

For ships with enclosed bridge wings, it shall be possible to open one side window to view the ship's side at water surface level if:

— the side windows are vertical and there are no windows in the deck providing a downward view
— the side windows are inclined but the bridge wing deck is not extended fully to the maximum width of the ship.

It shall be possible for one person to open the windows fully. Alternative solutions may be acceptable if the view cannot be achieved by opening windows alone.

Guidance note:

An adequate camera system may be acceptable for the purpose of achieving the required view. The camera system and arrangement should be approved by the Society prior to installation.

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2.2.5.8 Window stiffeners

Dimension of division between windows shall be kept to a minimum. If stiffeners are covered for decoration this shall not increase the dimensions (width and depth) of the stiffener.

Guidance note:

The division between windows, especially within the required field of vision, should not exceed 150 mm. If stiffeners are used, the width between window panes should not exceed 100 mm and the depth of the stiffeners should be less than 120 mm.

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2.2.6 Arrangements for clear view through bridge windows

2.2.6.1 From the workstations to be operated by the OOW there shall be a clear view through the bridge windows within the required field of vision at all times regardless of weather conditions.

The following installations are required:

— To ensure a clear view in conditions of rain and sea spray, heavy duty wipers and fresh water washing system shall be provided on all front windows within the field of vision required from the monitoring and navigating and manoeuvring workstations.

— To improve the visibility and reduce eye strain in bright sunshine sun-screens shall be provided on all applicable bridge windows.
— To ensure a clear view in conditions of icing and dew, an efficient de-icing and de-misting system shall be provided on all applicable bridge windows.

Systems installed shall comply with appropriate international standards. Heated glass panes shall be installed on ships to be assigned one of the Polar or Ice Breaker class notations.

Guidance note:

The window wipers should be straight-line and capable of wiping a window area of not less than 70% of the required area of panes and the maximum speed of the blades should not be less than 68 metres/minute. A blade length of 1000 mm is deemed acceptable irrespective of the size of the window pane. Reference: ISO 17899. (CVS may be installed on front windows not being perceptible from the workstations for monitoring and navigating and manoeuvring)

The sun screens should be of type roller blinds and offer anti glare and heat rejecting properties. Only the outer surface should be highly reflective while the inner surface should offer a non-reflective appearance. Anti glare effect (reduction) better than 80% and heat rejection better than 60% should be achieved.

Applicable windows are commonly all the front and side windows. However, it should be noted though that additional sunscreens may be required on aft windows to prevent direct sunlight from obscuring information on monitor screens and displays.

Reference is made to ISO 8863 and ISO 3434 for specifications of heating by hot-air and heated glass panes respectively.

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2.2.6.2 Clear view through bridge windows

The glass panes used shall not give any nonlinear or blurred effect to the line of sight.

2.2.6.3 Additional cleaning requirement for totally enclosed bridge wings

If the bridge wings are totally enclosed, heavy duty wipers and fresh water window washing shall be provided on forward and aft windows within the field of vision required from workstations for docking operations. If there is no window for opening on the bridge wing, window wipers and fresh water washing shall also be provided for the bridge wing side windows.

2.2.6.4 Additional cleaning requirement - **NAUT(AW)**

Heavy duty wipers and fresh water window washing to be provided on aft window(s) within the view astern sector required from the navigating and manoeuvring workstation.

2.2.7 Bridge configuration

2.2.7.1 Bridge wings

Bridge wings shall in general extend out to the maximum beam of the ship so as to make the ship's side visible from the workstations for docking operations.

2.2.7.2 To sustain the view of the sea surface from the workstations to be operated by the OOW the height of the bridge wing bulwark shall not exceed 1000 mm. A suitable handrail shall be fit on top of the bulwark at a height not less than 1200 mm. The opening between the bulwark and the handrail shall not be less than 120 mm.

2.2.7.3 If wind deflectors are fitted in the length of the bridge wing front, the resulting obstruction of sea surface in close proximity shall be minimized. The length of the deflector shall not impede a sector of more than 10º seen from the operating position at workstations to be operated by the OOW.

Guidance note:

The maximum height of the wind deflector above bridge deck should satisfy the following equation:

Height of wind deflection (m) $\leq 1.5 - \frac{d_w \cdot \sqrt{h_e}}{1000}$

d_w = distance from operating position at workstations to the farthest part of the wind deflector (usually from the GMDSS station) to the outermost part of the wind deflector on port side

h_e = eye height above sea level at the workstation

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Moreover, the view to starboard from the GMDSS-workstation will usually determine the length of the deflector based on the ruling blind sector.

2.2.7.4 Catwalk

A fixed catwalk or similar arrangement with means to prevent an accidental fall shall be fitted in front of the bridge windows to enable manual cleaning of windows from the outside and repair work in the event of failure of window wipers or fresh water washing system.

2.2.7.5 Height of deckhead

The clear deckhead height in the wheelhouse shall take into account the installation of deckhead mounted equipment as well as the height of door openings required for easy entrance to the wheelhouse. The following clear heights for unobstructed passage shall be provided:

The clear height between the bridge deck surface and the underside of the deck head covering (ceiling) shall be at least 2250 mm.

a) The lower edge of deck head-mounted equipment in open areas and passageways, as well as the upper edge of door openings to bridge wings and other open deck areas shall be at least 2100 mm above the deck.
b) The height of entrances and doors to the wheelhouse from adjacent passageways should not be less than 2000 mm.

2.2.7.6 Accesses

All wheelhouse doors shall be operable with one hand. Bridge wing doors shall not be self-closing and means shall be provided to hold the doors in open position.

2.2.7.7 Ships with fully enclosed bridge wings shall at least have one door allowing direct access to the adjacent bridge deck area.

2.2.7.8 Access to the compass deck shall be provided from the bridge deck in proximity of the wheelhouse.

2.2.7.9 It shall be possible to watch the deck area in front of the bridge superstructure from inside the wheelhouse by providing direct access to at least one front window.

2.2.7.10 Toilet facilities shall be provided on the bridge deck adjacent the wheelhouse.

2.3 Wheelhouse arrangement and workstation configuration

2.3.1 General requirements

2.3.1.1 The workstation arrangement shall be designed in accordance with established principles of ergonomics for safe and efficient operations, enabling the navigator to perceive all relevant information and execute pertinent actions with a minimum workload.

2.3.1.2 The safe control and command of the ship while under way shall be allocated to a certain area of the wheelhouse where only instruments, equipment and controls necessary for the performance of primary bridge functions shall be located.

2.3.1.3 From the area allocated safe control and command of the ship the navigator shall have easy access to equipment related to the safety state of the ship.

2.3.1.4 Individual workstations for performance of primary bridge functions under normal, irregular and abnormal operating conditions during the various phases of the voyage from port to port shall be provided. Such workstations shall include:

— workstation for monitoring
— workstation for navigating and manoeuvring
— workstation for manual steering
— workstation for safety monitoring
— workstations for docking operations
— workstations for conning
— workstation for voyage planning
— workstation for GMDSS.

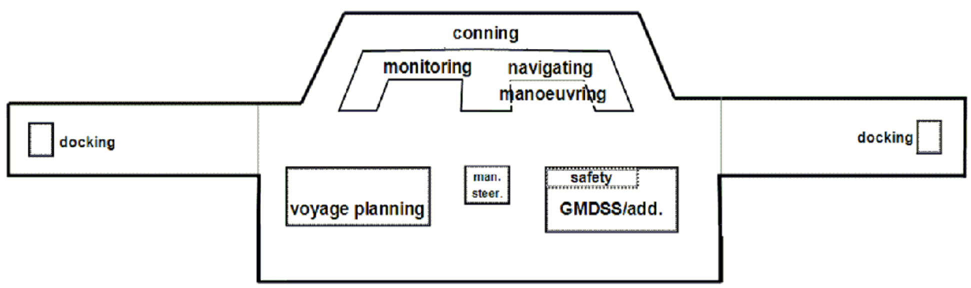

Figure 13 Design principles – example of wheelhouse arrangement

Guidance note:

The workstation for voyage planning and/or workstation for GMDSS may be waived on a particular ship on conditions recognized in the applicable requirements.

The workstation for manual steering may be waived on a particular special purpose vessel having extraordinary means for steering (e.g. multiple azipods) requiring special competence by the operator. Two conditions should be fulfilled though:

— manual steering can be exercise at the navigating and manoeuvring workstation and at least one other workstation and
— the pertinent steering UIDs located on the two workstations are autonomous and one UID can be operated by personnel other than the OOW without interfering with the navigation of the vessel.

The design of the manual steering arrangement and pertinent UIDs shall be approved by the Society prior to the waiver.

Workstation for dynamic positioning (DP) may be included in the above mentioned workstations. If DP workstation is provided, special design requirements is applicable and given in Sec.1 and Sec.2.

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2.3.1.5 The individual workstations allocated primary bridge functions shall be arranged for easy operation by one person as well as allowing close co-operation between personnel at the various workstations when manned for individual operations.

Guidance note:

The workstations for primary bridge functions, except for docking operations, should be located within an area not more than 10 m wide.

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2.3.1.6 Workstations for additional functions may be located on the bridge provided the performance of such additional functions does not interfere with the ability of the OOW to carry out the primary bridge functions. Workstations for additional functions may include:

— extended communication functions
— monitoring and control of ballasting and cargo operations
— monitoring and control of machinery
— monitoring and control of hull openings
— monitoring and control of domestic systems
— dynamic positioning.

2.3.1.7 The height of consoles forming workstations for additional functions located inside the wheelhouse shall not obstruct the sea surface within the required field of vision from sitting position at the workstations for monitoring and navigating and manoeuvring.

2.3.1.8 The navigation bridge shall not be used for purposes other than navigation, communications and other functions essential to the safe operation of the ship, its engines and cargo, and workstations should be arranged with the aim of promoting effective and safe bridge resource management.

2.3.1.9 It shall be possible for persons at a workstation to communicate with persons at other workstations of relevance for the function to be performed, under all operating conditions.

2.3.1.10 Means for controlling speed, heading and control modes shall only be located at workstations providing the required field of vision and being intended for the related tasks.

2.3.2 Passageways

2.3.2.1 There shall be a clear route across the wheelhouse from bridge wing to bridge wing for two persons to pass each other. The width of the passageway shall in the main be 1200 mm and not less than 700 mm at any single point of obstruction.

2.3.2.2 The distance between separate workstation areas shall be sufficient to allow unobstructed passage for persons not working at the stations. The width of such passageways shall not be less than 700 mm allowing for persons sitting or standing at their workstations.

2.3.2.3 If the consoles of the monitoring and navigating and manoeuvring workstations are not to be located directly against the front bulkhead of the wheelhouse then the distance between the front bulkhead and the consoles shall be sufficient for one person to pass a stationary person. The width of this passageway should preferably be 1000 mm and shall not be less than 800 mm.

Guidance note:

The Panama Canal Commission (ACP) requires a minimum of 1 metre clearance between the front bulkhead and any adjacent consoles. Requests for relaxation of this requirement may be considered by ACP on a case-by-case basis.

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2.3.2.4 The distance between bridge wing consoles, when installed, and adjacent bulwarks/bulkheads shall be as small as possible for easy operation of manoeuvring UIDs while having an optimum view of the ship's hull side and mooring operations, but yet wide enough for one person to pass the console. The width of the passageway shall preferably be 600 mm.

The Panama Canal Commission (ACP) requires a minimum of 1 metre clearance between any consoles and adjacent to bulkheads/-bulwarks

Guidance note:

Requests for relaxation of this requirement may be considered by ACP on a case-by-case basis.

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2.3.3 Console configuration

2.3.3.1 Consoles should principally be divided into two separate areas;

— one inclined area for display of information and
— one horizontal (desktop) part for the UIDs to be within reach from the working position.

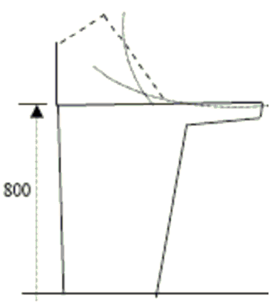

Figure 14 Principle console configuration

2.3.3.2 To provide a functional reach from standing position, the height of console desktops above bridge deck surface, equipped with UIDs should preferably be 800 mm and not less than 750 mm.

2.3.3.3 Console configuration shall provide the user with the information required to be easily readable at the workstation within a viewing angle from right ahead to 90° to each side seen from the normal working position.

2.3.3.4 The configuration of consoles at the workstations for monitoring and navigating and manoeuvring shall enable easy use of equipment required for safe and efficient performance of the tasks to be performed from both standing and sitting positions.

2.3.3.5 Leg room in consoles – **NAUT(AW)**

The console in front of the seated working position (generally the radars) shall provide sufficient leg room as required to ease the reach of equipment and controls to be used.

2.3.3.6 The leg room of the console should have a minimum of 450 mm in depth in the lower part.

2.3.3.7 Console height

The consoles forming the workstations for monitoring and navigating and manoeuvring shall not obstruct the lower part of the window panes as seen from a sitting position behind the consoles (eye height 1500 mm). The height of these consoles shall not exceed 1200 mm.

Guidance note:

A console height of 1200 mm is acceptable even if it should interfere with the line of sight from an eye height of 1500 mm providing the height of the chair can be adjusted to compensate for the obstruction.

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2.3.3.8 The height of consoles forming other workstations that are intended to be operated by the OOW shall not exceed 1300 mm. If such workstations are located within the horizontal field of vision required from the workstations for monitoring and navigating and manoeuvring then the console height shall not exceed 1200 mm.

2.3.3.9 Chart console (if provided)
The height of the chart console desktops shall preferably be 950 mm and not less than 850 mm.

2.3.3.10 The surface of the chart console desktop shall have an effective working area of at least 1 600 mm × 800 mm.

2.3.4 Chairs

2.3.4.1 The bridge design and console configuration shall permit installation of chairs at the workstations for monitoring and navigating and manoeuvring even if the ship is not to be equipped with chairs at the time of delivery.

Guidance note:

The decision on installation of chairs on the bridge is left to the current owners of the ship, considering the trade and type of the ship and the need to mitigate fatigue and promote increased concentration and efficiency of the bridge watch.

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2.3.4.2 When chairs are installed at the monitoring and navigating and manoeuvring workstations it shall be easy to adjust the vertical level of the seats to suit users of different heights for optimum view and reaching distance.

2.3.4.3 It shall be possible to regulate the chairs in fore and aft direction for easy reach of the equipment to be used and to move the chairs away from the consoles completely to achieve good working conditions from a standing position and attain an unobstructed passage next to the consoles.

2.3.4.4 It shall be easy to enter and leave the chairs in any position.

2.3.4.5 Deck rails used to support horizontal movements of the chairs shall be installed level with the deck surface to prevent tripping of personnel.

2.3.4.6 Compulsory chairs - **NAUT(AW)**
Adequate chairs shall be installed at the monitoring and navigating and manoeuvring workstations in compliance with this section. The following additional characteristics shall be attained:

— The vertical adjustment of the seat shall range from at least 600 to 800 mm above deck level.
— The chairs shall be fastened to rails, enabling easy reach of relevant equipment while seated and allowing fore and aft movement as well as the chairs being moved out-of-the-way from the workstation consoles providing a passage of ≥700 mm.
— The chair shall be equipped with an adjustable footrest.

2.3.5 Wheelhouse surveillance system

2.3.5.1 An active surveillance system shall be arranged in the wheelhouse to ensure the navigational watch being attended at all times. See [6.8] for detail system requirements.

2.3.5.2 The surveillance system shall be positioned so that it can detect activities on the conning-, monitoring- and navigating and manoeuvring workstations to verify that the OOW is on the lookout.

2.3.5.3 Other workstation areas may be included in the surveillance scheme only if their location support the minimum field-of-vision required by [2.2.3.12].

Guidance note:

If the bridge navigation watch alarm system (BNWAS) reset function is provided at workstations in the aft part of the bridge as may be relevant for vessels with an aft bridge intended for i.e. offshore operations, this bridge area should be deselected while the vessel is underway (I.e. selection is provided between fore and aft bridge).

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2.4 Workstations for primary bridge functions - location of equipment

2.4.1 General

2.4.1.1 The arrangement of equipment within the workstations shall take in the frequency of use, the importance of the related task and the ergonomics of the UID while adhering to acknowledged anthropometric measurements in order to ensure safe and efficient operations from standing or sitting positions as made applicable by the requirements.

2.4.1.2 UIDs for manoeuvring
Where several workstations are equipped with means for control of propulsion, steering and auxiliary manoeuvring device(s) the arrangement of UIDs shall be consistent on all workstations.

2.4.1.3 Where more than one unit of propulsion, steering and/or auxiliary manoeuvring devices is installed, the arrangement of pertinent UIDs and indicators/displays shall correspond to the physical arrangement of the associated power units on the ship.

2.4.1.4 All instruments shall be logically grouped according to their functions within each workstation. The operation of UIDs shall not obscure associated indicators which observation is necessary for carrying out the task.

2.4.1.5 Indicators and displays providing visual information to more than one person shall be located for easy viewing by all personnel concurrently. If this is not achievable, the indicator or display shall be duplicated.

2.4.2 Locating equipment - within reach and easily readable

2.4.2.1 Within reach from standing position
The distance the operator can reach and use an UID from a standing position next to a console. This distance shall be maximum 800 mm in forward direction and 1400 mm sideways from the working position. Figure 15.

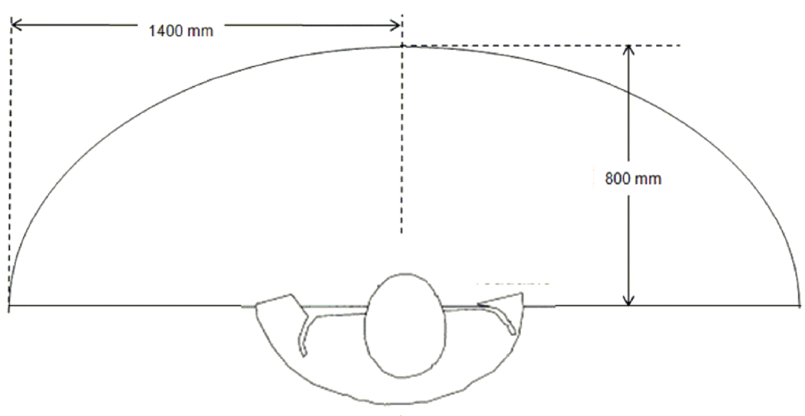

Figure 15 Area within reach from standing position

2.4.2.2 Within reach from sitting position

Location of UIDs for different tasks to be performed in a seated, at a distance of 350 mm from a console, to be maximum 1000 mm, and maximum 800 mm for frequently used equipment, which shall be within easy reach. The designated areas defined by Figure 16 when being addressed by individual requirements.

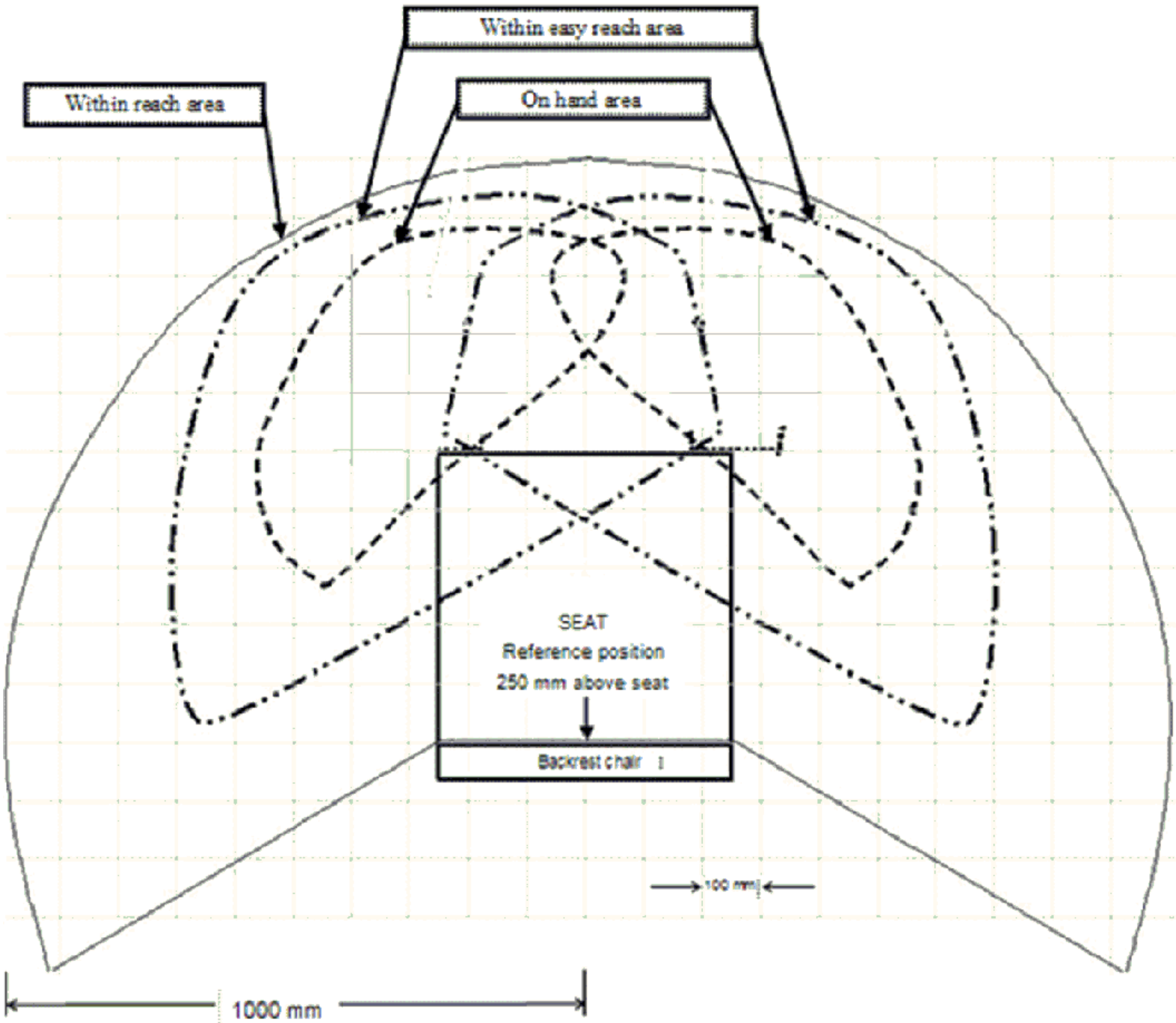

Figure 16 Areas within reach from seated position

2.4.2.3 Easily readable

For information to become easily readable at the workstation all relevant indicators and displays shall be located within the forward* 180º view sector seen from the operating position. An indicator or display that is monitored concurrently with operation of an UID shall be located within the forward 120º view sector seen from the operating position.

The indicators and displays shall be placed with its front perpendicular to the navigator's line of sight seen from the operating position, or to a mean value (angle) if the information is used by personnel located at more than one workstation.

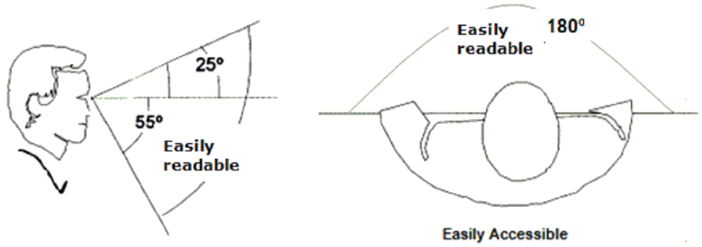

Figure 17 Forward view sector

Guidance note 1:

The height of letters and figures in mm should be not less than 3.5 times the reading distance in m. Pertinent character width should be approximately 0.7 to 0.9 times the character height, e.g.:

— letter height for reading distance 2 m: 2 × 3.5 = 7 mm
— letter width for character height 7 mm: 7 × 0.7(0.9) = 4.9 to 6.3 mm
— resulting minimum letter size: 7 mm × 5 mm.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

* On docking workstations where consoles are arranged for view astern or where consoles are arranged for operation from the outward side the term “forward” used in this requirement should be understood as astern or inward respectively.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.3 Workstations for monitoring and navigating and manoeuvring

2.4.3.1 The workstations for monitoring and navigating and manoeuvring shall be arranged to enable two navigators to carry out their tasks in close cooperation.

2.4.3.2 Various mutual equipment may be installed to serve the individual tasks allocated both these workstations provided the within reach requirement and/or readability requirement are complied with from the working positions at both workstations. Figure 18.

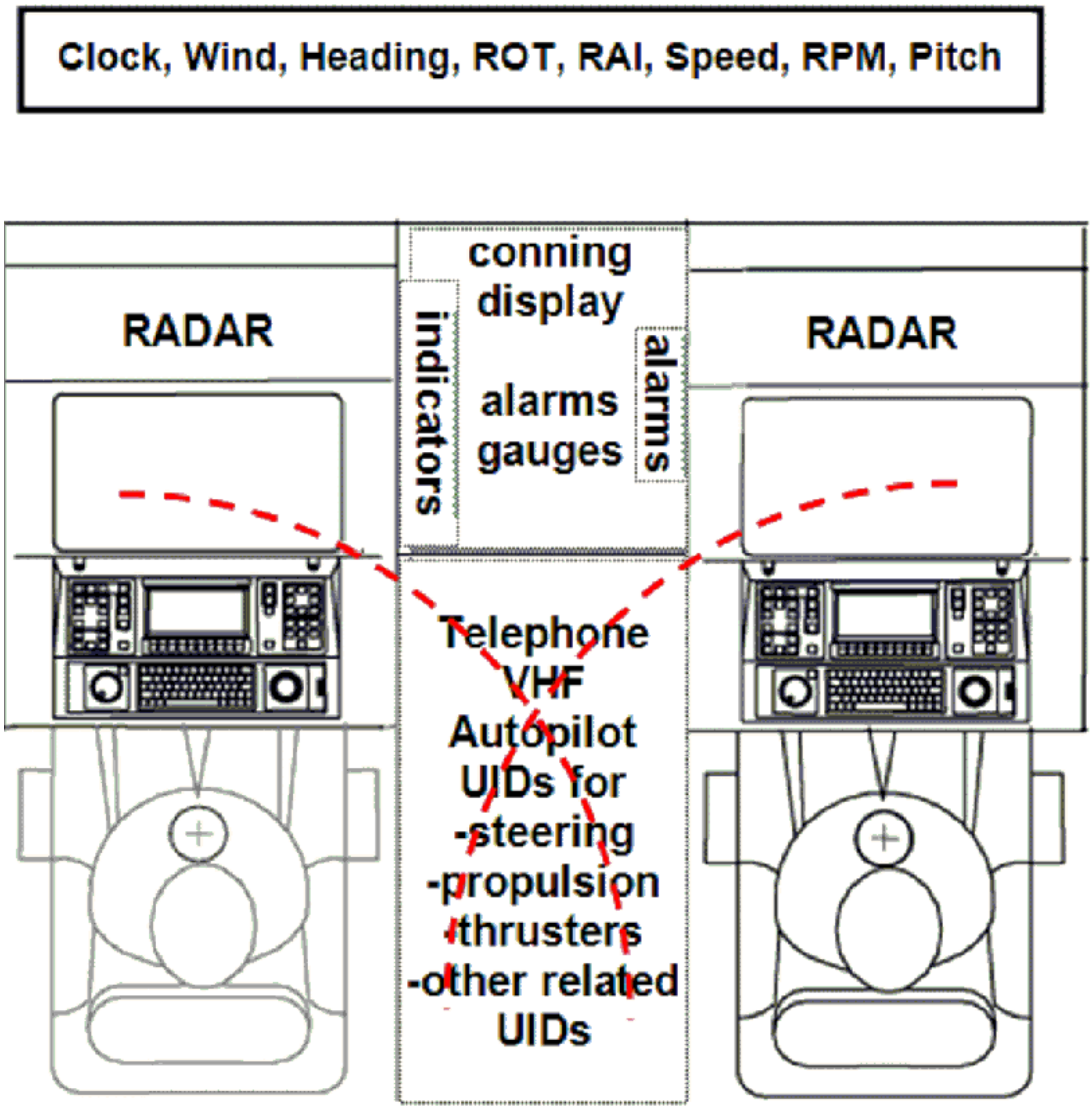

Figure 18 Shared UIDs and information displays

2.4.4 Workstation for monitoring

2.4.4.1 The workstation for monitoring shall enable the following tasks to be performed:

— determine and plot the ship's position, course, track and speed made good
— effect internal and external communication
— monitor time, heading, speed, rudder angle, propeller revolutions and propeller pitch (when applicable)
— monitor position, COG, SOG and track made good (past positions) against the voyage plan
— adjusting the voyage plan
— monitor and analyse the traffic situation
— decide on collision avoidance manoeuvres

— cooperation with personnel at the navigating and manoeuvring workstation.

2.4.4.2 Equipment to be installed

The navigation radar shall be located within easy reach from a sitting position at the monitoring workstation. Additionally the following equipment considered essential for operations at the workstation for monitoring shall be located within reach from a sitting position:

— electronic chart display and information system (ECDIS)
— VHF unit
— internal communication equipment (auto telephone)
— central alert management system UIDs.

and the following equipment shall be within reach from a standing position:

— NAVTEX
— whistle and manoeuvring light (if provided) push buttons
— control of dimmers for indicators and displays at the workstation.

Guidance note:

The NAVTEX may be located in another location if it is connected to an integrated navigation system located at the workstation for monitoring and able to show the required messages

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.4.3 Information to be provided

Instruments, indicators and displays providing information considered essential for safe and efficient operations at the workstation for monitoring shall be easily readable from both standing and sitting positions at the workstation. The equipment includes:

— gyro repeater
— rudder angle indicator
— speed indicator(s)
— distance indicator
— rate-of-turn indicator
— depth indicator
— clock
— propeller revolutions indicator
— pitch indicator, when provided
— wind speed and direction indicator
— human machine interface for presentation and handling of alerts on the bridge (CAM-HMI)
— indicator warning of surveillance period elapsing
— two GNSS-position displays (with access to satellite data).

Guidance note:

If both the ECDIS and the radars are separately interfaced with the two GNSS-receivers and the user can access HDOP, mode indicator and number of satellites in use from either of these displays it may be deemed an acceptable solution and no additional displays are required at this workstation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

If the consoles are located directly against the front bulkhead, both an AIS pilot plug, power outlet and free desktop space for a personal pilot unit (laptop) shall be provided and be within reach from a standing position.

2.4.4.4 Means to be easily accessible

Means to be used at intervals for securing safe course and speed and safety of bridge operation shall be easily accessible from the workstation for monitoring. These means include:

— instruments and equipment installed at the workstation for navigating and manoeuvring

— instruments and equipment at the workstation for safety monitoring
— window wipers and wash controls for the windows within the required field of vision
— light switch and dimmer for workstation illumination
— depth recording device
— navigation light distribution panel
— whistle fog signal control panel
— speed log control unit.

2.4.5 Workstation for navigating and manoeuvring

2.4.5.1 The workstation for navigating and manoeuvring shall enable the following tasks to be performed:

— monitor the traffic by sight and hearing as well as by available means
— analyse the traffic situation
— manage AIS information and messages
— decide on collision avoidance manoeuvres
— change course
— change speed
— change operational steering mode
— effect internal and external communication
— operate auxiliary manoeuvring devices
— monitor time, heading, speed, propeller revolutions, thrust indicator, if the ship is equipped with thrusters, pitch indicator, if the ship is equipped with pitch propeller, rudder angle and rate of turn
— monitor position, COG, SOG and track made good (past positions) against the voyage plan
— adjusting the voyage plan
— acknowledge all navigational alarms
— monitor all alarm conditions on the bridge
— cooperation with personnel at the monitoring workstation.

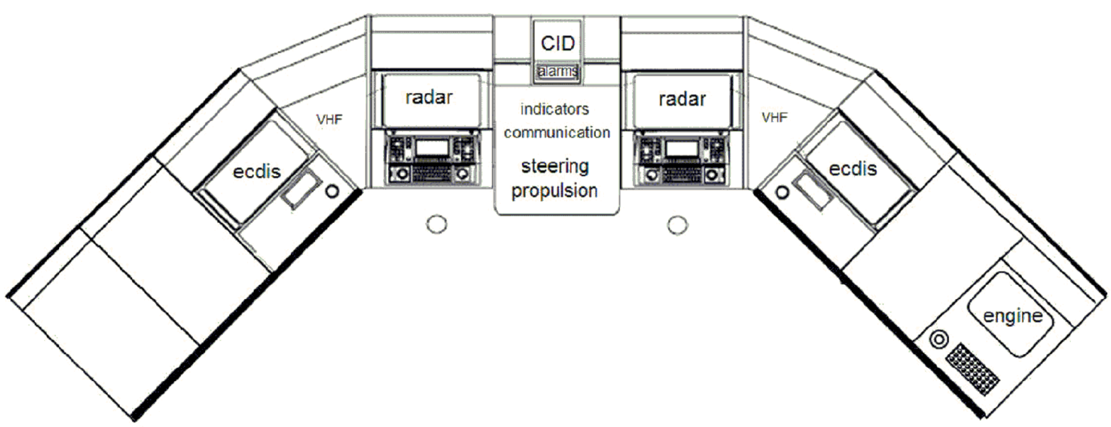

Figure 19 Example: Joint arrangement of workstations for monitoring [2.4.4] and navigating and manoeuvring [2.4.5]

2.4.5.2 Equipment to be installed
Instruments and equipment that are operated by the navigator at the workstation for navigating and manoeuvring and considered essential for safe and efficient performance of his tasks, shall be within reach from a sitting position at the workstation, priority given to location of UIDs for radar, course and speed.

The following instruments and equipment shall be installed within easy reach from a sitting position:

— navigation radar
— propulsion control
— manual steering device (follow up with take-over)
— heading control
— track control, when provided.

The following equipment shall be installed within reach from a sitting position:

— ECDIS
— steering mode selector switch
— steering control station selection (if provided)
— VHF unit
— whistle and manoeuvring light (if provided) push buttons
— internal communication equipment (auto telephone)
— central alert management system UIDs
— general alarm control
— window wiper and wash controls for the windows within the required field of vision
— control of dimmers for indicators and displays at the workstation.

The following equipment shall be within easy reach from either a sitting or standing position at the centre console:

— steering UIDs
— propulsion
— thruster UIDs, when provided
— emergency stop for propulsion machinery
— emergency stop for thruster(s), when provided.

The following equipment shall be installed within reach from a standing position at the workstation:

— gyro compass selector switch
— steering gear pumps (operation panel).

2.4.5.3 Information to be provided

Instruments, indicators and displays providing information considered essential for the safe and efficient performance of tasks at the workstation for navigating and manoeuvring shall be easily readable and audible from the working positions at the workstation and includes:

— propeller revolution indicator(s)
— thrust indicator(s), when provided
— pitch indicator(s), when provided
— speed indicator(s)
— wind speed and direction indicator
— rudder angle indicator(s)
— rate-of-turn indicator
— heading indicator
— steering mode indicator
— steering position in command (when relevant)
— depth indicator
— clock
— conning information display, when provided
— CAM-HMI
— alarm panel related to unmanned machinery space
— alarm panel related to steering control system and steering gear

— sound reception indicator/display
— indicator warning of surveillance period elapsing.

2.4.5.4 Means to be easily accessible

Means to be used at intervals for securing safe course and speed and safety of bridge operation shall be easily accessible from the workstation for navigating and manoeuvring. The means include:

— instruments and equipment installed at the monitoring workstation
— engine automatic control and monitoring system, if provided
— public address system
— instruments and equipment at the workstation for safety monitoring
— searchlight control panel, if provided
— light switch and dimmer for workstation illumination
— control panel for the sound reception system
— navigation light distribution panel
— whistle fog signal control panel
— anchor winch control panel, if provided.

2.4.5.5 Additional tasks - **NAUT(AW)**

The workstation for navigating and manoeuvring shall enable performance of the following additional tasks:

— monitor the performance and status of the equipment and sensors of the grounding avoidance system
— monitor speed over ground in both longitudinal and transversal directions.

2.4.5.6 Additional equipment - **NAUT(AW)**

The additional information displays to be readable and UIDs to be installed within reach at the workstation are:

— conning information display
— dual axis speed information display.

2.4.6 Workstations for conning

2.4.6.1 A workstation for conning of the ship shall be arranged to enable navigators (pilots) to assist in navigating and manoeuvring of the ship without interfering with the tasks of the ship's bridge personnel on duty.

2.4.6.2 The workstation for conning shall enable a pilot to observe all relevant external and internal information for determination and maintenance of safe course and speed of the ship in narrow waters, harbour areas and during canal passages.

2.4.6.3 The workstation for conning shall be located close to:

— the forward centre window in order to optimise the view of the sea surface close to the sides of the ship, and
— the workstation for monitoring and navigating and manoeuvring to allow good co-operation between all navigators, each at their workstation.

2.4.6.4 If the view in the centreline is obstructed by large masts, cranes, etc., an additional conning position providing a commanding view shall be located on the starboard side as close to the centre line as possible, and not more than 5 m from the centreline.

Guidance note:

The Panama Canal Commission requires conning positions directly behind the three centre windows.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.6.5 The monitoring workstation may serve as the conning workstation if the height of the lower edge of front windows is maintaining the line-of-sight in accordance with [2.2.5.2] for **NAUT(OC)** or [2.2.5.3] for **NAUT(AW)**.

2.4.6.6 An AIS pilot plug and power outlet and desktop space shall be provided for at the monitoring workstation if it also serves as the conning workstation.

2.4.6.7 Tasks to be performed

The workstation for conning shall enable the following tasks to be performed in narrow waters, harbour areas and during canal passages and anchoring:

— enable a pilot to monitor surrounding traffic and conduct pilotage and direct the ship's heading and speed in close cooperation with the attending bridge team
— give sound signals
— effect external communication
— monitor heading, rudder angle, rate-of-turn, propeller revolutions, propeller pitch (if controllable), status of thrusters (if provided) and speed.

2.4.6.8 Information and equipment to be provided

The instruments and equipment required for safe and efficient performance of the pilot's tasks shall be available from the workstation.

a) The indicators and displays required to be easily readable from the working position include:
   — heading indicator
   — rudder angle indicator
   — rate-of-turn indicator
   — propeller revolutions indicator
   — pitch indicator, when relevant
   — speed indicator
   — auxiliary manoeuvring device indicators (thrust), if provided.
b) Means that shall be available from the working position(s) include:
   — whistle and manoeuvring light (if provided) push buttons
   — VHF
   — AIS pilot plug, power outlet and space for a pilot personal unit (e.g. a folding table).

2.4.7 Workstation for voyage planning

2.4.7.1 A workstation for voyage planning shall be provided to enable navigators to carry out passage planning and chart works while taking in nautical publications without interfering with ongoing navigation of the ship. The workstation shall be equipped with means for efficient voyage planning and means for direct transfer of the planned voyage to the monitoring and navigating and manoeuvring workstations.

Guidance note:

The workstation for voyage planning may be waived if the vessel is not to be engaged in world wide trade but should operate only in regional waters having adequate coverage of ENCs. See [1.1.5.3] for information about the waiver.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.7.2 Tasks to be performed

The workstation for voyage planning shall enable the following tasks to be performed:

— determine and plot the ship's position
— plan the forthcoming voyage on the basis of available information from charts and nautical publications
— plotting of the intended track in appropriate charts including: planned courses, radii of turns, wheel-over-lines, distances, ETAs, as well as identification of all areas of danger, existing ships' routeing and reporting

systems, vessel traffic services, and any areas where marine environmental protection considerations apply
— transferring the voyage plan to the ECDIS' on the workstations for monitoring and navigating and manoeuvring.

2.4.7.3 Equipment to be installed
In order to enable efficient performance of the tasks the following means and equipment shall be installed at the workstation:

— position display
— voyage planning terminal interconnected with ECDIS (within easy reach from standing position)
— weather information device
— clock
— a chart console suitable for plotting of the intended track in nautical paper charts
— storage space (drawers) for all nautical paper charts
— storage appliance for nautical publications (incl. CDs/DVDs).

2.4.8 Workstations for manual steering

2.4.8.1 The workstation for manual steering shall enable the helmsman to carry out the following tasks:

— control the position of the rudder (rudder angle)
— maintain a steady heading by compass readings as well as external visual means
— maintain a steady rate-of-turn
— conduct two-way communication with workstations for conning, navigating and manoeuvring and docking operations.

2.4.8.2 Information and equipment to be provided
The following equipment, indicators and displays shall be easily readable from the workstation:

— gyro repeater
— rudder angle indicator
— rudder order indicator, when follow-up steering is provided
— magnetic compass display
— rate-of-turn indicator.

The following equipment should be located on hand from the working position:

— manual steering UID(s) (helm)
— communication equipment
— control of dimmers for indicators and displays at the workstation.

Guidance note:

The communication equipment may be a suitable wireless system (e.g. UHF) or a PA talk-back system or similar fixed installation.

The communication equipment may be waived on vessels with enclosed bridge wings if the distance to the docking workstations is <10 m and the noise level <65 dB(A).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.8.3 The workstation for manual steering shall preferably be located on the ship's center line and shall not interfere with the functions to be performed by navigators at the monitoring and navigating and manoeuvring workstations.

2.4.8.4 If the view ahead is obstructed by large masts, cranes, etc., the workstation for manual steering should preferably be located off the centre line to obtain a clear view dead ahead.

When the workstation is located off centre line a steering reference (range and light) shall be installed in the fore ship, equally distanced off the center line, and clearly visible from the working position by day and night.

If the fore ship (e.g. stem or foremast) cannot be seen from the working position an equivalent steering reference shall make up a line-of-sight parallel to the ship's cent line for use by the helmsman.

Guidance note:

The Panama Canal authority (ACP) requires all ships >100 m in length to install, at or near the stem, a steering range equipped with a fixed blue light which should be clearly visible from the bridge along the cent line. The height of the light should be as close as possible to the height of eye level on the bridge. If said range and light so placed would be partially or completely obscured from Conning Position 1, then two such ranges and lights should be installed ahead of Conning Positions 2 and 3.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.9 Workstation for emergency steering

2.4.9.1 The workstation for manual steering in the steering gear compartment shall enable the following tasks to be performed from the working position:

— control the position of the rudder (rudder angle)
— monitor rudder angle
— monitor heading
— effect two-way communication with the bridge.

Equipment to be available at the workstation for emergency steering

2.4.9.2 The following equipment shall be available and readable from the working position while operating the steering UIDs:

— UIDs for controlling the rudder angle (on hand)
— hands-free internal communication (headset)
— heading indicator
— means for reading rudder angle.

2.4.10 Workstation for safety monitoring

2.4.10.1 The workstation for safety monitoring shall enable monitoring of all the equipment and alarm panels installed relating to the safety state of the ship as well as relevant UIDs provided for instant actions and tasks assigned to the OOW at the initial stage of an emergency situation. At least the following tasks are assigned to the OOW:

— observe and deal with equipment installed for monitoring of the safety state and integrity of the ship
— take immediate action on alarms and execute relevant measures according to contingency plan
— call upon other personnel for assistance and/or communicating situational awareness.

2.4.10.2 Equipment to be provided

Equipment installed for monitoring and early detection of internal dangers threatening the integrity of the ship shall be centralised in the workstation for safety monitoring together with pertinent UIDs being fitted for urgent follow-up actions.

The following equipment shall be easily readable and operable from a standing position at the safety workstation when being installed in the wheelhouse:

— fire detection system
— smoke detection systems
— control panel for fire pumps
— control panel for fire doors
— control panel for watertight doors
— control panel for hull openings and hatches
— emergency stop for ventilation fans
— gas detection systems
— any monitoring, alarm or safety system for additional functions assigned to the OOW

— internal communication system (auto telephone)
— general emergency alarm system
— public address system
— fire-fighting local application system(s)
— other safety systems if fitted.

2.4.10.3 The location and configuration of this workstation shall:

— enable personnel to carry out the relevant functions at the workstation without interfering with the tasks to be performed at the workstation for navigating and manoeuvring
— enable a person at the workstation to observe the workstation for navigating and manoeuvring and maintain the field of vision for proper lookout
— enable the navigator at the workstation for navigating and manoeuvring to observe information related to the safety state of the ship.

Guidance note:

For passenger ships the workstation for safety monitoring should be separated from workstation for navigation and navigation support in such a way that management of emergencies can be performed without distracting watch officers from their navigational duties. MSC82/24 Annex 2.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.10.4 The workstation for safety monitoring shall be located for easy viewing from the workstation for navigating and manoeuvring. All alarms and warnings appearing on the safety equipment shall be apparent and distinguishable from the normal working position at the workstation for navigating and manoeuvring.

2.4.10.5 Additional means to be provided

The following means to organise and execute emergency operations shall be easily accessible:

— hard copies of safety plans and drawings with desk top space to accommodate study of drawings or computer system providing all relevant information
— the GMDSS installed at the workstation for communication.

2.4.11 Workstations for docking operations

2.4.11.1 The workstations for safe docking of the ship shall enable the navigator together with a pilot to observe all relevant external and internal information to direct the manoeuvring of the ship.

2.4.11.2 Tasks to be performed

The workstation for docking operations shall enable the following tasks to be performed:

— supervision of docking operations
— monitor the ship's heading, rudder angle, propeller revolutions, propeller pitch (if relevant) and thruster(s) (if relevant)
— release sound signals
— monitor the relevant mooring operations on board and ashore
— govern the mooring operations by having orders effected
— effect two-way communication with mooring stations on board and ashore
— effect two-way communication with wheelhouse workstations for manual steering and navigating and manoeuvring.

2.4.11.3 Equipment to be available

Equipment essential for the safe performance of docking operations shall be within reach from a standing position providing the required field of vision and is including:

— whistle and manoeuvring light (if provided) push buttons

— means for two-way communication with mooring stations on board and relevant workstations in the wheelhouse
— VHF unit
— control of dimmers for indicators and displays at the workstation.

Guidance note:

A wireless portable radio system (UHF) enabling hands-free operation may be acceptable as means for two-way communication between personnel involved in mooring operations. See [6].

The VHF unit may be a handset enabling selection of channels, or a complete mobile unit. If a handheld or mobile unit is used, a specific location at the workstation should be provided with means supporting the VHF unit.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.11.4 Information to be provided

Information essential for safe conduct of the docking operations shall be easily readable from the workstation for docking operations.

The following information indicators shall be easily readable from the workstation:

— propeller revolutions indicator(s), and propeller pitch indicator(s) (when applicable)
— thruster indicator(s) (when applicable)
— rudder angle indicator
— heading indicator.

2.4.11.5 Additional tasks - NAUT(AW)

The workstations shall enable the following additional tasks to be performed:

— control the position of the rudder (rudder angle)
— control the propulsion (RPM/Pitch)
— control the thrusters (if installed)
— effect two-way communication with engine control room, steering gear and department offices.

2.4.11.6 Additional equipment - NAUT(AW)

The following additional equipment shall be installed within reach from a standing position at the workstation providing the required field of vision to enable safe performance of the tasks:

— propulsion UID
— thruster UID, if provided
— steering UID
— internal communication (auto telephone)
— window wiper and wash controls for the windows within the required field of vision.

The following additional indicators or displays shall be easily readable from the working position:

— starting air pressure
— speed indicator displaying longitudinal and transversal speeds
— wind speed and direction
— CID, CAM-HMI and ECDIS (when provided at the WS or when **INS+**)
— rate-of-turn indicator.

Guidance note 1:

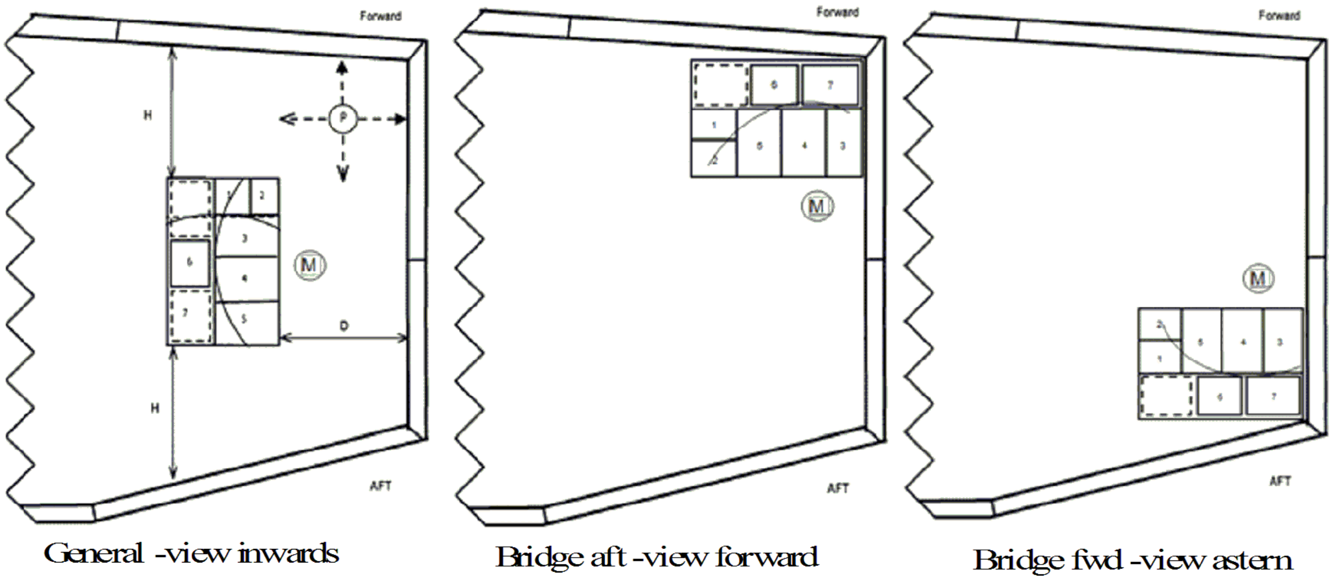

Figure 20 Examples on arrangement of docking workstation

D: 600 ≤ Distance ≤ 800 mm	1: VHF	5: Steering UID
H: Passageway ≥ 700 mm	2: Whistle	6: Internal communication
M: Working position	3: Thruster UID	7: Indicators and displays
P: Pilot	4: Propulsion UID	See also FOV requirement of [2.2.3.10].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

*ACP requires a minimum of 1 m clearance from the console to the outer bulwark on the bridge wing. Requests for relaxation of this distance may be granted by ACP on a case-by-case basis.

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2.4.11.7 MFD equipment required - NAUT(AW, INS+)

The workstations for docking operations shall be provided with two independent MFD-displays supporting applications for radar, ECDIS, conning display and central alert management (CAM).

Guidance note:

The MFDs may substitute for the separate indicators/-displays required on these workstations provided the screen type is easily readable in bright daylight (sunshine).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.12 Workstations for GMDSS

2.4.12.1 In order to maintain the safety of navigation, also when the OOW is responsible for GMDSS-operations, pertinent equipment shall be located in a separate workstation for communication in close vicinity of the navigating and manoeuvring workstation.

Guidance note:

If the workstation for GMDSS is not to be operated by the OOW, it may be located elsewhere but should then be easily accessible from the workstation for emergency operations. Both workstations may be waived if their functions are arranged for outside the bridge area.

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2.4.12.2 The GMDSS equipment installed for detection of ships in distress shall be audible and visible to the OOW at the navigating and manoeuvring workstation. The visibility requirement may be renounced though if the audible alarm has a characteristic sound being easily identifiable.

2.4.12.3 From the normal working position at the GMDSS workstation it shall be possible to observe the equipment on the workstation for navigating and manoeuvring, monitor the ship's heading and rudder angle as well as maintaining a proper lookout.

2.5 Additional workstations

2.5.1 Additional functions assigned the officer of the navigational watch

2.5.1.1 In order to maintain the safety level in bridge operation, also when the officer of the watch performs other functions than those related to primary bridge functions, the following requirements shall be complied with:

a) Each additional function shall be designated a separate workstation (separate workstations may be adjacent primary workstations).
b) From workstations for additional functions, it shall be possible to monitor the workstation for navigating and manoeuvring, the ship's heading and rudder angle, and to maintain the minimum field of vision for efficient lookout.
c) The workload at workstations for additional functions shall not prevent the officer of the watch from maintaining a proper lookout.
d) In situations where primary functions may require the immediate attention of the OOW, nothing shall prevent abandoning a workstation for additional functions.
e) It shall be possible to operate workstations for additional functions without interfering with the operation of workstations for primary functions.

2.5.2 Other functions located on the bridge

2.5.2.1 Other functions than those related to navigation, manoeuvring, safety and distress may be performed on the bridge by other personnel than the officer of the watch, provided the following requirements are complied with:

a) The additional tasks to be carried out at workstations for other functions shall not in any way affect the performance of primary bridge functions, neither by use of light or noise disturbance nor visual or audible distractions.
b) Furniture arranged for meetings or relaxation shall preferably not be installed within the area of the navigating bridge. If still provided, such arrangements shall not to be located within the field of vision sectors required from the workstations for primary bridge functions.

Guidance note:

IMO urges governments to ensure that ship's navigation bridge is not used for purposes other than navigation, communication and other functions essential to the safe operation of the ship, its engines and cargo. IMO Res. A.708(17).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.6 Requirements specific for class notation NAUT(AW) and NAUT(AW, INS+)

2.6.1 General

2.6.1.1 This subsection gives an overview of the requirements specifically addressing **NAUT(AW)** and **NAUT(AW, INS+)** in [2.2] to [2.5].

2.6.2 Field-of-vision from workstations

2.6.2.1 Workstations for navigating and manoeuvring – vertical view NAUT(AW)

To be able to view objects and river banks in the proximity of the ship, a person standing at the workstation for navigating and manoeuvring shall be able to observe the sea surface at a distance of no more than 500 m from the hull within the sectors from 10º on either side of the bow to 90º on both sides, under all conditions of draught, trim and deck cargo (eye height 1500 mm). See Figure 5.

2.6.2.2 Workstations for navigating and manoeuvring - horizontal view astern NAUT(AW)

The navigator shall be able to employ leading lights and marks astern of the ship as visual reference for grounding avoidance, while seated at the workstation for navigating and manoeuvring. A field of vision sector astern shall be available and extend over an arc from dead astern to at least 5º on each side. No blind sectors shall occur within this 10º field of vision sector.

Guidance note:

Leading lights (or range lights) consist of two lights, separated in distance and elevation, so that when lined up vertically, with one behind the other, they provide a bearing to be used for positioning of the vessel in fairways.

Adequate camera(s) may be accepted for the purpose of achieving the required field of vision astern. The camera system and arrangement should be approved by the Society prior to the installation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.6.2.3 Workstations for navigating and manoeuvring - vertical view astern - NAUT(AW)

The vertical view through the aft window pane(s), seen from the workstation for navigating and manoeuvring shall enable the navigator to view the sea surface in the wake of the ship at a distance not more than 2000 m abaft the stern.

The upper edge of the window(s) shall not be less than 2000 mm above bridge deck surface.

The maximum height from deck to the lower edge of the window(s) shall be 1000 mm or at least fulfil the following condition:

The lower part of the window panes shall disclose all obtainable sea surfaces aft of the vessel when viewed from a sitting position at the navigating and manoeuvring workstation. Only the superstructure/-deck may be concealed when viewed from seated position at this workstation (eye height 1500 mm).

2.6.2.4 Workstation for docking operations - vertical view NAUT(AW)

The vertical view from the docking workstation shall enable the navigator(s) to observe the parallel hull side of both fore ship and stern from a standing position besides the console while operating the UIDs on hand for manoeuvring of the ship. The hull's side plates shall be visible over a total length of not less than L/2 (eye height 1500 mm). See Figure 7.

Guidance note:

Windows should be arranged in the lower part of the bulwark and deck as appropriate to obtain the required vertical view.

Alternatively, adequate cameras may be accepted. The camera system and arrangement should be approved by the Society prior to the installation.

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2.6.3 Bridge windows

2.6.3.1 Lower edge of front windows - NAUT(AW)

When the distance between the windows and the viewing point 350 mm aft of the consoles in sitting positions at the workstations for monitoring and navigating and manoeuvring is more than 1500 mm, the height of the lower edge of the windows in the sector from 10° to 90° on each side shall be decreased sufficiently to maintain the line of sight. See Figure 12.

2.6.4 Arrangements for clear view through bridge windows

2.6.4.1 Additional cleaning requirement - NAUT(AW)

Heavy duty wipers and fresh water window washing to be provided on aft window(s) within the view astern sector required from the navigating and manoeuvring workstation.

2.6.5 Console configuration

2.6.5.1 Leg room in consoles – NAUT(AW)

The console in front of the seated working position (usually the radars) shall provide sufficient leg room as required to ease the reach of equipment and controls to be used.

2.6.6 Chairs

2.6.6.1 Compulsory chairs - NAUT(AW)

Adequate chairs shall be installed at the monitoring and navigating and manoeuvring workstations in compliance with this section. The following additional characteristics shall be attained:

- The vertical adjustment of the seat shall range from at least 600 to 800 mm above deck level.
- The chairs shall be fastened to rails, enabling easy reach of relevant equipment while seated and allowing fore and aft movement as well as the chairs being moved out-of-the-way from the workstation consoles completely.
- The chair shall be equipped with an adjustable footrest.

2.6.7 Workstation for navigating and manoeuvring

2.6.7.1 Additional tasks - NAUT(AW)

The workstation for navigating and manoeuvring shall enable performance of the following additional tasks:

- monitor the performance and status of the equipment and sensors of the grounding avoidance system
- monitor speed over ground in both longitudinal and transversal directions.

2.6.7.2 Additional equipment - NAUT(AW)

The additional information displays to be readable and UIDs to be installed within reach at the workstation are:

- conning information display
- dual axis speed log display.

2.6.8 Workstations for docking operations

2.6.8.1 Additional tasks - NAUT(AW)

The workstations shall additionally enable the following tasks to be performed:

- control the position of the rudder (rudder angle)
- control the propulsion (RPM/Pitch)
- control the thrusters (if installed)
- effect two-way communication with engine control room, steering gear and department offices.

2.6.8.2 Additional equipment - NAUT(AW)
The following additional equipment shall be installed within reach from the working position to enable safe performance of the tasks:

— propulsion UID
— thruster UID, if provided
— steering UID
— internal communication (auto telephone).

The following additional indicators or displays shall be easily readable from the working position:

— speed indicator displaying longitudinal and transversal speeds
— wind speed and direction
— CID, CAM-HMI and ECDIS (when provided at the WS or when **INS+**).

2.6.8.3 MFD equipment required - NAUT(AW, INS+)
The workstations for docking operations shall be provided with two independent MFD-displays supporting applications for radar, ECDIS, conning display and alarm management system.

Guidance note:
The MFDs may substitute for the separate indicators/-displays required on these workstations provided the screen type is easily readable in bright daylight (sunshine).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3 Workplace environment

3.1 General

3.1.1 Scope and application

3.1.1.1 This section contains human factors design requirements pertaining to the workplace environment in the wheelhouse.

3.1.2 General

3.1.2.1 Throughout the various design stages of the ship care shall be taken to achieve a good working environment for bridge personnel.

3.1.2.2 Equipment installed to control the workplace environment shall be capable of sustained operations within the climatic extremes specified for the ship.

3.2 Environmental factors

3.2.1 Vibration

3.2.1.1 Uncomfortable levels of vibration causing short and/or long term effects on human body shall be avoided in the bridge area.

Guidance note:
The vibration levels on the bridge deck should not exceed 0.16 m/s^2 from 0.5 Hz to 5 Hz, and 5 mm/s from 5 Hz to 100 Hz.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.2.2 Noise

3.2.2.1 Uncomfortable levels of noise, and noise which may affect safe and efficient bridge operation, shall be avoided in the bridge area. Consideration shall be made to the need for speech, telephone and radio communication and for hearing audible alarms and sound signals.

Guidance note:

The noise level (sound pressure) for the wheelhouse workplace should not exceed 65 dB(A) while the ship is underway and with all normal bridge equipment in operation (measured in good weather conditions).

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3.2.3 Climate control system

3.2.3.1 The bridge shall be equipped with a temperature control and ventilation system that allows regulation of the temperature and humidity in the wheelhouse enabling bridge personnel to maintain the workplace thermal environment within the range of the human comfort zone.

3.2.3.2 It shall be possible to maintain the effective temperature range in the wheelhouse within 18°C to 27°C for an external temperature range of -10°C to +35°C. The temperature gradient inside of the wheelhouse shall not exceed 5°C.

Guidance note:

Approximately 45% relative humidity should be provided at 21°C and decrease with rising temperatures.

The thermal comfort zone for personnel varies. The optimum range of effective temperature for accomplishing bridge tasks while dressed appropriately for the climate is 21° to 27°C in a warm climate and 18° to 24°C in a colder climate (DOT/FAA/CT-96/1).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.2.3.3 The ventilation system shall ensure a sufficient exchange rate and air movement inside the wheelhouse.

Guidance note:

— In general, air movement should vary with the different temperatures in the wheelhouse: the higher the temperature, the greater the air movement needed for comfort. With temperature maintained in the range 18°C to 23°C, the air movement should preferably be 0.3 m/s and not exceed 0.5 m/s.
— The rate of air exchange for the wheelhouse (enclosed space) should be >360 m^3/hour and not less than 40% of this volume should be an outdoor air supply.
— The exhaust airflow should be at least the same volume as the supply airflow.
    — The recommended rate of air circulation for enclosed spaces is depending on the number of personnel in the room and is >0.02 m^3/s per person with 40% outdoor supply.
— The weighted sound pressure level specified for the air distributing system measured 1 m from the air discharge should not exceed 55 dB(A).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.2.3.4 The ventilation system shall be installed so that air discharges are not directed at personnel located at their workstation.

3.3 Lighting

3.3.1 General

3.3.1.1 An adequate level of lighting shall be provided, facilitating the performance of all bridge tasks at sea and in port, during daytime and night-time. The lighting shall comprise both general lighting and task related lighting to ensure that illumination is compatible with individual operations and tasks.

3.3.2 Illumination levels

3.3.2.1 The lighting system shall enable the bridge personnel to adjust the illumination level as required in different areas of the bridge and by the needs of individual tasks. Table 5.

Guidance note:

Local arrangement for adjustment of illumination level and direction of light should be provided at all workstations. White ceiling lights for general bridge illumination do not require dimming facilities.

Table 5 Illumination levels

Place	*Colour and illumination*
Wheelhouse, general	White, at least 200 lux
Workstations (day)	White, at least 300 lux
Workstations (night)	Red, variable up to 20 lux
Open staircase inside wheelhouse (day)	White, at least 200 lux
Open staircase inside wheelhouse (night)	Red, variable up to 20 lux (Alt: fixed indirect red or filtered white light may be provided in the steps)
Chart table (day)	White, variable 100-1000 lux
Chart table (night)	White filtered, variable up to 20 lux
Toilet (day)	White, at least 200 lux
Toilet (night)	Red, variable up to 20 lux

Lighting controls should always be arranged at entrances and exits to adjacent rooms. Light controls should preferably be noticeable in darkness.

The white illumination levels should be available on the desktops/consoles, (70 cm above the deck surface in the absence of consoles) on a dark rainy day.

The red and filtered illumination levels shall be available during hours of darkness.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.2.2 During hours of darkness; the lighting provided to discern control devices and read labels and markings shall preserve the night vision of the OOW. It shall be possible to dim down the illumination intensity to nearly zero.

Guidance note:

Except at the chart table, red light or filtered white light (CIE coordinates x and y equals 0.330) should be used whenever possible in areas or on items of equipment requiring illumination in the operational mode, including bridge wing instruments. Provision should be made to prevent red lights from being visible from outside of the ship. Local lighting with red dimmable narrow beam light fixtures and minimum horizontal stray light should be arranged at each workstation. An example on local lighting may be gooseneck lamps.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.2.3 The voyage planning workstation shall sustain the required illumination levels independent of the lighting of the rest of the wheelhouse. Lighting of workstations which may be used by personnel other than OOW shall have separate ON/OFF switch (circuit).The lighting and any glare shall be properly shielded at all times. If curtains are provided these shall not obscure the minimum FOV-sectors required for the OOW to maintain a proper lookout including the 360º view from inside the wheelhouse.

3.3.3 Specular reflections and glare

3.3.3.1 Care shall be taken to avoid glare and stray image reflections on windows and deckhead surfaces. High brightness contrast between work areas and surroundings shall be avoided.

Guidance note:

Ceiling mounted night time lighting arrangements should be sufficiently screened or retracted into the ceiling to avoid unwanted horizontal stray of light. A non-reflective surface should be used on the surface of the retraction or screen. Floodlight arrangement should be fitted with a non-reflective raster screen.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.3.2 The bridge surface finishes shall have a dull, matt coating and colours with low reflection range in order to reduce specular reflections and glare to a minimum. Ceiling, bulkheads and consoles are of special importance. See Table 6 for information on reflection range for typical colour densities.

Guidance note:

The following are recommendations to reduce glare and specular reflections in the wheelhouse:

a) The contrast ratio between the luminance of workstations and adjacent areas in the wheelhouse should not exceed 3:1.

b) Light sources should as far as possible not be placed within the FOV sector through a 30 degrees vertical line of sight when the eyes are in the working position.

c) Smooth and polished surfaces shall be avoided inside the wheelhouse.

Table 6 Reflection range for some typical colour densities

Reflectance range	*Typical colour densities*
5% to 10%	Dark Green Blue or Brown
15% to 30%	Mid Green Blue or Red
50% to 60%	Pale Green Blue or Yellow
80% to 90%	Off White Pale Yellow

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.3.3 Lighting sources located in adjacent rooms and corridors shall be prevented from illuminating the wheelhouse at night time.

Guidance note:

Automatic door switches preventing white light from flooding the bridge area should be fitted on entrances from adjacent rooms and corridors.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.3.4 It shall be avoided that glaring lights from deck lights and searchlights are dazzling the operator at the workstations.

3.3.4 Colours

3.3.4.1 Colours shall be chosen to give a calm overall impression and minimise reflections.

Guidance note:

Bright colours should not be used. Dark or mid green colours are recommended; alternatively, blue or brown may be used. See Table 6.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.4 Safety of personnel

3.4.1 General

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

Guidance note:

There should be no sharp edges or protuberances that could cause injury to personnel. The bridge deck should be free of trip hazards; such as curled up carpet edges, loose gratings or equipment. Means should be provided for properly securing portable equipment.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.4.1.2 Hand or grab rails shall be fitted to enable personnel to stand and move safely between workstations in bad weather. Protection of stairway openings shall be given special consideration.

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

3.4.1.4 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.

3.4.1.5 Wheelhouse deck, bridge wings and bridge deck shall have a non-slippery surface in both wet and dry conditions.

4 Bridge equipment - carriage requirements

4.1 General

4.1.1 Scope

4.1.1.1 This section contains the minimum range of bridge equipment to be installed for compliance with this section.

4.1.1.2 It is assumed that all ships shall comply with the equipment carriage requirements of SOLAS.

4.1.2 Application

4.1.2.1 Ships requesting class notation **NAUT(OC)** shall comply with the carriage requirements of subsection [4.2]. Ships requesting class notation **NAUT(AW)** shall comply with the carriage requirements of both subsections [4.2] and [4.3].

4.1.2.2 Ships applying for the qualifier **INS+** shall in addition fulfil the supplementary requirements of sub-section [4.4].

4.2 Basic bridge equipment

4.2.1 Steering control systems

4.2.1.1 Manual steering control

The ship shall be equipped with two independent manual steering control systems with pertinent UIDs provided in the wheelhouse and at least one system shall support follow-up-control.

It shall be possible to select the steering mode provided at each workstation.

4.2.1.2 Override function

The FU manual steering (azimuth thrusters if provided) shall have a override function (tiller/miniwheel) located as described in [2.4.5.2].

4.2.1.3 Heading control system

A heading control system (HCS) enabling automatic steering of the ship with a minimum use of rudder and being adaptive to various loading and weather conditions shall be provided.

4.2.1.4 Rate-of-turn gyro

A rate-of-turn-gyro or other approved means for measuring angular rate shall be provided.

Guidance note:

The ROT-gyro information may also be derived from the gyro system provided that the requirements of [6] are complied with.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.1.5 Indicators

The ship shall be equipped with at least two independent rudder angle indicating systems.

Guidance note:

One of the RAI-systems may share the feedback unit with the heading control system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.1.6 A sufficient number of rudder angle indicators and rate-of-turn indicators shall be provided as needed to be readable at all steering control positions as well as all applicable workstations.

Guidance note:

Applicable workstations may be conning, monitoring, navigating and manoeuvring, manual steering, GMDSS station (RAI), docking(RAI).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2 Heading information systems

4.2.2.1 Main compass system

Two separate and independent gyrocompasses or other approved means having the capability to determine the ship's heading in relation to geographic (true) north shall be provided.

Guidance note:

Compass A is independent of compass B when any single system failure occurring in system A has no effect on the maintained operation of system B and vice versa.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2.2 Gyro repeaters shall be provided as needed to provide heading information at all steering control positions and being readable at all the applicable workstations. Additional gyro bearing repeaters shall be provided suitably positioned to cover an azimuth of 360° around the ship.

Guidance note:

Applicable workstations may be conning, monitoring, navigating and manoeuvring, manual steering, GMDSS station, docking stations and other workstations to be operated by the OOW.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2.3 Distribution system

The distribution system shall enable continuous distribution of heading information to repeaters, radar systems, heading control- and track control systems and ECDIS.

Duplicated processing and distribution units are required. See also [6.3.1.3].

4.2.3 Speed information systems

4.2.3.1 SDME
A speed log, or other approved means, for measuring the ship’s speed and distance through the water continuously shall be provided.

Guidance note:

The system should be able to support uninterrupted output of ship's speed through the water (STW) to the radars also when other speed modes are selectable (e.g. SOG).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.3.2 A sufficient number of speed indicators shall be provided as needed to be readable at applicable workstations.

Guidance note:

Applicable workstations may be conning, docking, monitoring and navigating and manoeuvring.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.3.3 Propulsion and thrust
A sufficient number of RPM, pitch, and thruster indicators when relevant, shall be installed as needed to be readable at applicable workstations.

Guidance note:

Applicable workstations may be conning, monitoring, navigating and manoeuvring and docking.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4 Collision avoidance – decision support systems

4.2.4.1 Radar systems
The vessel shall be provided with two separate and independent radar systems. One radar shall operate in the X-band (9 GHz). The other radar shall operate in the S-band (3 GHz).

Guidance note:

Where extraordinary operational aspects are deemed to exists, two X-band radars may be justifiable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4.2 Both radar systems shall be equipped with a performance monitor.

4.2.4.3 Both radar systems shall support user selectable inter-switching being operable from relevant workstations.

4.2.4.4 Both radar systems shall support full CAT 1 functionality.

4.2.4.5 Both radar systems shall be able to display and acquire AIS targets.

4.2.4.6 At least one radar system shall be a chart radar.

4.2.4.7 At least one radar system shall support AIS minimum keyboard and display (MKD) functionality.

Guidance note:

If at least one ECDIS required by the rules are supporting AIS MKD functionality this may be accepted as an equivalent solution.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4.8 Automatic identification system
The ship shall be equipped with an automatic identification system (AIS) supporting interconnection with the two radars and/or ECDIS.

4.2.4.9 A1S reported targets on graphical display
Both radar displays installed in accordance with this section shall be capable of presenting AIS reported targets in accordance with relevant IMO standards and guidelines.

4.2.4.10 Sound reception system
The ship shall be equipped with a sound reception system.

4.2.5 Grounding avoidance – decision support systems

4.2.5.1 ECDIS
The vessel shall be provided with two separate and independent ECDIS.

Guidance note:

An interconnection should be provided linking the two ECDIS for exchange of ENC updates and voyage plans without jeopardizing the integrity of the segregation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.5.2 Both ECDIS installations shall be interfaced to the to the radar systems for transferral of chart information.

4.2.5.3 Ships engaged in worldwide trade shall additionally be provided with a separate terminal for voyage planning being interfaced with the ECDIS. The terminal provided for this purpose shall be operable independent of the two ECDIS required by [4.2.5.2] being in use for navigation.

Guidance note:

Reference is also made to [2.4.7.1] for the applicability of this requirement on a particular ship.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.5.4 Electronic position fixing systems
The ship shall be equipped with two separate and independent position-fixing systems both being suitable for the waters to be navigated.

Ships engaged in worldwide trade shall carry two separate, independent and augmented global navigation satellite system (GNSS) receivers.

Guidance note:

At present two DGPS-receivers is deemed satisfactory. Alternatively one DGPS-receiver and one combined GPS/GLONASS-receiver may be acceptable.

Other combinations of approved receivers involving newly deployed GNSS are satisfactory subsequent to such GNSS reaching operational capability.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.5.5 Depth measuring system
The ship shall be equipped with a depth measuring system providing the water depth under the keel.

4.2.5.6 A sufficient number of depth indicators shall be provided as needed to be readable at workstations for monitoring and navigating and manoeuvring.

4.2.6 Weather surveillance systems

4.2.6.1 The ship shall be equipped with an anemometer providing information about wind speed and direction.

4.2.6.2 Ships engaged in world-wide trade shall be equipped with a shipboard weather station providing information about air temperature, air humidity and barometric pressure.

4.2.6.3 Ships shall be equipped with a weather information system.

Guidance note:

A marine computer including a software application for receipt and displaying of regular weather forecasts, or a weather fax may be acceptable.

Ships not engaged in world-wide trade may, if found unreasonable, be exempted from this requirement provided an alternative suitable system or method for receiving relevant weather information is provided.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.7 Bridge navigational watch alarm system (BNWAS)

4.2.7.1 The ship's bridge shall be equipped with a surveillance system continuously monitoring the presence of an alert OOW.

Guidance note:

The surveillance system should be able to detect human activity (motion).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.8 Bridge alert management

4.2.8.1 The ship shall be equipped with a central alert management system centralising the alert of all navigational functions.

Guidance note:

The CAM-HMI may be an integral part of the conning display.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9 Alarm transfer system

4.2.9.1 The ship shall be provided with a system for transferring un-acknowledged alarms from CAM and BNWAS to dedicated areas in the accommodation.

4.2.10 Internal communication systems

4.2.10.1 The ship shall be provided with two separate and independent internal communication systems.

4.2.10.2 The ship shall be provided with means enabling the OOW to summon the assisting crew member (look out) to the wheelhouse. The means shall be of hands-free type for the crew member and capable of attaining his/her attention while working in the accommodation or on open deck and in noisy environment.

Guidance note:

A paging system, portable UHFs, a public address system or other means of summoning the supporting crew member to the bridge may be satisfactory.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.10.3 The ship shall be provided with a communication system enabling sustainable operations by responsible personnel at all relevant workstations and deck areas being involved in mooring operations.

Guidance note:

Suitable portable wireless transceivers may be provided as means for communication between applicable workstations and areas involved in the mooring operations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.11 VHF transceivers

4.2.11.1 The wheelhouse shall be provided with two independent and fixed VHF transceivers.

4.3 Additional bridge equipment - NAUT(AW)

4.3.1 Manoeuvring information

4.3.1.1 Heading-, rudder angle-, RPM/pitch-, ROT- and speed information shall be presented on each docking workstation.

Guidance note:

If the gyro bearing repeaters are readable from the working position at the docking workstation then additional digital gyro repeaters may be waived on vessels <50000 GRT.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.2 Manoeuvring devices

4.3.2.1 UIDs for control of propulsion and steering shall be installed on each docking workstation.

If the ship is equipped with thruster(s) such UIDs shall be installed on each docking workstation.

4.3.3 Speed over ground log

4.3.3.1 The ship shall be fitted with speed measuring equipment providing speed over ground (SOG) in both longitudinal and transversal (athwart ship) directions.

Guidance note:

The SDME for SOG may be combined with the SDME for STW as required by [4.2.3.1] provided that the requirement for continuous STW information to the radars is maintained and that the vessel is less than 50.000 GT.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4 Chart radar

4.3.4.1 Both radar systems shall be chart radars and provide for interface with ECDIS and superimposition of the voyage plan on the display.

4.3.4.2 Both radar systems shall support AIS MKD functionality.

Guidance note:

If both ECDISs required by the rules are supporting AIS MKD functionality this may be accepted as an equivalent solution.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.5 Conning information display

4.3.5.1 The ship shall be equipped with a conning information display centralising sensor information, set-values and voyage plan data supporting surveillance of the performance of the grounding avoidance system.

4.3.6 Track control system

4.3.6.1 The ship shall be provided with a track control system (TCS) Category C.

4.3.7 Training course

4.3.7.1 The supplier or manufacturer of the grounding avoidance system shall be able to offer a proficient training course for bridge personnel that are at least complying with the knowledge requirements of [9].

4.4 Integrated navigational systems qualifier INS+

4.4.1 Application

4.4.1.1 For carriage requirements for the additional qualifier **INS+**, see [7].

5 Bridge equipment – general requirements

5.1 General

5.1.1 Scope and application

5.1.1.1 This section contains general requirements pertaining to all bridge equipment to be fitted in accordance with this section as well as other bridge equipment to be situated in the wheelhouse or in the vicinity of the wheelhouse as deemed applicable.

5.1.2 Certification

All navigational equipment installed shall be fully compliant with related IMO performance standards.

Guidance note:

IMO resolutions A.694(17) and MSC.191(79) is applicable for all navigational equipment irrespective of purpose and carriage requirements. (SOLAS V/18.7).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.1.2.1 All navigational equipment installed shall come with a certificate showing compliance with applicable IMO performance standards.

It is assumed that all navigational equipment to be installed for compliance with SOLAS and/or these rules comes with a valid type approval certificate issued by a recognized certification authority.

Any non-type-approved equipment shall be certified in accordance with the systematic of Pt.4 Ch.9, or MED module G if deemed applicable, for verification of compliance with appropriate international standards and the relevant requirements of this section.

5.1.2.2 Equipment installed in addition to both SOLAS and the carriage requirement of this section shall comply with performance requirements not inferior to the rules or associated IMO performance standards as deemed applicable.

Navigational equipment or systems that may affect steering or propulsion shall be certified in accordance with the systematic of Pt.4 Ch.9 (or MED module G if deemed applicable) for verification of compliance with the rules and relevant international standards unless the applicable function is already incorporated by the type approval certificate.

Additional equipment installed should at least meet the requirements in IEC 60945 or DNVGL-CG-0339.

5.1.2.3 Additional bridge equipment, not required by the rules or international regulations that may have an impact on the safety of main functions (see Pt.1 Ch.1 Sec.1) shall comply with the applicable requirements of Pt.4 Ch.9.

Any non-type-approved equipment of this category shall be certified in accordance with the systematic of Pt.4 Ch.9 or MED module G as deemed applicable.

5.2 Location of equipment

5.2.1 General

5.2.1.1 All instruments, panels, etc. shall be permanently mounted in consoles or at other appropriate places, taking into account both operational and environmental conditions. Portable bridge equipment shall have a safe storage location in the wheelhouse when not in use. All other items, such as safety equipment, tools, lights, pencils etc. to be used by bridge personnel, shall be stored in designated places.

5.2.1.2 All equipment, sensors and antennae shall be installed in such a manner that their specified performance is not impaired and otherwise follow the instructions detailed by the manufacturer.

Guidance note:

Approval of installations that diverges from the arrangement specified in the installation manual (instructions) may only be granted following a formal endorsement by the manufacturer's representative and successful testing.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.1.3 Vibration

The enduring vibration levels of consoles and ship structures supporting equipment and antennae required by this section shall not exceed the conditions specified for the particular equipment.

Guidance note:

While the ship is operating at normal seagoing speed the vibration level at the relevant position should not exceed the test criteria of IEC60945 or DNVGL-CG-0339 unless the equipment has been tested to a tougher standard withstanding the actual vibration level.

Equipment may be provided with an additional mount designed to withstand higher vibration levels and dampening the amplitude of vibration.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.1.4 Temperature

Equipment shall be located away from excessive heat sources, such as a heating vent or equipment heat exhaust.

5.2.1.5 Equipment to be fitted into a console shall be protected from durable high temperature conditions unless specifically designed for such heat.

Guidance note:

If natural ventilation is deemed inadequate then forced ventilation, e.g. fans, should be installed to increase the air flow. If the temperature inside the console cannot be maintained below 45ºC while the ambient wheelhouse temperature is below 28ºC then the ventilation is considered insufficient and additional measures should be implemented.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.1.6 Humidity

Equipment that is not specifically designed for outdoor installation shall not be installed near a doorway, open window or hatch opening.

5.2.1.7 Compass safe distance

In order not to affect the accuracy of the standard magnetic compass, all equipment shall be installed at a distance not less than the minimum safe distance specified for the equipment.

Guidance note:

All type approved equipment should be provided with a label indicating the minimum safe installation distance from the standard compass, alternatively the equivalent distance should be stated in the pertinent equipment manual or type approval certificate. If no such distance is stated or obtainable from documentation the minimum compass safe distance should be not less than 5 m.

Minimum safe distance in this context is the radius of a sphere where the compass bowl is situated in the origin of the sphere.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.2 Antennae

5.2.2.1 The antennae for radars, position-fixing receivers, GMDSS equipment, VHFs and other communication systems shall be installed in such a manner that interference is avoided and the specified performance is not noticeably impaired.

Guidance note:

GMDSS VHF aerials should be installed as high as possible and with at least 2 metres horizontal separation from constructions made by conductive materials. In addition, the VHF/DSC watch receiver antenna should be installed outside the radar beams. At least one VHF/DSC watch receiver antenna should be vertically separated (installed on a straight vertical axis) from any VHF transmitting antenna. If vertical separation is not possible, then the distance from the middle of at least one VHF/DSC watch receiver antennae to the middle of any VHF transmitting antennae should be not less than 5 m.

The GNSS antennae should be positioned outside of transmitting beam of any satellite antennae, the main lobe of the radar antennae and at least 3 meters away from any VHF transmitting antennae.”

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.2.2 Radiation hazard

Location of transmitting antennae and related components shall include suitable protection so as not to constitute an inadvertent hazard to personnel.

Guidance note:

The seating of radar wave guides, satellite communication and HF transmitter feed lines should be safeguarded, so as to protect personnel against open wave-guide radiation power and accidental contact with high voltages, by means of isolating trunks or fences.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.2.3 Satellite communication and radar antennae are required to have a warning label, detailing the safe distances and posted outside the perimeter of this distance, being readable at all access points to the area of location.

A signboard may be posted next to the access ladder or staircase leading to the compass deck if antennae are located on this level. If an elevated radar mast is provided then the signboard may be located next to the ladder of the mast if the safe distance is less than the height to the antennae allowing for the height of a person.

5.2.2.4 Radar and satellite communication systems are required to have human risk warnings and pertinent instructions in operator handbooks.

5.3 Electrical power supply

5.3.1 Main electrical power supply

5.3.1.1 Navigational equipment shall be individually connected to distribution board(s) being supplied from both main and emergency sources of power by separate circuits. Such distribution boards shall be located at or adjacent to the bridge deck.

5.3.1.2 The power supplies to the distribution boards shall be arranged with automatic changeover facilities between the two sources. Failure of one of the power supplies to the distribution board(s) shall initiate an alarm (audible and visual signal) in wheel house (CAM-HMI).

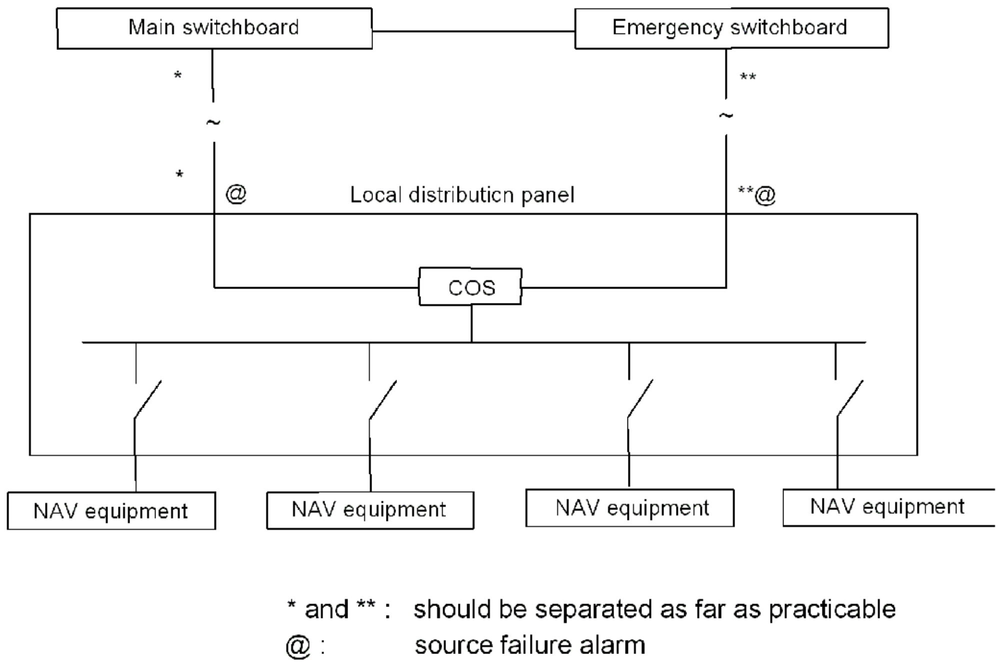

Figure 21 Power supply for navigation equipment operated by AC

5.3.2 Transitional source of power

5.3.2.1 Essential equipment shall be provided with a transitional source of power with a capacity to keep the equipment running during a loss of main and emergency power of at least 10 minutes. The equipment regarded essential in this context is at least:

— radar (including the antenna) installed at workstation for navigating and manoeuvring.
— ECDIS installed at workstation for navigating and manoeuvring
— GNSS
— CAM and CAM-HMI
— BNWAS
— speed log.

5.3.2.2 In addition to the requirements of [5.3.2.1] at least one gyro compass shall be provided with a transitional source of power with capacity to keep it running for 30 minutes.

5.3.2.3 The UPSs used to supply bridge equipment shall have automatic bypass functionality.

5.3.2.4 Appropriate means for bypassing an UPS manually, in case of failure in the automatic bypass, shall be provided.

5.3.2.5 Failure of an UPS shall initiate a caution at the CAM-HMI.

Guidance note:

A battery in compliance with the above requirements is considered as equivalent arrangement to UPS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.3 Internal communication emergency power supply

5.3.3.1 At least one of the telephone systems as required by [6.10.1.1] and [6.10.1.2] shall be supplied by a transitional source of emergency power sufficient to operate the system for at least 30 minutes.

Guidance note:

If sound power telephone system or portable self contained two-way voice communication apparatuses are used for compliance with [6.10.1.2], then [5.3.3.1] is considered to be complied with.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4 Integration and interfaces

5.4.1 Circuit integrity

5.4.1.1 The equipment talker drive circuit and the equipment listener circuitry shall support a balanced interconnection and include appropriate protection in agreement with international standards.

Guidance note:

Reference is made to ITU-T X.27/V.11 and IEC61162-standards for detailed guidance.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.2 Alarm and warning messages

5.4.2.1 All navigational equipment shall be provided with a communication interface in compliance with the BAM concept of IMO.

Guidance note:

The interface should comply with MSC.302(87) module C. For protocol details reference is made to the latest version of IEC 61162-1.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.3 Data integrity

5.4.3.1 The data output from the equipment shall comply with international standards where such protocols are provided. Any proprietary protocol shall include measures to preserve the integrity of the information carried by the message applying methods not inferior to those implemented by related international standards.

5.4.3.2 Data received for presentation only shall be checked for validity before being displayed. Data received and employed in processing shall be checked for both validity and plausibility before being employed by the related process. Data which fails the check shall not be used.

Guidance note:

See [5.5.5.3] for requirements to presentation of information following an alarm condition and resulting mode awareness indication.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.3.3 False alarm rate

The number of alarms in the wheelhouse milieu shall be minimized and the false-alarm-rate shall be kept as low as reasonably possible. The validity checks of interfaces and data input shall take into consideration the transmission rate, data availability, response times and expected bit-error-rate for the data to be received as well as the urgency and dynamics of the pending process prior to initiating a warning or alarm.

Guidance note:

The false alarm rate of the integrity checks should preferably be kept below 10^{-8}. The threshold set for alarms and warning should give some leeway for insignificant incidents. E.g. an erroneous checksum or CRC due to bit-error occurring in a single message should not generate an alarm if the subsequent message is error-free.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.3.4 Multiple sensor input

When the number of sensors and equipment being integrated exceeds the minimum quantity required by this section or international standards the interface and integration of such additional sensors and equipment shall comply with all the requirements being applicable to the obligatory configuration.

5.4.4 Networks

5.4.4.1 Bridge equipment being integrated by means of network based communication links shall be designed and arranged in compliance with the requirements of Pt.4 Ch.9 Sec.4.

Guidance note:

Wireless technologies may be used in systems that are additional or supplementary to those required by main class rules. Any use of wireless technology in systems required by this section is subject to special consideration and case-by-case approval.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.4.2 Only functions and processes being important for vessel operation may be connected to bridge equipment or make use of the same network.

Guidance note:

Generally, office- and/or entertainment related systems should not be connected. If the navigation equipment is connected to administrative networks (e.g. for report generation, process analysis, decision support) the connection should ensure that any function or failure in the administrative net cannot harmfully affect the functionality of the navigational systems or its network. The administrative functions should be hosted by separate servers and should, if at all necessary, merely have 'read only' access to the navigation equipment.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.4.3 Fall-back arrangement

If the navigational equipment required by this section is integrated by means of multiple networks the availability of essential navigational functions shall continuously be available following a concurrent failure of all networks. Following failure of multiple networks the minimum range of equipment to sustain their full operational capability is:

— one radar and
— one ECDIS.

Additionally all information required by SOLAS V/19 shall still be easily accessible in the wheelhouse.

Guidance note:

An exemption from this general fall-back principle may be accepted for completely independent network systems including independent software. Approval may only be granted following documented design, failure analysis and testing verifying that any logical failure, including uncontrolled broadcast of data packets (network storm), of any computer connected to the networks cannot cause a meltdown of more than one of the networks.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.4.4 Access

It shall not be possible for unauthorised personnel to connect equipment to the network topology for bridge equipment or otherwise have access to the network.

Guidance note:

This pertains to both communication onboard the vessel as well as remotely via external communication. Any access point to navigational network should be clearly marked and sufficiently secured e.g. by location with restricted access, a lockable device or password access.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.4.4.5 Unauthorised access to the operation of bridge equipment from a position outside of the vessel shall in general not be possible.

Bridge equipment and networks allowing for remote connection (e.g. via internet for remote diagnostics or maintenance purposes) shall be secured with sufficient means to prevent unauthorised access and to preserve the security of the navigational functions. The security properties installed shall be documented.

Guidance note:

Any remote access to the bridge equipment network should only be possible subsequent to being authorised by responsible personnel onboard. The system should have appropriate virus protection related to the possibility of infection via the remote connection.

If remote connection is possible, the integration and interface is subject to special considerations and case-by-case approval.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5 Human machine interface

5.5.1 General

5.5.1.1 Equipment and systems shall be designed as simple as possible in line with the prevailing principles of ergonomics.

Guidance note:

Equipment designed with simplicity in mind is generally more reliable and easier for personnel to operate. When different designs are compared from a human factors view, the simplest design usually has less potential for human error.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.1.2 Equipment installed and their human-machine interface shall be standardized to the degree practical and compatible with their functions and purposes. Equipment with identical functions shall employ identical or similar human-machine interfaces.

5.5.1.3 Equipment with different functions shall have distinctive interfaces (UIDs and display features) so they cannot be interconnected or used erroneously.

5.5.1.4 When designing UIDs and displays, consideration shall be given to the significance of human factors in an abnormal condition. The amount of information presented in conducting the various tasks, including the methods of displaying the information needed, shall give consideration to the capabilities of the human operator in regard to both perception and processing of the information presented.

5.5.1.5 Equipment shall be designed to facilitate console installation and mounting in a group with instruments of other makes. Applicable equipment shall facilitate the UID and pertinent display/indicator being separated to attain the most favourable ergonomic solution.

Guidance note:

See [2.4] for additional information on arrangement of UIDs and indicators in workstations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.1.6 The purpose of each UID and indicator shall be indicated by a label in English or clearly illustrated by symbols (where symbols have been internationally adopted)unless the purpose is unmistakably apparent.

5.5.2 UIDs

5.5.2.1 The shape of UIDs shall indicate their method of operation. The functionality and purpose of the UID shall be logically coordinated with the direction of actuating the device.

Guidance note:

The actuating principles according to functions should be in accordance with IEC 447 *Standard directions of movements for actuators which control the operation of electrical apparatus*.

Example: Rotary finite-position UIDs (e.g. stepping switches) should employ toggles or levers, whereas rotary continuous position UIDs (e.g. rheostats) should have knobs or wheels.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.2.2 Direction of movement of UIDs shall be consistent with any related movement of an associated process, or component. In general, moving a UID forward, clockwise, up, or to the right shall cause a quantity to increase or cause the process, or component to move forward, clockwise, or up.

Guidance note:

Examples:

UIDs for steering of the ship should rotate clockwise (or be moved towards starboard) to initiate a starboard turn.

UIDs for thruster should be moved in the same direction as the reacting thrust force (i.e. the same direction as the hull will move/ rotate).

One exception is rotary valve controls which should move in a counter clockwise direction to open a valve, e.g. for valve operated window washing.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.2.3 UIDs shall be designed so that they are not susceptible to being moved accidentally, particularly UIDs affecting propulsion and steering. Any method of guarding a UID from inadvertent operation shall not preclude the operation of the control within the time required.

Guidance note:

As applicable, one or more of the following methods may be used to guard a UID from accidental actuation.

Locate and orient the UID so that the user is not likely to strike or move it accidentally in the normal sequence of movements.

Provide the UID with a physical barrier, e.g. a recess or a shield.

Cover the UID, but without using safety or lock wire.

Provide an audible warning when the UID is being engaged (not an alarm)

Provide the control with an interlock so that an extra movement is required.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.2.4 A push button shall provide positive feedback of operation, for example, a snap action, an audible click, or an integral light.

Guidance note:

If it is imperative that a push button is not to be operated inadvertently, e.g. an engine shutdown button, the push button should be recessed or protected by a barrier or a cover. If a cover is used, the opened cover should not interfere with the operation of its protected push button or adjacent UIDs.

A pushbutton provided for engagement of the override steering UID may be protected from inadvertent operation by initiating and audible warning upon initial engagement.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.2.5 A UID or combined UID and indicator shall be visually and tactually distinguishable from equipment which only indicates.

Guidance note:

Rectangular pushbuttons should be used for control elements, and round lights for indicator elements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.3 Indicators and displays

5.5.3.1 All indicators and displays shall be designed for the operational environment of the wheelhouse allowing easy and accurate reading by day and by night.

a) Quantitative and comparative readings should be presented by means of:
   - digital counter, if subject to rare changes
   - clockwise moving index on circular scale or horizontally moving index on linear scale, if subject to frequent changes.

b) Qualitative readings should be presented by means of:
   - vertically moving index on linear scale to indicate trend changes
   - clockwise moving index on circular scale to indicate rate changes.

c) Control readings should be presented by means of:
   - moving index on circular scale, preferably with the index in the 12 o'clock position for normal readings
   - for an index moving relative to a circular scale, the index should move clockwise (or the scale anti-clockwise) for increased 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 increased readings
   - for RAI the zero rudder angle should be in the 6 o'clock position and for ROTI the zero rate-of-turn should be in the 12 o'clock position.

   There may be special cases where these guidelines do not apply, e.g. where the readings may be positive or negative, or where depth is indicated.

5.5.3.2 A letter type of simple, clear-cut design shall be used for presentation of related information.

Guidance note:

Internationally used and recommended letter type is Helvetica medium. However, light-emitting diode text matrices are acceptable. In descriptive text, lower case letters are easier to read than capitals.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.3.3 All information shall be presented on a background of high contrast, emitting as little light as possible at night.

Guidance note:

All ship's bridge instruments should preferably show a light text on a dark non-reflecting background at night. The contrast should be within 1:3 and 1:10.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.3.4 Scale graduations shall progress by 1, 2, 5, or 10 units or decimal multiples thereof. The number of minor or intermediate marks between numbered scale marks shall not exceed nine.

5.5.3.5 Indicator and display surfaces shall prevent interference by reflections from other illumination sources. If necessary, shields, filters, or other techniques shall be used to ensure that indicated information is not degraded.

Guidance note:

Where a transparent cover is fitted over an instrument, it should be designed to minimise reflection.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.3.6 The presentation of graphic or mimic diagrams shall be in accordance with ergonomic principles and easy to understand and operate. The status of the information displayed shall be clearly indicated.

Guidance note:

This applies for example to indications not being updated or an indication of an inhibited alarm.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.4 Illumination and lighting of instruments

5.5.4.1 All UIDs, indicators and displays shall be fitted with permanent internal or external light source as applicable to ensure that all required information is readable at all times.

5.5.4.2 To preserve night vision, illumination and lighting of indicators, displays, keyboards and other UIDs shall be adjustable down to virtually zero, except the lighting of warning and alarm indicators and the control of dimmers, which shall remain visible.

5.5.4.3 The internal illumination of all instruments shall be designed to avoid unnecessary glare and stray light and ensure easy and accurate reading of the information presented during night time without impeding the night vision.

Guidance note:

For the illumination of UIDS, indicators and displays with dark letters on a bright background, red light (wave length 620 nanometres or higher*)* should be used.

For the illumination of UIDs, displays with bright letters on a dark background, low level white lighting from the back may be used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.4.4 Each instrument shall be fitted with an individual light adjustment. In addition, groups of instruments in use simultaneously should be equipped with common light adjustment.

5.5.5 Alarm and warning indicators

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

5.5.5.2 Colour coding of alarms and warnings shall be in accordance with international standards.

Guidance note:

White and light blue should not be used on indicators in the wheelhouse.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.5.5.3 Integrity of information displayed

The presentation of unreliable or failed information on displays and indicators shall support indications for mode awareness. The perception of any failed sensor data or system mode shall be apparent and unambiguous to a navigator being unfamiliar with the particular equipment.

Guidance note:

Failure of a data input or a data process, whether it is due to loss of data or failure to pass a check routine, should be made clearly visible to the operator on all relevant displays by replacing the related data with a conspicuous message, e.g. -------- or $$$$$$, or by colouring the data red, or similar methods.

The importance of instant mode awareness following failure of any steering control mode is particularly emphasized.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.6 Software

5.6.1 General

5.6.1.1 System software shall be installed and maintained in compliance with Pt.4 Ch.9 Sec.4.

5.6.1.2 Maintenance
Software shall be as standardized as possible so that applications that address common functions employ the same user dialogues, human-machine interfaces, and procedures. When software improvements are necessary, the revised software shall employ the same or similar (but improved) dialogues, interfaces, and procedures to minimize operator confusion.

5.6.1.3 Access
Access to equipment's operating system shall be highly restricted, and any alteration of operating system or application software after final inspection and testing on board shall be subject to initial approval by the Society.

Guidance note:
See also [5.4.4.5] for remote upgrades of software by the manufacturer.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.6.1.4 Software and data essential to ensure satisfactory performance of the computer system shall be stored in a non-volatile memory (e.g. FLASH, HDD, etc.).

Guidance note:
Such data includes at least all ship dependent parameters determined during commissioning and sea trials. A back-up copy should be made of such ship specific parameters by means of a suitable device and reside on board.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6 Bridge equipment - specific requirements

6.1 General

6.1.1 Scope

6.1.1.1 This section contains specific requirements relating to design and installation of the bridge equipment required by this section.

6.1.2 Application

6.1.2.1 Ships requesting class notation **NAUT(OC)** shall comply with the basic rules in [6.2] to [6.10].

6.1.2.2 Ships requesting class notation **NAUT(AW)** shall comply with the basic rules in [6.2] to [6.10] and additionally the requirements specifically addressing **NAUT(AW)** in these subsections and [6.11] and [6.12].

Guidance note:
A requirement being specific for **NAUT(AW)** only is identified by inclusion of the notation in the head line as in the following example: [6.2.3.6] Dual heading input – **NAUT(AW)**.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2 Steering control systems

6.2.1 Manual steering control

6.2.1.1 UIDs human – machine interface

The UIDs for manual steering of the ship shall employ a clockwise rotation of the device to turn the ship to starboard and anti-clockwise rotation to turn to port.

Guidance note:

Steering tillers should be designed to turn the ship to starboard with clockwise movement of the axle regardless of the position of the tiller on the axle.

Exemption may be given for steering tillers or joysticks used solely for harbour manoeuvring and not for steering the ship while underway. This may be applicable to vessels with two or more rudders or azipods and engines, and where the UID(s) are used for setting a rudder angle only and not with the intention to create a rotation. In such case the UID should indicate the position of the rudder. Additionally, when the rudders are used in combined mode a separate UID being easily distinguishable from the individual tillers, should be provided in accordance with this requirement.

Exemption may also be given for non-follow-up steering (NFU) consisting of dedicated buttons for port and starboard respectively.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.1.2 If push-buttons are provided for NFU-operation of the steering gear the buttons shall be properly marked with port and starboard respectively and also coloured red and green. At night time the buttons shall include internal lighting. It shall not be possible to dim the internal light to zero but the buttons shall remain discernable at the lowest dimmable level whilst the steering station is in command.

6.2.1.3 UIDs for follow-up steering (FU) shall encompass indication of the rudder order.

6.2.1.4 FU-steering on navigating and manoeuvring workstation

The manual steering device to be installed on the navigating and manoeuvring workstation shall employ follow-up steering control. The UID shall enable the navigator to set a rudder order and the rudder (UID) shall then stay on in the set position unassisted. The rudder amidships position shall be easily obtainable by the navigator during blind operation.

Guidance note:

The UID should be designed with a snap-on in the amidships position or a similar attribute being noticeable by the operator blindfolded. A spring-loaded UID automatically returning the rudder to amidships is not satisfactory.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.1.5 Take-over

A take-over functionality shall be incorporated with the manual steering UID on the navigating and manoeuvring workstation. The take-over device shall require no more than a single operator action to let the navigator take on the rudder control/azimuth control of thrusters (if propulsion thrusters are used for steering control) irrespective of the steering mode or steering position being in command at the time of take-over. Means shall be incorporated to alert about accidental use.

Guidance note:

If the take-over is done directly (automatically) by the sole grip of the UID an audible warning requiring acknowledgement by the operator should follow the initial operation of the UID. If a switch is provided for take-over preceding the operation of the UID the inadvertent operation of the switch should be protected by an audible warning lasting 2 seconds (no call for acknowledgement is needed) or a shield or similar physical prevention.

It should be possible to select the steering mode provided at each workstation accordingly.

A single operator action signifies that one operator action in addition to the grip of the UID is acceptable, e.g. like pushing a button or turning a toggle.

If a toggle switch is used it should have no more than two positions, i.e. resembling ON/OFF.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.1.6 A take-over functionality for control of rudder(s), thruster(s) and propulsion(s) shall be provided on each bridge workstation where steering is provided, and applicable control UID accordingly. It shall be possible to select all steering modes provided at each respective workstations.

6.2.1.7 The take-over functionality shall enable the UID on the navigating and manoeuvring workstation to override all other steering control modes and steering control positions (disregarding the steering gear room).

6.2.1.8 The take-over device and pertinent steering UID shall be discernable at night time.

6.2.2 Information and indicators

6.2.2.1 Steering control modes

The active steering control mode shall at all times be unambiguously presented and easily readable at both the monitoring and navigating and manoeuvring workstations.

Guidance note:

The steering modes to be indicated include:

— manual control
— heading control
— track control.

If other steering modes are provided related indication fulfilling the requirement should be provided. The indication of steering modes is not to be mixed with steering positions which requires a separate appearance.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.2.2 Steering control positions

The steering position or control station in command shall be unambiguously presented and easily readable at both the monitoring and navigating and manoeuvring workstations.

Guidance note:

Typical steering positions are the docking workstations, manual steering workstation and navigating and manoeuvring workstation.

If more than one computer HMI (display) can be selected as UID for manual and/or automatic steering control, e.g. MFDs supporting heading- and/or track control functions, the individual HMIs should be properly marked and the control station in command should be clearly indicated.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.2.3 If take-over functionality is provided on workstations other than the navigating and manoeuvring workstation then a characteristic audible indication shall be sounded on such workstation whenever take-over is effectuated.. This audible indication shall also be audible on the workstation that relinquishes control. A visual indication of status shall be displayed on the workstation in command. The indicating sound shall be characteristic so it will not be associated with any other alerts.

6.2.2.4 Rate of turn indicator (ROT)

The scale of the rate-of-turn indicator shall be in accordance with the turning ability of the ship while proceeding at normal seagoing speed.

Guidance note:

The scale of the rate-of turn-indicator should be able to indicate the steady state angular velocity (ROT) that the vessel will achieve when applying at least a rudder of 20º or an angle providing an equivalent force if other means of steering is provided.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.3 Heading control system

6.2.3.1 The heading control system (HCS) shall be capable of self-tuning and being adaptable to the ship's steering characteristics under prevailing weather conditions and various loading conditions while using a minimum of rudder to maintain the heading.

Guidance note:

The HCS should be able to maintain the heading with an accuracy of 1º (rms) in fair weather conditions (Beaufort ≤ 5) employing rudder angles < 2º (rms).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.3.2 The HCS shall be able to carry out course changes employing user selectable turn radii for control of the ROT during the course change. It shall be simple to adjust the pre-set turn radius at any time during the course change.

6.2.3.3 The off-heading alarm shall not be initiated during a normal course change.

6.2.3.4 The heading control system shall sustain a fail-safe design and the most probable failures in the control loop shall result in the least critical of any possible new conditions.

Guidance note:

The heading control system should upon any detectable failures in the control loop maintain the rudder in a position that will best possible keep up the set heading (order). Such failures include at least power failure, short circuits and broken connection.

— While keeping a straight course the rudder may gracefully be put amidships or alternatively freeze in instant position.
— While executing a course change in ROT or radius mode the rudder should be maintained in the position that will best possible keep up the ROT or radius order set by the user. (Relevant data may be obtained from spiral trials, either full-scale trials or model test, in accordance with [8].) Alternatively the rudder may freeze in instant position at the time of failure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.3.5 The most probable type of failures in the command- and feedback loop shall be monitored. Following detection of a control loop failure an unambiguous alarm shall be activated and include an unmistakable warning message.

Guidance note:

The method employed for detection of failures in the control loop should provide instant detection and be independent of the position of the rudder and/or command transmitted by the HCS. E.g. monitoring the difference between the rudder order and the rudder feedback is not a sound method in a FU-system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.3.6 Dual heading input – NAUT(AW)

Upon failure of the selected compass system the HCS shall automatically employ the heading information from the second compass system. Any heading difference present at this instant shall not cause any undue rudder order.

Guidance note:

If the preset heading of the autopilot is being maintained any heading difference should be smoothly eliminated. Alternatively the autopilot may take the instant heading as new preset heading followed by an informative warning to be acknowledged by the OOW.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.3.7 Safety system – NAUT(AW)

A safety system shall be provided together with the HCS and be so designed that upon failure of the main processing unit the safety system will automatically maintain the instant heading, if on a straight course (leg,) or the instant ROT (radius) if in a turn.

Guidance note:

The safety system may be waived if full scale pull-out- or spiral trials reveal that the ship sustain an outstandingly directional stability in all loading conditions. The hysteresis loop as determined by such trials should be less than ±3º/min.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.2.3.8 Fall-back mode – NAUT(AW)

The HCS shall support the interface and memory required for automatic employment of relevant parameters of the planned voyage to conduct a smooth fall-back to heading control mode subsequent to failure of the track-control mode.

Guidance note:

The HCS should have the necessary attributes to accommodate the planned radius of the turn and the next course to steer following initiation of every course change.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3 Heading information system

6.3.1 Dual compass systems

6.3.1.1 The two compass systems shall perform in accordance with specifications at normal seagoing speed (NCR) in the latitudes where the ship is to operate.

Guidance note:

Generally the accuracy and availability of the individual compass system should not be inferior to the international standards applicable to the gyro compass whilst extended to latitudes up to at least 75º. A waiver may be accepted for ships intended for sole operation in designated areas of lower latitudes. See [1.1.5.3].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.2 The two compass systems shall be arranged for continuous performance in accordance with their specifications and at least one of the compasses shall be an autonomous system.

Guidance note:

If one of the compasses installed is a GNSS based THD certified in compliance with ISO 22090-3 then the second compass should be able to operate in accordance with its specifications independent of means external to the ship.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.3 The two compass systems and their pertinent distribution systems shall sustain a fault-tolerant design and be arranged so that no single failure will cause enduring loss of heading to repeaters and/or navigational equipment for which heading information is compulsory.

6.3.1.4 The two compass systems shall be able to maintain continues heading output to steering repeaters and essential navigation equipment which performance is dependent on the heading information, subsequent to any single failure in either one of the two systems.

Guidance note:

Essential navigation systems in this context are at least the radars and the heading control system (HCS) and track control system which should automatically be provided with heading information from the second compass system following a failure of the selected compass system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.5 The heading information being distributed to repeaters and navigational systems shall enable the receivers to align with the main compass automatically.

Guidance note:

A digital interface should be provided to all heading indicators/displays, radars, ECDIS', AIS and conning display for **NAUT(AW)**.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.6 The heading information being distributed to repeaters and navigational systems shall enable the receivers to carry out an integrity check of the information received.

Guidance note:

The IEC61162-1 message $..THS indicating the autonomous mode is satisfactory. See also [5.4.3] Data integrity.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.7 The heading being distributed to repeaters and essential navigational systems shall be corrected for predictable errors.

Guidance note:

A gyro compass should at least be corrected for speed-latitude errors. In addition to the IEC61162-1 message $..THS, a gyro should include a proprietary mode indicator in the message(s) to inform about such correction being applied or not.

Ref. IEC61162-1(2007) 6.3.5 or 7.3.10 for detailed guidance on protocol.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.8 Failure of input from a single GNSS receiver or a single SDME shall not degrade the accuracy of the distributed heading from both compasses.

Guidance note:

The speed and latitude applied for the purpose of speed-latitude corrections may be derived from dual GNSS receivers, one being a hot back-up for the other.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.3.1.9 The heading outputs of two compasses shall be monitored and an alarm shall be initiated if the deviation exceeds a pre-set limit selectable by the user.

Guidance note:

It should be possible to select the alarm threshold within a range not less than 3º - 6º.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.4 Speed information system

6.4.1 Speed distance measuring equipment (SDME)

6.4.1.1 The SDME shall measure the speed through the water (STW) relative to a water layer being no more than 3 metres below the hull.

6.4.1.2 The SDME shall be able to provide the radars with STW continuously. If a single SDME unit is capable of measuring STW and SOG (speed over ground) then these measurements shall be done simultaneously and both measurements shall be transmitted to applicable navigational equipment.

Guidance note:

The message $..VBW should include both STW and SOG so that the receiver may employ either speed irrespective of the speed category selected for display on the speed indicators.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.4.1.3 Maintenance

Any part of the SDME including parts installed below the waterline shall be easily replaceable when the ship is afloat.

Guidance note:

Generally, a gate valve is considered to be an acceptable solution for replacement of the transducer. Technical solutions involving replacement employing divers are subject to case-by-case considerations of the simplicity of the method and the procedure to accomplish the replacement. A confirmation from a diving company about the simplicity may be requested.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.4.1.4 Dual axis SOG – NAUT(AW)

The SDME shall be able to determine and display the longitudinal SOG in fore and aft directions and the athwart ship SOG of both the fore ship and the aft ship.

6.5 Collision avoidance - decision support systems

6.5.1 General

6.5.1.1 Any navigational system providing the functionality of collision avoidance, including the provision of CPA and TCPA information, shall be certified for compliance with applicable international standards.

Guidance note:

The foremost international standard relating to collision avoidance functionality is established by IEC62388 *Ship borne radar*.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.2 Radar systems

6.5.2.1 The radars shall support a clear an unambiguous presentation of the following modes and target vectors:

— sea stabilized mode with graphical indication of targets (true) heading and STW vector
— ground stabilized mode with graphical indication of targets (true) COG and SOG vector
— relative mode with graphical indication of targets relative direction and speed vector.

6.5.2.2 AIS

At least one of the displays shall provide a suitable HMI allowing the navigator to manually insert data into AIS. For **NAUT(AW)**, both displays shall provide such functionality. The HMI shall not be inferior to the minimum keyboard and display (MKD) of the AIS itself. The display shall be capable of presenting AIS reported targets in accordance with relevant IMO standards and guidelines.

6.5.2.3 Performance monitor

The radar systems shall incorporate a performance monitor and the pertinent operation manual shall include comprehensible instructions how to determine a significant drop (10 dB) in the performance.

6.5.2.4 Inter-switch

The radar systems shall incorporate an inter-switch facility and the pertinent HMI shall be available from both radar displays. Failure of the inter-switch shall not reduce the availability of either one of the two radar systems.

6.5.2.5 Interfaces

The radar systems shall support the interface needed to employ serial information from the following equipment:

— 2 compass systems
— SDME
— GNSS
— AIS
— AMS.

6.5.2.6 Network

Upon failure of a networked radar system at least one of the radar systems shall continue to be fully operational as a radar not inferior to a stand-alone system.

Guidance note:

In addition to the network connections, one radar should be directly connected to a gyro and speed log. See [5.4.4].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.2.7 Antennae location

Both antennae shall as far as practicable be mounted clear of any structure that may cause signal reflections, including other antenna, masts, funnel and deck structure or cargo.

Blind sectors shall be kept to a minimum, and shall not occur in an arc of the horizon from right ahead to 22.5° abaft the beam on either side.

The dual antennae installation shall provide coverage over an arc of the horizon of 360° by installing the two radar antennae so as to avoid common blind sectors.

6.5.2.8 ECDIS interface

Both radar installations shall have a bi-directional interface to facilitate communication with ECDIS so that course lines of the voyage plan can be transferred to and displayed on the radar screens. In case the chart radar(s) does not have its own database selected parts of SENC shall be possible to transfer from the ECDIS to be displayed on the radar screen(s).

6.5.3 AIS

6.5.3.1 The AIS shall have an interface facilitating communication with both radars as well as a separate interface located at the conning workstation.

6.5.3.2 The AIS shall have the interface and facilities needed to support the MKD functionality being conducted by a remote operating unit.

6.5.4 Sound reception system

6.5.4.1 The sound reception system (SRS) shall be capable of detecting sound signals from ship whistles operating in the audio band 70 Hz - 820 Hz whilst suppressing wind and mechanical noise within this band as well as frequencies outside this band. The SRS performance shall endure microphones being located in a position having an ambient noise level of 70 dB(A).

6.5.4.2 The SRS shall have means for muting of audio signals up to 75 dB(A) to adjust for more severe ambient noise levels in rough weather. If the means provided for muting involves mechanical adjustment by the operator the pertinent UID shall indicate the muting threshold in steps of no more than 3 dB(A).

6.5.4.3 The SRS shall include filters suppressing background noise from wind and own ship/s machinery letting only sounds having a characteristics reckoned to be a ship’s whistle pass through.

Guidance note:

Sufficient noise suppression may normally only be obtained by digital filtering techniques.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.4.4 The SRS shall be capable of determining the approximate direction to the source of the sound signal. The SRS shall as a minimum indicate the source of the sound signal being to port or starboard side and forward or abaft of the beam.

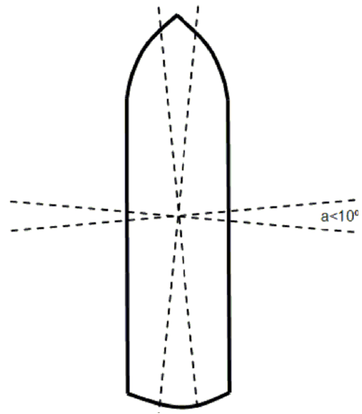

Figure 22 Sectors of ambiguity

6.5.4.5 The accuracy of the determination of the applicable quadrant shall be within ±5º.

Guidance note:

The sectors of ambiguity (s) along the longitudinal and transversal axis of the ship should either be insignificant (<10º) or be determined and indicated as separate directions (sectors).

If a higher resolution than the 4 sectors is provided, (typically 4n where n = 2, 4, etc.), then the accuracy requirements applies analogous to the separation of the available directions (sectors).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.4.6 The resolution of direction to the source of the sound signal shall not be lesser than the four quadrants plus the four sectors of ambiguity.

Guidance note:

If a dual axis display (e.g. a CROSS or 4 LEDs) is used for visually presenting the direction to the signal source then two axes or two LEDs should be used to represent the accurate quadrant. When the direction to the signal source is within the longitudinal or transversal sectors of ambiguity only one axis or LED should litght to enhance the perception of the direction by the user.

If an SRS makes use of 4 microphones located in a defined configuration comparing the signal time delay involving the two signals (microphones) on the same axis this time difference is a function of the direction of the incidence of the signal and will approach zero when the axis of incidence is near normal to the axis of the microphones. The accuracy with which the SRS can determine the time delay will determine the sector of ambiguity.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.4.7 The sound reception display shall give a clear visual indication of the direction for at least the duration of the sound signal plus 2 seconds. The direction (or quadrant) shall be clearly readable by day and by night on a distance of not less than 2 metres.

6.5.4.8 The loudspeaker(s) shall be installed so that incoming sound signals are audible at all working positions inside the wheelhouse for which the OOW has been assigned tasks.

6.5.4.9 The microphones shall be installed away from noise sources and in lee of strong wind and otherwise abide by the instructions of the manufacturer.

6.5.4.10 The system shall be muted upon activation of own ship's whistle and outdoor PA-system.

6.5.4.11 Sound intensity in the wheelhouse

It shall be possible to adjust the sound intensity level (volume) of the loudspeaker.

6.5.4.12 The volume knob of the loudspeaker shall have a mark of the position where the sound level in the wheelhouse is alike the sound level at the outdoor listening post.

Guidance note:

The OOW should be able to set the sound intensity of the reproduced signal measured 1 m from the loudspeaker(s) in the wheelhouse (with *all bridge windows and doors closed*) to the same level as the sound intensity that is measured outside the wheelhouse at a location near the microphone that is closest to the signal source.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.5.4.13 With the volume control adjusted to the outdoor level and in the absence of any intelligible sound signal the SRS shall be muted.

6.6 Grounding avoidance - decision support systems

6.6.1 Electronic chart display and information system

6.6.1.1 The ECDIS' shall be interfaced with the AIS for the possibility of AIS information to be added to the ECDIS display.

6.6.1.2 The ECDIS’ shall support the necessary interface and configuration for employing at least two EPFS-receivers.

6.6.1.3 The ECDIS’ shall support the necessary interface and configuration for employing at least two gyro compasses.

6.6.1.4 Inter-ECDIS connections

Both ECDISs shall be interconnected and accommodate uploading of voyage plans from a separate voyage planning station.

Guidance note:

The separate ECDIS voyage planning station may be waived on vessels which do not have a separate voyage planning workstation. See [2.4.7.1].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.1.5 The inter-unit connection of the ECDIS’ shall sustain the integrity of the individual ECDIS including the planning station.

Guidance note:

The connection arrangement should accomplish electrical separation and isolation between the ECDIS stations. The software application provided for the purpose of inter-unit communication should not be inferior to the requirements of [5.4].

In cases where network is employed the fall-back requirement of [5.4.4.3] should be fulfilled.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.1.6 It shall be possible to edit the parameters of the voyage plan by means of the HMI on both ECDIS’. Subsequent to acceptance of alterations of the voyage plan on one station the voyage plan of all ECDIS’ shall be automatically updated with the revised voyage plan.

6.6.1.7 Installation of new ENCs and /or updates on one ECDIS shall automatically update the chart portfolio on both ECDIS.

6.6.1.8 The ECDIS shall automatically employ an ENC whenever available at the ship’s position.

6.6.1.9 Voyage planning station

The voyage planning station shall allow the navigation officer to carry out all the tasks and store all the information necessary to accomplish a voyage plan in accordance with international standards.

Guidance note:

Reference is made to the requirements of IMO's performance standards for ECDIS (res.MSC.232(82)) concerning the HMI-functions of route planning and IMO's Guidelines for Voyage Planning (res.A.891(21)) on information to be included.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.1.10 Network

Upon failure of a networked ECDIS arrangement at least one of the ECDIS shall continue to be fully operational as an ECDIS not inferior to a stand-alone system.

Guidance note:

In addition to the network connections one ECDIS should be directly connected to a GPS, gyro and speed log. See [5.4.4.3].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.2 Electronic position fixing systems

6.6.2.1 The GNSS receivers shall be able to track a minimum of 6 satellites simultaneously.

6.6.2.2 The GNSS receivers shall make use of pseudo-range corrections broadcasted by ground based augmentation system.

Guidance note:

The correction data formats used around the world for differential satellite navigation for differential GNSS are the formats standardized by the RTCM Committee. The SC-104 standards prescribe formats for publicly supported radio beacon broadcasts of differential GPS and GNSS corrections.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.2.3 The GNSS receivers shall be provided with a receiver autonomous integrity monitoring (RAIM) algorithm, or similar fault detection and exclusion (FDE) algorithm.

6.6.2.4 The GNSS installation shall support interface circuitry in accordance with international standards capable of providing all applicable equipment with the position and system information needed for their performance.

Guidance note:

A typical range of equipment are 2 ECDIS, 2 radars, 2 gyro compass, AIS, GMDSS, CID, VDR, i.e. a total of 10 listeners.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.2.5 Antennae

The GNSS antennae design shall optimize out-of-band rejection and sustain high performance multipath interference mitigation.

Guidance note:

The GPS antenna element should be optimised for right hand circularly polarised signals at the L1-frequency. The antenna gain should be >3 dBic (in zenith) and have a near hemispherical pattern to maximise the number of satellites for tracking while simultaneously reducing signals below 5ºof elevation. The axial ratio should be <3dB (for elevation angles >45º).

The antenna should also have a narrow bandwidth, a L1-filter and provide for low noise amplification of the received signal.

The S/N-ratio attained following installation should not be less than 45 dB for satellite elevation angles >30º.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.6.3 Echo sounding equipment

6.6.3.1 When more than one transducer is provided and located in different positions on board the presentation of depth on all displays and indicators shall clearly indicate which transducer is currently the source of information. When changing transducer on the main unit, the indication shall automatically be updated on all other displays and indicators.

6.6.3.2 If the system can display water depths other than under the keel such other depth shall be clearly indicated on all displays and indicators. When changing transducer on the main unit, the indication shall automatically be updated on all other displays and indicators.

6.6.3.3 If the transducer is located in a place being shallower than the deepest part of the keel the echo sounder shall be properly corrected for the difference and the correction figure shall be stored in a non-volatile memory.

Guidance note:

Either the echo sounder should add the correction figure to the measured depth prior to transmitting data to listeners or all receivers (listeners) of the data should be able to employ the negative offset value of the $..DPT message. If manoeuvring device(s) protruding beneath the keel is installed (e.g. azipod or azimuth thruster) then the echo sounder should be calibrated to the deepest part of such device. If the datum of the depth measurement is different from keel a label stating the actual datum should be posted at or near the main unit of the echo sounder.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7 Weather surveillance systems

6.7.1 Shipboard weather station

6.7.1.1 Wind speed and direction

The wind speed sensor shall work over a range not less than 0 to 100 knots with accuracy and resolution better than 2.5 knots.

6.7.1.2 The wind direction sensor shall cover an azimuth of 360° with an accuracy and resolution better than 5º.

6.7.1.3 The anemometer shall be able to display at least the relative wind speed and direction.

6.7.1.4 If other modes than the relative speed and direction is available the actual presentation mode shall be explicitly indicated on the display.

6.7.1.5 The anemometer shall have a serial interface to convey the wind speed and direction in accordance with international standards.

6.7.1.6 The sensors shall be situated in locations where the effects of air flow distortion due to superstructure or other large shipboard structures are being minimized.

Guidance note:

Top of the fore mast is the ideal location on ships with its superstructure aft. Sensors located above the compass deck should be placed as far forward as possible and as high as possible, ideally on a slim mast located at the forward edge of the compass deck. If this is impracticable then the sensor should be located above compass deck at a height, z, according to:

$$z = 0.3(H + x)$$

H = Height of compass deck above sea level

x = horizontal distance from edge of compass deck

z = height of sensor above compass deck

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

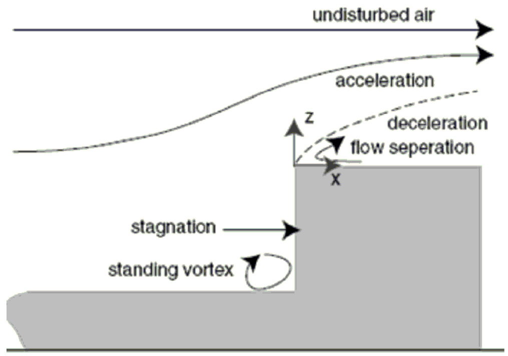

Figure 23 Air flow around the bridge on a generic tanker/bulker

6.7.1.7 If a large radar mast or similar structure is located on the same height adjacent the sensor then two sensors shall be installed, one on each side of the ship. The processing unit shall be able to weigh the output of the two sensors in proportion to the relative wind direction.

6.7.1.8 Relative humidity and air temperature
The relative humidity shall be measured within a working range from 0 – 100% having accuracy better than 5%.

6.7.1.9 The temperature shall be measured within a working range not less than -15°C to 55°C having accuracy better than ±0.5°C (with >10 knots wind speed and sunlight).

6.7.1.10 The pertinent humidity and temperature measurements shall be displayed with a resolution not inferior to the accuracy.

6.7.1.11 Barometric pressure
The barometric pressure shall be measured with accuracy better than 5 mbar (500 Pa) and resolution higher than 2 mbar.

6.7.2 Weather information system

6.7.2.1 The system shall be able to receive, on regular basis or upon request, weather forecasts for all areas relevant for the ship, from a recognized weather service.

Guidance note:

The service providing the weather forecasts should comply with technical regulations and recommendations made by World Meteorological Organization.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.7.2.2 The weather forecasts shall at least have duration of 5 days, with time steps not exceeding 6 hours and geographical resolution of not less than 60 km × 60 km.

6.7.2.3 The system shall graphically display the received weather forecasts on a chart in a user friendly manner.

Guidance note:

The user should be able to select, for display, individual weather parameters and logical groups of parameters. The user should also be able to select any of the time steps available from the forecasts.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8 Bridge navigational watch alarm system

6.8.1 Surveillance of the navigational watch

6.8.1.1 The bridge navigational watch alarm system (BNWAS) shall be able to maintain continuous supervision of the wheelhouse to ensure the navigational watch being attended when the ship is underway.

6.8.1.2 Means for activating the BNWAS reset function shall be provided at the workstation for monitoring, workstation for navigating and manoeuvring and workstation for conning and shall be activated by automatic detection of human motion.

Guidance note:

The most common method by which human motion can be detected involves sensors processing infrared images, microwave reflections, ultra sonic sound reflections and/or image recognition systems.

Sensors/CPUs should use several of these technologies in combination. Sensors approved for alarm systems for intrusion and hold-up systems according to EN 50131 may be used provided that the BNWAS complies with following functional requirements:

— Timer is reset if a forearm is moving 0.5 to 1 m/s at the working positions.
— Failure of or tampering with the motion sensor is deactivating the timer reset function (resembling no motion detection).
— Timer is not reset due to shifting sunlight, moving objects or warm surfaces as expected in a wheelhouse.
— When masking is needed, proper masking of sensor coverage should be prepared inside the motion sensor enclosure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8.1.3 Facilities shall be provided for the OOW to select individually any of the navigation officers, including the captain, as being the assigned back-up officer for receiving the second stage remote audible alarm.

6.8.1.4 It shall be possible to configure the BNWAS to always include the captain's cabin and captain's office in the second stage remote audible alarm.

Guidance note:

The configuration should be protected so that access is restricted to the captain only.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8.1.5 The third stage remote audible alarm shall be activated in the following locations:

— captains cabin and office
— officers' office
— officers' mess
— officers' day room
— cargo control room (if provided)
— gymnasium (if provided)
— prayer room (if provided)
— other public lounges and areas (if provided).

Guidance note:

To extend the accessible area for back-up personnel the alarms may additionally be transferred by means of a wireless system to call the assigned back-up navigator on the condition that it is possible for the assigned person to reach the bridge within 2 minutes.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8.1.6 The BNWAS second and third stage remote audible alarms shall not be acknowledged by the motion detection system.

Guidance note:

Activation of the BNWAS motion detection function should only reset (acknowledge) the first stage audible alarm on bridge.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8.1.7 BNWAS shall include possibility for the OOW to initiate emergency call by a single operator action.

Guidance note:

Accidental activation of emergency call should be avoided. Protective measures should be implemented to avoid inadvertent operation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8.1.8 BNWAS shall provide facilities to immediately actuate the emergency call from other equipment capable of transferring an unacknowledged alarm.

Guidance note:

Such facilities may be contact closure or IEC 61162 interface or similar circuit. An emergency call initated by other equipment may only be deactivated by acknowledging the alarm at the source of the alarm or the CAM system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.8.2 Alarm transfer

6.8.2.1 The BNWAS second and third stage remote audible alarms shall be inter-connected with the alarm transfer system without influencing on the alarm handling of the CAM.

Guidance note:

The user operation of CAM-HMI may reset the BNWAS, but the BNWAS reset device should not be able to acknowledge the CAM-HMI.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9 Bridge alert management

6.9.1 Integration of navigational equipment

6.9.1.1 All alerts generated by individual navigational equipment and systems shall be managed by the CAM.

Guidance note:

The minimum equipment to be integrated by the CAM should include:

Table 7

— track control system	— EPFSs
— heading control system	— speed logs
— heading information systems	— echo sounder
— radars	— BNWAS (2nd and 3rd stage alarms)
— ECDISs	— AIS

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.1.2 Other equipment generating alerts in the wheelhouse shall be connected to the CAM if the pertinent supervision is the responsibilty of the OOW and the equipment interface is in accordance with the requirements of [5.4.2]

Guidance note:

Additional equipment may comprise:

— UMS alarm panel
— steering gear alarm panel
— navigation light alarm panel
— VDR alarm panel
— etc.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.1.3 The CAM shall handle alert priorities and categories supporting the bridge team in the immediate identification of abnormal conditions and present alerts as individual alerts or as aggregated alerts on the CAM-HMI.

Guidance note:

The conning information display may act as CAM-HMI.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.1.4 The number of alerts shall be kept as low as possible and be classified in accordance with the BAM concept.

Guidance note:

Alerts additonal to the alerts required by applicable IMO/IEC standards should be assigned to a priority level using the BAM criteria for classification (MSC.302(87)).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.1.5 Alerts of the same kind, for which individual presentation is anyway necessary at the alert releasing equipment, shall be presented on the CAM-HMI as an aggregated alert. Other non-required IMO alerts of the same kind shall be subject for aggregation where possible.

6.9.1.6 If additional equipment is interfaced to the CAM, and the interface does not support the BAM protocol for alert handling, the CAM-HMI shall present their alerts in accordance with the BAM concept.

Guidance note:

Reference is made to IMO resolution MSC.302(87) Module A for presentation and handling of alerts on the bridge, and Module C for interfacing to the CAM.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.1.7 The CAM-HMI shall present the alert messages in English language using standard maritime terminology where such exists. Proprietary messages shall be clear text allowing for prompt comprehension of the message and pertinent actions to be taken.

6.9.2 Alarm transfer

6.9.2.1 The CAM shall provide a suitable interface for transmitting un-acknowledged alarms to the alarm transfer system.

Guidance note:

In this context un-acknowledged alarms is the announcement state "active-unacknowledged"; hence not including other alarms with status "active-silenced", "active-responsibility transferred" nor "rectified-unacknowledged" - ref. IEC 61924-2.

The interconnection may be contacts, serial, Ethernet or other.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.9.2.2 Un-acknowledged alarms shall be transferred to the alarm transfer system within 30 seconds of the alarm occurrence unless otherwise stated in the performance standards applicable for the equipment.

Guidance note:

Applicable equipment standards comprise IMO, IEC and ISO standards.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.10 Nautical internal communication systems

6.10.1 Internal communication equipment

6.10.1.1 Automatic telephone system

a) An automatic telephone system shall be installed and shall provide two-way voice communication between the bridge and:

— all officers cabins
— all deck hand cabins
— all public rooms
— all normal crew working spaces and
— all emergency working positions.

b) The telephone network shall be designed with a minimum capacity of four simultaneous calls.

c) The wheelhouse shall be fitted with at least two independent telephone extensions.

d) The telephone extensions in the wheelhouse and engine control room shall have priority function over any other extension.

e) Incoming calls on adjacent telephones shall be distinguishable by lights and/or different ring tones.

f) The automatic telephone system shall be supplied by mains and emergency sources of power.

6.10.1.2 Back-up telephone system

a) A back-up telephone system shall be installed and shall be independent of any failure in the automatic telephone. It shall be provided for two-way voice communication between the wheelhouse and at least the following places:

— engine control room (ECR)
— local engine operation position(s)
— steering gear control position(s)
— local thruster control position(s)
— emergency generator room(s)
— cargo control room (if provided)
— captain's living quarters
— chief engineer's living quarters
— emergency station, fire station (when located outside of the bridge area)
— other compartments to be manned in an emergency situation according to the contingency plan.

b) If portable two-way voice communication equipment is used for compliance with the back-up telephone requirements, then all of the applicable locations shall be provided with transceivers being readily available. The equipment is considered additional to the equipment provided for fulfilment of the requirements of [6.10.1.6] and [6.10.1.7]. The portable two-way voice communication equipment shall comply with the Society's statutory interpretations for internal communication systems.

c) If fixed telephone extensions are used for compliance with the back-up requirements, then the extensions on bridge and ECR shall have priority.
The back-up telephone system shall be supplied by mains and emergency sources of powers.

Guidance note 1:

The above requirement does not prevent the use of self-contained communication systems, such as sound powered telephones or other battery operated communication systems. Refer to the Society's statutory interpretations for internal communication systems for power supply, battery and charger requirements for portable two way voice communication systems (DNVGL-SI-0364).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

If sound powered telephones are used for compliance with the back-up requirements, then priority function is not required unless the number of the extensions exceeds the required number as listed in [6.10.1.2] a.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.10.1.3 Noisy milieu

Applicable to the automatic telephone system and the back-up telephone system. In rooms and compartments with an ambient noise level above 75 dB(A) a headset with a noise cancelling microphone or similar facilities suitable for voice communication in noisy environment shall be provided.

Guidance note:

Applicable rooms and compartments will as a minimum include steering gear room, engine room and thruster compartment (if provided).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.10.1.4 Applicable to the automatic telephone system and the back-up telephone system. A reference list of extensions shall be permanently posted near each telephone being readable while dialling.

6.10.1.5 Public address system

a) The public address system call stations on bridge shall be suitable for flush panel mounting in workstation consoles.
b) Each PA call station shall be equipped with activation light to indicate communication readiness.
c) A reference list of all PA-areas (where different areas are selectable) shall be permanently posted being readable from the PA call stations.

6.10.1.6 UHF equipment

a) To assist in safety and navigation operations on board, the bridge shall be provided with at least four portable UHF transceivers operating in the 457 to 467 MHz band.
b) The transceivers shall have a capacity to operate continuously for at least 5 hours.

Guidance note:

Continuous operation means sequences of 1 minute transmissions followed by 9 minutes reception, without signals at the receiver input.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

c) A battery charger having sufficient capacity to re-charge all UHF transceivers simultaneously shall be installed within the wheelhouse.
d) Portable UHF transceivers used for compliance with the requirement of [6.10.1.7] shall comply with the Society's statutory interpretations for internal communication systems.

6.10.1.7 Communication system for Mooring operations

a) A communication system supporting hands free two-way voice communication between the wheelhouse, bridge wings and all applicable mooring stations on board shall be provided.

Guidance note:

The communication system may be a fixed installation or alternatively dedicated potable two-way voice communication apparatuses. A push to talk (PTT) activation facility, on portable UHF transceivers used for compliance with the requirement of 108-a, is accepted as an alternative to hands free operation, provided that such portable UHF equipment can be secured firmly in position to the person operating the apparatus, and that a dedicated headset/earpiece and one hand operated PTT activation facility be utilised.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

b) If portable UHF transceivers are used for compliance with the requirement of [6.10.1.7] then the total number of transceivers provided, including the four transceivers required by [6.10.1.6], shall not be less than 2 times the number of mooring stations onboard.

c) If portable UHF transceivers are used for compliance with the requirement of [6.10.1.7].a then a battery charger having sufficient capacity to re-charge all UHF transceivers simultaneously shall be installed within the wheelhouse.

d) Portable UHF transceivers used for compliance with the requirement of 108a shall comply with the Society's statutory interpretations for internal communication systems.

e) Fixed installations used for compliance with [6.10.1.7] a shall be such that:

   — when a member of the mooring team activates a call to any location all other locations also receive the call
   — it shall be possible for any location to take over the call by a simple operation and continue to communicate on a hands-free basis.

6.11 Track control system – NAUT(AW)

6.11.1 General

6.11.1.1 The track control system (TCS) in conjunction with their sources of position, heading and speed information are intended to keep a ship automatically on a pre-planned route with the accuracy in metres equal to the ship's breadth to either side of the track under calm weather conditions with minor effect of currents/tidal streams within the limits related to the ship's manoeuvrability.

6.11.1.2 The track control system shall in addition to requirements in IMO performance standard for track control system, comply with the below requirements.

6.11.2 Additional integration

6.11.2.1 The following equipment and systems shall be integrated to make up the TCS:

— two EPFS
— two gyro compass
— ECDIS
— radar/chart radar
— heading control system (HCS)
— conning information display (CID)
— CAM.

6.11.3 Additional functional requirements

6.11.3.1 EPFS
The integrity of the position employed by TCS shall be continuously monitored. At least two independent EPFS positions shall be included in the validation algorithm.

6.11.3.2 The individual position fixes shall be properly filtered incorporating own ship's real time speed vector (DR-position) deduced from gyro and speed log information or equivalent independent sensors.

6.11.3.3 Upon failure of the selected EPFS system (e.g. loss of data or invalid data) the TCS shall automatically employ the EPFS from the second EPFS system and keep up the set course. Any position difference at this instant shall be gracefully reduced.

6.11.3.4 Gyro compass
The gyro compass configuration shall sustain continues heading information to TCS equipment which performance is dependent on heading information, following any single failure in either one of the two gyro systems shall not degrade the TCS. See [6.11.3.8].

6.11.3.5 The integrity of the heading employed by TCS shall be continuously monitored.

6.11.3.6 ECDIS
One of the two ECDIS shall provide the HMI for the assignment of TCS and engagement of track control mode. If more than one ECDIS supports the HMI for TCS only one workstation shall be in command at the time and it shall be clearly perceptible to navigator which workstation is in command.

6.11.3.7 The ECDIS shall support the interface required for timely transmission of relevant parameters of the planned track so the autopilot can conduct a smooth fall-back to heading control mode subsequent to failure of the TCS.

6.11.3.8 HCS/TCS
Upon failure of the selected compass system (e.g. loss of data or invalid data) the HCS/TCS shall automatically employ the heading information from the second compass system and keep up the set course. Any heading difference at this instant shall be gracefully reduced.

6.12 Conning information display – NAUT(AW)

6.12.1 General

6.12.1.1 Information required for efficient monitoring of the TCS performance shall be systematised and displayed in a single screen for easy and continuous monitoring by the navigators. Information not related to safe navigation and manoeuvring shall be avoided on the screen.

6.12.1.2 To enable a straightforward perception, the conning information display shall employ a graphical display locating relevant sensor data and pertinent set values (orders) appropriately on and around an illustration of own ship. The set value and pertinent sensor value is deemed a logical set of parameters.

6.12.1.3 Additionally, present and impending information related to the voyage plan shall be presented on the screen together with environmental data which may affect the performance of the TCS.

6.12.1.4 The CID shall present the set and drift vector (magnitude and direction) being experienced. The accuracy shall not be inferior to the combined accuracy of the EPFS, gyro and SDME information.

6.12.2 Information categories

6.12.2.1 The information categories to be logically grouped and clearly displayed shall comprise:

— control system data
— voyage plan data
— depth, wind and set and drift data.

Additional data categories may be included if related to the navigation and manoeuvring of the ship and providing the perceptibility of the listed information is not impaired with.

6.12.2.2 Control system data

a) Present system orders and set-values:

— set heading (heading to steer, e.g. from $..HTC)
— set turn radius (only during turn, i.e. subsequent to WOL)
— rudder angle order
— set speed (only if speed pilot is provided)
— present steering control mode.

b) Corresponding sensor data and actual values:

— heading
— turn rate
— rudder angle
— speed over ground
— longitudinal
— athwart ship
— propeller revolutions
— pitch indication, when relevant
— thruster indication, when relevant.

6.12.2.3 Voyage plan data

a) General:

— identification (name) of selected route.

b) TO-waypoint:

— number (name) of waypoint
— planned course
— planned turn radius
— bearing to WOP
— time to go to WOL (h,m,s <24h<d,h,m))
— cross-track-limit
— cross-track-distance, XTD (m if <0.5nm).

c) NEXT-waypoint:

— planned course
— distance to WOP.

6.12.2.4 Wind and current data

a) Graphical and alphanumeric presentation of:

- wind vector (velocity and direction)
- set and drift vector (velocity and direction)
- present and preceding depth sounding(s) (>30min).

Guidance note:

The NEXT waypoint should turn into the TO-waypoint subsequent to passing the WOL.

The current vector may be attained from calculus of the SOG- and STW-vectors using information from gyro, speed log and GPS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.12.3 Fall-back information

6.12.3.1 Subsequent to failure of ECDIS all of the information listed in [6.12.2] shall continue to be updated and displayed on the CID until the course change of the TO-waypoint is completed.

7 Integrated navigation system(INS+)

7.1 General

7.1.1 Objective

7.1.1.1 The requirements of this subsection augment the functional requirements of NAUT-rules to increase availability and integrity of the information presented on the bridge and thereby improve the situational awareness of the bridge team.

Moreover, requirements for an interconnection of the INS and the ship-shore communication link is incorporated supporting a secure infrastructure for data exchange with sea traffic management services ashore and facilitating remote condition monitoring and maintenance of the INS.

7.1.2 Scope

7.1.2.1 The scope of **INS+** encompasses a type approved INS with additional requirements for:

- embedded ethernet
- INS-topology and redundancy arrangement
- enhanced HMI
- interconnection to the ship-shore communication system
- setup and commissioning of the INS.

7.1.3 Applications

7.1.3.1 This section is applicable to ships requesting the qualifier **INS+**. The rule requirements are supplementary to the rules for any of the other qualifiers to the **NAUT** notation and prerequisites are a type approved INS and the additional class notation **Cyber secure(Basic)** as a minimum.

7.1.3.2 Ships complying with the rule requirements may add the qualifier to their class notation; e.g. **NAUT(NAV, INS+)**, **NAUT(OC, INS+)**, **NAUT(AW, INS+)** or **NAUT(OSV, INS+)** as appropriate.

7.2 Multi-function-displays

7.2.1 Distribution of functions on workstations

7.2.1.1 The INS shall comprise minimum five MFDs each with sufficiently redundant processing units capable of supporting two or more of the navigational functions of collsion avoidance (RADAR), route planning and route monitoring (ECDIS), conning information display (CID) and central alert management system (CAM).

Guidance note:

The five MFDs should comply with IMO minimum requirement of radars and ECDIS/ECDIS back-up as appropriate.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.1.2 The required functions shall be redundantly available on both the workstation for monitoring and the workstation for navigating and manoeuvring so that following any single failure of any part of the INS all the required functions shall be available on both workstations continuously.

Guidance note:

A typical distribution of functions on the workstations for monitoring and navigating and manoeuvring are:

ECDIS RADAR CID CAM	RADAR ECDIS	CID CAM	RADAR ECDIS	ECDIS RADAR CID CAM

Figure 24 INS functions

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.2 Additional workstations

7.2.2.1 Workstation for voyage planning

For NAUT-notations where a voyage planning workstation is required the pertinent Route Planning task station shall be incorporated in the INS.

7.2.2.2 Workstations for docking operations (NAUT(AW))

Two MFDs, each supporting the applications of RADAR, ECDIS, CID and CAM, shall be installed on both workstations for docking operations and shall be incorporated in the INS.

7.2.2.3 Operational bridge (NAUT(OSV))

At least two MFDs, each supporting the applications of RADAR, ECDIS, CID and CAM, shall be installed on the operational bridge. These MFDs shall cover the requirements for RADAR, ECDIS, CID and CAM at the workstation for ship handling and the requirements for CID and CAM at the workstation for aft support.

7.2.3 Track control system (NAUT(AW))

7.2.3.1 When TCS is in operation, CID and ECDIS shall be persistently displayed on at least two MFDs available and accessible at the workstation in command.

Guidance note:

An application running in the background of ECDIS may be called up temporarily, e.g. to acknowledge a cat A alert, but should automatically return to the ECDIS application within 30 seconds following the last operator action related to the substituting application. If other applications than ECDIS are necessary to fulfil the requirements for continuously displayed information, then such other application shall also be persistently displayed, e.g. in a separate window or screen (MSC.74(69)6.2.1).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.4 Human - Machine Interface (HMI)

7.2.4.1 INS Configuration display

A graphical presentation of the complete INS topology, including LAN components, interconnected sensors, assigned functions, available functions and functions in operation shall be available to the user via no more than a simple operator action.

Guidance note:

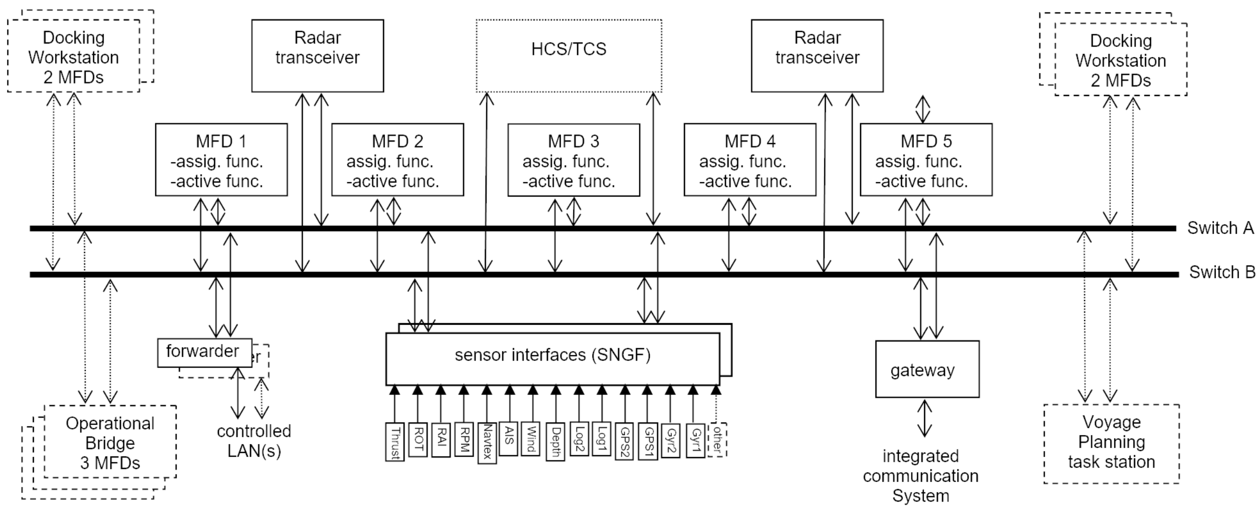

Figure 25 INS configuration display

If colour coding is used to distinguish operational status of INS-components (ON, OFF, Standby) the colours red and yellowish orange is reserved for alerts hence should not be used to indicate the operational status.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.4.2 Indication of active functions

The MFD display shall permanently indicate all assigned functions currently running on the MFD irrespective of the actual function being displayed or not.

7.2.4.3 The MFDs shall be able to run the assigned functions simultaneously and all active functions shall be accessible for display by a single operator action.

7.2.4.4 Assigned functions which are currently not running on a MFD shall require no more than a simple operator action to be activated.

7.2.4.5 TCS/HCS control functions

When a MFD is assigned HMI for TCS and/or HCS, it shall be possible for the user to take command of the assigned control function at the pertinent workstation.

Guidance note:

The workstation(s) assigned HMI for automatic control functions shall support take-over functionality.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.4.6 Display of raw sensor data

Upon user request the INS shall be capable of presenting non-processed data as transmitted by the sensors.

Guidance note:

It should be possible for the user to read (freeze) the stream of received IEC61162-n messages (ASCII) from sensors in a dedicated window.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.4.7 Consistent common reference point

For consistency between observed and measured ranges and bearings, the default reference location (CCRP) shall be the navigating and manoeuvring workstation.

Guidance note:

The workstation for conning is an acceptable CCRP when located adjacent the navigating and manoeuvring workstation, e.g. a passageway forward of the workstation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.4.8 Docking workstations (**NAUT(AW)**)

It shall be possible for the navigator to assign the docking workstation(s) as the CCRP.

7.2.4.9 The assigned CCRP shall be persistently indicated with all relevant applications.

Guidance note:

Relevant applications entail all functions involving presentation or calculation of range, bearing and position.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.5 Alerts

7.2.5.1 Alert display

Audible unacknowledged alerts shall be displayed on all MFDs where the source function is running irrespective of the assigned function presently displayed.

Guidance note:

A persistent alert window should be presented when an active application of the MFD is the source of alert.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.5.2 When several unacknowledged alerts are present the alert window shall display the oldest unacknowledged alert(s) in accordance with priority.

7.2.5.3 The alert message shall identify and address the alert condition and source in plain language.

7.2.5.4 Alert acknowledgement

Alerts being common to multiple MFDs shall be acknowledgeable by a single action on any of the MFDs currently running the alert source.

Guidance note:

Common alerts are typically category A alerts, e.g. the ECDIS safety contour alarm. A single acknowledgment on any of the alerting MFDs should acknowledge the entire INS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.5.5 Alerts shall automatically be terminated when the function generating the alert is switched off by the navigator.

Guidance note:

For example when steering control mode is switched from TCS to HCS or manual steering mode all existing TCS-alerts should be both rectified and acknowledged. Appropriate messages, $...ALF and $...ALC, is to be transmitted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.5.6 Alert limits

As default, all alert related limits shall be embraced by the CCRS. If the MFDs support user selectable thresholds entered locally this shall be both clearly and persistently indicated on the local HMI.

7.2.5.7 Alert suppression

User selectable suppression of individual alerts may be an option for non-mandatory alerts only. If provided, the HMI of all MFDs where the function is running shall clearly indicate that alert suppression is employed and identify the alert(s) being suppressed.

Guidance note:

Suppression of alerts made mandatory by relevant IMO and/or IEC standards is not acceptable. A list of alerts accessible for suppression and identification of alerts currently blocked should be obtainable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.6 Information integrity

7.2.6.1 Latency

Data latency shall be minimized and in no circumstances reduce the accuracy and update rates applicable for the pertinent information or process.

Guidance note:

The latency should be less than 1.0 second for information to be displayed only and it should be less than 0.1 second for information requiring high-speed transmission intended for control functions, e.g. HDG-input to HCS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.6.2 Integrity monitoring of essential information

As default, the INS shall automatically select the most accurate configuration of sensors and methods available for integrity monitoring. Optionally, the user may select other constellations.

7.2.6.3 Integrity monitoring thresholds

The monitoring thresholds shall be set considering the availability and accuracy of sensors, the response time of the process and hydrodynamic characteristics of the ship as applicable.

Guidance note:

The specified sensor accuracy (95% probability) in combination with a plausible time out period resulting in a false-alert-rate < 10^{-8} is concidered appropriate

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.2.6.4 The present configuration and thresholds employed by INS for integrity monitoring shall be available upon user request.

7.3 Network

7.3.1 General

7.3.1.1 The physical characteristics of the network shall conform to the ISO/OSI architecture for open systems interconnection and satisfy the pertinent international standards.

Guidance note:

The Ethernet should be compliant with IEEE 802.3 - 100BASE-TXS or 100BASE-SX for computer nodes and 1000BASE-T or 1000BASE-SX for network infrastructure components. See IEC 61162-450 and IEEE802.x for details.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.1.2 The network interconnection and communication services shall comply with the requirements of the IEC61162-450 and IEC61162-460 standards as applicable.

Guidance note:

In this subsection the term network means any device inter-connecting INS host computers as well as the nodes interconnecting INS and other networks.

IEC61162-450 nodes shall implement syslog messages supporting network management.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.1.3 The network interconnections shall be redundant supporting two independent transport paths between any two host computers of the INS.

Guidance note:

The switch-over time between the two networks should have low latency ensuring continuous availability of service. The latency should be less than the shortest timeout set for data monitoring and/or data processing within the INS. The network (component) failure shall be the only alert.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.1.4 Each network distribution service shall have at least one dedicated time server continuously synchronized with UTC.

7.3.2 Network controller

7.3.2.1 Each individual host computer shall have its own network interface controller and a unique and singular network identification.

Guidance note:

The single ID shall be convertible to two physical network addresses supporting the redundant networks.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.2.2 The network interface controller shall provide a satisfactory degree of independency from the application programs of the host computer.

Guidance note:

The network controller should supervise and control the application module and prevent error propagation from network to application and vice versa, e.g. using TCP/IP, shared memory or similar.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.2.3 The network controller shall maintain a watchdog function checking all connected nodes being alive.

7.3.3 Transport layer

7.3.3.1 The network traffic shall be specified as one of the IEC61162-450 compliant data types.

Guidance note:

For example, IEC61162-1 messages transmission, binary image traffic or ONF. The network transport profile should support a connectionless message transfer protocol (UDP) and a connection-oriented stream transfer protocol (TCP).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.3.2 If data of different significance is being intermixed on the network, adequate quality of service for INS-data shall be ensured by the protocol/signal path.

Guidance note:

System function blocks considered mandatory information per the INS standards, e.g. RADAR image, should have higher priority or be logically separated from other function blocks (ONF), e.g. streaming of CCTV images. If the vessel is engaged in definite operations where the CCTV image is considered being the more essential information then different priorities may be assigned by the user via a dedicated mode selector(HMI), e.g. harbour mode, DP mode and similar operational mode switching.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.4 Network management

7.3.4.1 A network management service shall be embedded performing monitoring and maintaining records of the configuration of network nodes (computer, switches, router(s), gateway(s)).

Guidance note:

The network management function should perform all required tasks in compliance with IEC61162-460.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.4.2 The following services shall be implemented in a safe way entailing a password and confirmation by authorized personnel only:

— remedial actions
— reconfiguration.

Guidance note:

Reconfiguration or remedial action should be initiated only when such action cannot endanger the ship's safety, e.g. while ship is at berth. The password and instructions should be deposited by the ship's master and the INS manufacturer.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5 Access control

7.3.5.1 The bridge shall be arranged as a secure area. The physical perimeters of the bridge shall be provided with adequate access control.

Guidance note:

Access control may entail personal PINs, electronic or physical keys, biometric scans, etc.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5.2 The physical network devices of the INS shall be installed within a secure area and be available to authorised personnel only.

Guidance note:

If an INS-node is installed outside the secure area, the node should be physically connected to a 460-switch or 460-forwarder and authorised by its MAC address.

The INS devices installed within the secure area may have means to enable or disable the authorisation by MAC address.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5.3 Access to make changes in the configuration of the INS network devices shall be subject to user authentication.

Guidance note:

User authentication mechanism should be provided before changing the device settings. Examples of authentication include passwords and/or key cards; if a password is required at login, it should be provided with at least 8 characters.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5.4 Only authorized devices shall be allowed access to the network. The network management shall ensure authentication verifying the network elements are registered as authorized devices.

7.3.5.5 The available connection point(s) (USB ports, disc drives, etc.) shall be limited to the minimum required for normal operation and maintenance of the INS. All unwarranted connection points shall be physically blocked from access.

7.3.5.6 USB connection points intended for mandatory system components (e.g. keyboard, rolling ball, etc.) shall be blocked from connection of different devices.

Guidance note:

Blocking may be by means of a password protected device setup. Connection points used for access to data storage should be configured to permit connection only to data sources identified as USB device class 08h.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5.7 If the configuration of the INS involves non-USB REDS or USB device classes other than data mass storage (class 08h), the INS manufacturer shall provide documentation about the technology used and how the connection point is secured.

7.3.5.8 All automatic execution of files from REDS shall be prohibited.

Guidance note:

Manual execution of files may be acceptable following authentication for accessing the executable file, for example by means of cryptographic hash function (SHA-2 digital signature).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.5.9 All non-executable data in REDS shall be verified before being used by the INS.

7.3.6 External interfaces

7.3.6.1 The following types of external interconnections shall be provided:

1) data transfer between the INS and other controlled networks on board (e.g. the engine control & monitoring network)
2) data exchange with systems ashore, (e.g. ship management office, manufacturer's remote maintenance, ship traffic management services (VTS)).

7.3.6.2 Interconnection(s) supporting navigational data communications with public or administrative systems on board the ship, (e.g. electronic log book, CCTV, reporting systems), may be provided.

7.3.6.3 All INS-devices supporting external interfaces shall be type approved in accordance with the applicable requirements of the IEC-standards

Guidance note:

Relevant standards are IEC60945, IEC61162-1/-2/-3, IEC61162-450, IEC61162-460 and DNVGL-CP-0231.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.6.4 The interconnection between INS and other network(s) shall include an isolation preventing problems propagating from one network to the other.

Guidance note:

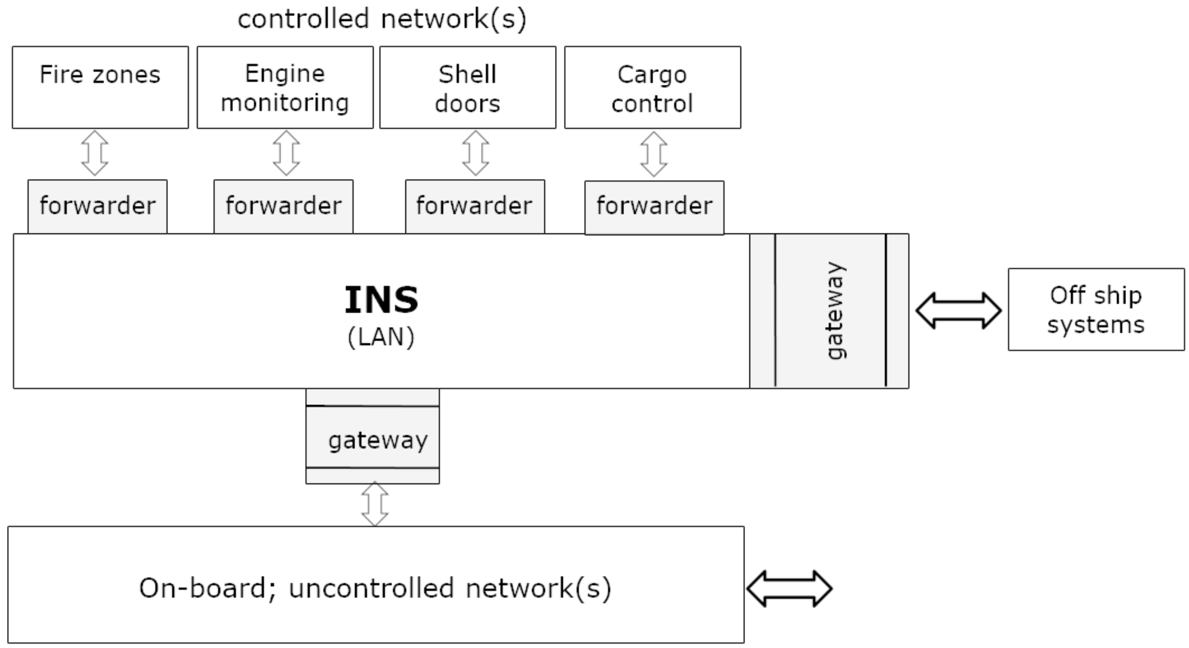

Figure 26 Interconnection between INS and other networks(s)

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.6.5 INS-nodes interconnecting other controlled networks on board shall comply with the requirements of a 460-forwarder.

7.3.6.6 If INS-nodes are interconnecting uncontrolled (e.g. administrative networks on board the device shall at least comply with the requirements of a 460-forwarder and include an application layer firewall. If the uncontrolled network is further connected to internet, then a 460-gateway is required between the INS-node and the uncontrolled network.

7.3.6.7 INS-nodes interconnecting uncontrolled networks off the ship shall comply with the requirements of a 460-gateway.

Guidance note:

A 460-gateway consists of firewalls and DMZ (e.g. proxy server(s)).

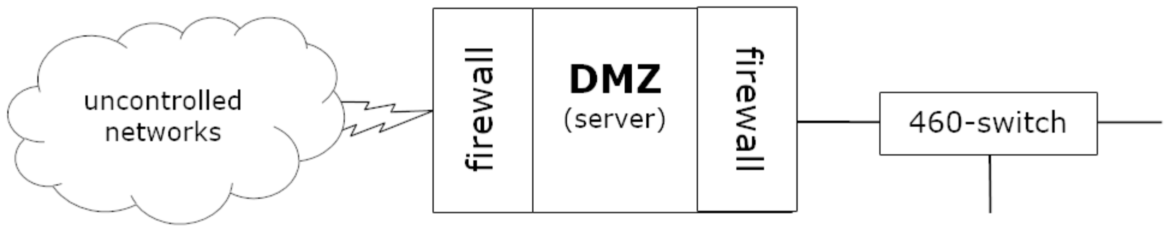

Figure 27 460-gateway

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.6.8 All data received from uncontrolled networks shall be encrypted.

Guidance note:

The gateway should as default "deny all" and only subsequently be configured to accept traffic using communication security not inferior to the TLS protocol.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.6.9 Direct connections between wireless communication access point(s) and the INS-network is not permissible. Any wireless access point(s) shall comply with the requirements of a 460-wireless gateway being operated as a client only.

Guidance note:

A corresponding SF or ONF as defined in IEC 61162-450 should be provided. All data exchanged through a wireless interface should be encrypted with strength not less than 256-bit AES. Wireless connection should be established only to registered wireless access point(s) with authentication.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.7 Failure modes

7.3.7.1 A failure of one part of the INS network shall not affect the functionality of other INS devices except for processes and functions directly dependent upon the defective device.

7.3.7.2 The INS response to malfunctions shall result in the safest of any possible configuration or mode of operation.

Guidance note:

The network should automatically retain maximum performance from the remaining available resources following a single failure.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.3.7.3 If subjected to a power interruption of more than 10 minutes the INS shall, upon restoration of power maintain the configuration and mode previously in use and continue operation as specified in the individual equipment standard. Automatic control functions shall only be restored upon confirmation by the navigator.

7.4 Documentation

7.4.1 Network documentation requirements

7.4.1.1 For additional documentation required for the **NAUT(OC, INS+)**, **NAUT(AW, INS+)**, **NAUT(NAV, INS+)** and **NAUT(OSV, INS+)** class notations, see Table 3.

7.5 Quality system

7.5.1 Quality assurance

7.5.1.1 The INS-integrator shall have a production quality control system embracing the INS network and being audited by a competent authority.

8 Ship manoeuvring characteristics

8.1 General

8.1.1 Scope

8.1.1.1 This section gives requirements for the provision of documentation establishing the manoeuvring characteristics of the ship.

8.1.1.2 Additionally, minimum requirements relating to the ship's course keeping performance is specified in [8.3].

8.1.2 Application

8.1.2.1 Ships requesting class notation **NAUT(AW)** shall comply with the requirements of this section.

8.1.3 Standards

8.1.3.1 The methods of tests and trials employed to determine the ships manoeuvring performance shall be in accordance with recognized international standards.

Guidance note:

The conduct of trials and use of mathematical models providing manoeuvring information should not be inferior to the principles of MSC/Circ.1053 *Explanatory notes to the standards for ship manoeuvrability*.

Note: In this section the term trial should read any of the methods stated in [8.2.1.1] unless the requirement specifically identifies only one of the methods as being applicable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.2 Trials and predictions

8.2.1 General

8.2.1.1 The ships manoeuvring characteristics shall be demonstrated based on the results of full-scale trials or calculations by means of scale model tests and/or computer predictions using mathematical models.

8.2.1.2 Validation of scale model tests and/or computer predictions shall be done by performing full scale trials and comparing the results of these trials with the results of model tests and/or computer predictions performed for the equivalent trial loading condition.

Guidance note:

The characteristic parameters should be within 15% of the parameters obtained from the full-scale trials. If deviation exceeds this figure, the whole full-scale trial program should be completed.

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8.2.1.3 The ship shall as a minimum complete the following full scale trials for at least one loading condition to demonstrate that its manoeuvring performance is in accordance with the requirements of this section:

— 10º/10º and 20º/20º zig-zag trials at full speed ahead
— full astern stopping trial from full speed ahead
— turning circle trials at full speed ahead to both port and starboard and completed by a pull out trial.

Guidance note:

At least one turning circle trial should complete a full 720º course change to ascertain the prevailing current vector. Reference is made to MSC/Circ.1053 for details.

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8.2.1.4 The full-scale manoeuvring trials shall be conducted in deep water and during calm weather conditions.

Guidance note:

Trials should be conducted in conditions within the following limits:

— Depth: more than 4 times the mean draught.
— Wind: not to exceed Beaufort 5.
— Waves: not to exceed sea state 4.
— Current: uniform distribution only.

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8.2.2 Sister ships

8.2.2.1 For ships built in series according to identical drawings and parameters, only one ship of the series shall have to undertake a complete trial program according to this section. The sister ships of the series can adopt the information from these trials provided a full-scale 10º/10º zig-zag trial at full speed ahead is satisfactory completed by all the ships of the series.

Guidance note:

The characteristic parameters should be within 10% of the parameters obtained from the original vessel. If deviation exceeds this figure; completion of the whole full-scale trial program may be required.

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8.3 Course-keeping ability

8.3.1 General

8.3.1.1 The ship design shall take in course keeping and yaw checking abilities aiming to reduce the average use of rudder during normal operation.

Guidance note:

The ship should comply with the following yaw-checking and course-keeping abilities;

1) The value of the first overshoot angle of the 10º/10º zigzag test should not exceed:
   - 10º if L/V is less than 10 seconds;
   - 20º if L/V is 30 seconds or more; and
   - (5 + 1/2(L/V))º if L/V is 10 s or more, but less than 30 s, where L and V are expressed in m and m/s, respectively.
2) The value of the second overshoot angle of the 10º/10º zigzag test should not exceed:
   - 25º if L/V is less than 10 s;
   - 40º, if L/V is 30 s or more; and
   - (17.5 + 0.75(L/V))º if L/V is 10 s or more, but less than 30 s.
3) The value of the first overshoot angle of the 20º/20º zigzag test should not exceed 25º.
   L = Lpp

   V = ships speed.

For ships with non-conventional steering and propulsion systems, the Society may permit the use of comparative steering angles to the rudder angles specified above.

The vessel is deemed to comply with this requirement if the documentation of [8.4.5] is found to be satisfactory.

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8.4 Provision of manoeuvring information

8.4.1 General

8.4.1.1 Information about the ship's manoeuvring characteristics shall be provided giving the navigator the best decision support available when deciding on speed and rudder angle needed to execute a manoeuvre under prevailing conditions.

8.4.1.2 The manoeuvring documentation shall include information about the speed ability, stopping ability, turning ability, course change ability, low steering ability, course stability, the effectiveness of auxiliary manoeuvring devices and a rational man-overboard rescue manoeuvre.

8.4.2 Speed ability

8.4.2.1 Information about speed ability in terms of the actual speed potential of the ship at various engine settings shall be provided for fully loaded and ballast conditions. Information shall be provided for at least three engine settings identifying the percentage used related to the maximum continuous power rating, (MCR):

- at full speed ahead (>90%)
- at half speed ahead (60%)
- at slow speed ahead (40%).

8.4.3 Stopping ability

8.4.3.1 Information about the ship's stopping abilities shall be provided for fully loaded and ballast conditions. Information shall at least comprise stopping from an initial full speed ahead and with application of the following astern powers:

- constant full astern power
- with propulsion and engine stopped.

8.4.4 Turning ability

8.4.4.1 Information about the ship's turning ability to port and to starboard shall be determined for fully loaded and ballast conditions applying full speed ahead and using maximum rudder angle available at this speed.

8.4.4.2 Information about the ship's turning ability to port and starboard following an engine shut down shall be provided:

— from initial full speed ahead and stopping the engine at the start of the turn (coasting turn) using maximum rudder angle available.

8.4.4.3 Information about the ship's turning ability when accelerating from a resting position to half speed ahead shall be provided. Turning information shall be made to both port and starboard:

— initial condition shall be standstill with propeller stopped:

— then apply half speed ahead using maximum rudder angle available (accelerated turn).

8.4.5 Yaw checking and course-keeping ability

8.4.5.1 Information about the ship's initial turning ability and course keeping ability shall be provided for fully loaded and ballast conditions. Zigzag trials shall be made for rudder angles/course changes equal to 10°/10° and 20°/20°.

8.4.6 Low speed steering abilities

8.4.6.1 Information about the lowest constant engine revolutions or lowest pitch control setting at which the ship can safely be steered in ballast and loaded conditions shall be provided.

8.4.7 Heading stability

8.4.7.1 Information about the heading stability (directional stability) of the ship shall be provided. A pullout trial shall be made to port and starboard. A spiral trial shall be made if the pullout trial indicates that the ship is unstable.

8.4.8 Auxiliary manoeuvring device trial

8.4.8.1 Information about the performance and effect of auxiliary devices installed to improve the manoeuvring abilities of the ship shall be provided. The performance and limitations of such manoeuvring devices shall be determined for the following conditions:

— the time required to turn the ship 90º to each side at full thrust while the ship is lying dead in the water should be determined
— the forward speed at which the device ceases to be effective should be determined.

8.4.9 Man-overboard rescue manoeuvre

8.4.9.1 Information about how to perform an effective man-overboard rescue manoeuvre shall be provided. Manoeuvring trials to establish the most effective manoeuvre procedure in case of man over board shall be carried out.

Guidance note:

For large ships with conventional rudder systems, the characteristics of a Williamson turn are recommended to be confirmed:

The initial trial should apply full rudder until a course deviation of 60° has been achieved and then apply full rudder to the opposite side to complete a 180º turn and steadying on the opposite course (heading down its own wake). The trial should be repeated as needed with different course deviation angles until the vessel’s opposite track is within 50 meters of the original wake.

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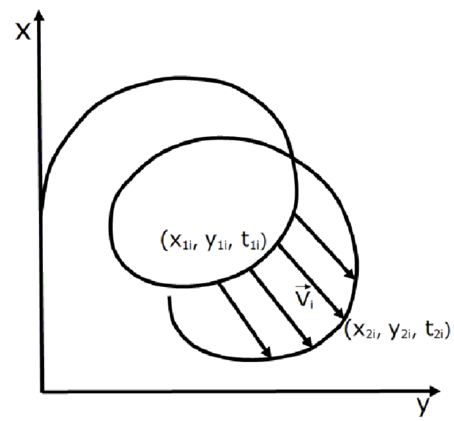
8.4.10 Corrections

8.4.10.1 The documentation of ship manoeuvring characteristics and trajectories when obtained from full-scale trials shall be corrected for any current vector being present during such trials.

Guidance note:

Position (x_{li}, y_{li}, t_{li}) and (x_{2i}, y_{2i}, t_{2i}) in the figure below are the positions of the ship measured after a heading rotation of 360° with a steady ROT. By defining the local current velocity Vi as the difference between any two corresponding positions the estimated current velocity can be obtained from the following equation:

$$\vec{V}_c = \frac{1}{n}\sum_{i=1}^{n}\vec{v}_i = \frac{1}{n}\sum_{i=1}^{n}\frac{x_{2i}-x_{1i}, y_{2i}-y_{1i}}{t_{2i}-t_{1i}}$$



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8.4.11 Information from sister ships

8.4.11.1 All information, which is merely duplicated from a sister ship shall be marked with a statement to this effect together with the identification of the sister ship (hull no.).

8.5 Presentation of manoeuvring information

8.5.1 Wheelhouse poster

8.5.1.1 A summary of manoeuvring information shall be presented in the format of a wheelhouse poster containing general ship particulars and data describing the key manoeuvring characteristics of the ship, both graphical and numerical, to support ease of use. The poster shall be of sufficient size to be easily readable.

Guidance note:

The wheelhouse poster should not be less than A3 format. As regards information content and layout reference is made to IMO Resolution A.601(15), Appendix 2 for details.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.5.1.2 The wheelhouse poster shall be permanently posted in the wheelhouse.

8.5.1.3 The wheelhouse poster shall include a warning that the manoeuvring performance of the ship may differ from that shown on the poster due to environmental, hull and loading conditions.

8.5.2 Manoeuvring booklet

8.5.2.1 The ship shall be provided with a manoeuvring booklet. The booklet shall contain all the details of the ship's manoeuvring characteristics together with all relevant data from trials and scale model tests and/or computer predictions.

8.5.2.2 Trajectories shall be shown graphically together with a scale sample of the ship. The trial trajectories shall always be corrected for current but also for influence of wind and waves if the conditions of [8.2.1.4] are exceeded.

8.5.2.3 The booklet shall contain note fields (space) enabling the information of the booklet to be supplemented in the course of the ship's life.

Guidance note:

The information recommended to be included in the manoeuvring booklet is specified in IMO Resolution A.601(15), Appendix 3.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.5.2.4 A diagram showing the double turn circle of 720° and supplementary data demonstrating the effect of current setting and wind drift registered during the performance of the manoeuvring trials shall be included.

8.5.3 Pilot card

8.5.3.1 The ship shall be provided with appropriate pilot card(s). The pilot card(s) shall be suitable for conveying information to the pilot about the current condition of the ship with regard to its loading condition, availability of propulsion and manoeuvring equipment as well as other relevant equipment.

Guidance note:

The pilot card should either be made of a material suitable for both writing and re-use. A card made of plastic material, or an adequate amount of paper copies supporting a year in operation or an electronic version in a printable format (e.g. PDF-file) should be readably available on board. An example of information content and layout of a pilot card is given in IMO Resolution A.601(15), Appendix 1.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

9 Qualifications and operational procedures

9.1 General

9.1.1 Introduction

9.1.1.1 Modern technology has the potential to improve the situational awareness of the OOW. But this potential can only be realised if the OOW has gained the knowledge and skills necessary for using the technology safely and efficiently.

9.1.2 Scope

9.1.2.1 This section specifies requirements for competence and navigational procedures related to equipment and systems required by this section.

9.1.3 Application

9.1.3.1 Although the requirements of this section are merely informative the Society encourages the ship operator to ensure that the navigation officers on board their ships is provided with adequate training and tools attending to the principles outlined below.

9.2 Watch keeping arrangement

9.2.1 Operational assumptions

9.2.1.1 The following assumptions are made:

— the master ensures that the manning of the bridge watch is in accordance with national regulations in the country of registration and for the waters the ship is navigating
— the master ensures that pre-planning and watch-keeping arrangements are adequate for maintaining a safe navigational watch in accordance with STCW
— the master ensures that the OOW has received the required training prior to being assigned the navigational watch
— the master designates individuals who shall provide assistance when needed by the OOW
— the OOW maintain a navigational watch in compliance with STCW
— the OOW carefully assesses that the workload is well within his capacity to maintain full control of the operational situation while carrying out all the tasks assigned to the bridge watch
— the OOW immediately summons assistance to the bridge in case of irregular operational conditions including situations causing excessive workloads.

9.2.1.2 It is assumed that the ship operator and ship master ensure that all the requirements of this section are complied with.

9.3 Qualifications

9.3.1 General

9.3.1.1 All officers being assigned the responsibility of the navigational watch should be fully qualified to operate the navigational equipment and systems installed on the particular ship. The master and all OOW should hold a certificate of competence documenting completion of TCS training.

9.3.1.2 The OOW should have attained the required competence prior to be assigned a single-man watch.

9.3.1.3 It is the responsibility of the ship operator to make certain that the master and the navigation officers have completed the necessary training and courses prior to their full assignment.

9.3.1.4 The master, holding a certificate of competence issued by the manufacturer of the TCS and having sufficient practical experience, may train and certify navigators through a systematic on board training program prior to their full assignment. The on board training should cover all parts of the manufacturer based training course, and include a statement of competence upon completion of the training.

Guidance note:

The course should at least comprise the following:

— system design
— operational modes
— training in daily operation of the system
— the capabilities and limitations of TCS as well as the individual instruments
— effect of failure in any of the bridge equipment and sensors constituting the grounding avoidance system and the resulting fall-back or fail-to-safety mode of operation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

9.4 Bridge watch procedures

9.4.1 Procedures for safe watch-keeping

9.4.1.1 Procedures for bridge team management and safe watch-keeping should be established and be easily available on the bridge.

9.4.1.2 Procedures and instructions for irregular and abnormal operating conditions should be established based on the failure modes and effect analysis for the grounding avoidance system and heavy workload situations caused by external conditions and combination of external conditions and system failures.

9.4.1.3 The length of dormant intervals of the bridge watch surveillance system should be set with due consideration of the time needed for the back-up officer to get to the bridge (response time), and the external conditions to be experienced, including the time to danger of grounding along the route and traffic density. The parameters for setting the intervals should be known to the watch officer and included in the procedures for safe watch-keeping.

10 Bridge equipment - on-board tests

10.1 General

10.1.1 Application

10.1.1.1 The requirements in this subsection are applicable for **NAUT(OC)** and **NAUT(AW)**.

10.2 On board testing of bridge equipment

10.2.1 General

10.2.1.1 Onboard testing of the bridge equipment shall be performed in order to ascertain that the equipment installed operates satisfactorily.

10.2.2 Test preparations

10.2.2.1 To facilitate a successful sea trial the performance and accuracy of bridge equipment shall be verified while the ship is moored. Prior to the sea trial a survey confirming the accurate calibration of at least the following equipment shall be done:

— gyro compass and repeaters
— radars
— echo sounder
— EPFS
— ECDIS
— rudder angle indicators.

10.2.2.2 Prior to testing, all equipment shall have completed the commissioning and be calibrated in accordance with manufacturer’s specification.

10.2.2.3 Prior to a survey, all instruments and tools necessary for inspection and measurements shall be available.

Guidance note:

The shipyard should prepare for the following:

— At least 8 hours of uninterrupted power supply should be provided to the gyro compass prior to inspection and maintained during the whole survey.
— ENCs covering the area where the ship is moored should be available. If ENCs are unavailable then a large scale (>1:10000) raster chart or another digital chart may be acceptable upon surveyor's satisfaction
— A bearing dioptre (azimuth device) should be available.
— The true bearing of the quay (with an accuracy of 0.2°) where the ship is moored.
— Additional tools that are needed may be audio-metre/signal generator, lux-metre as applicable.

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10.2.3 General requirements for the testing of bridge equipment

10.2.3.1 Failure conditions shall be simulated on all applicable equipment and systems.

Guidance note:

These tests should verify the results of previous failure modes and effect analysis.

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10.2.3.2 A demonstration of start-up of the individual systems shall be carried out.

10.2.3.3 The bridge equipment shall be subject to a complete power failure (both main and emergency PS) causing a blackout period enduring not less than 10 minutes.

10.2.3.4 The testing shall be to the surveyor's satisfaction and tests in addition to the approved test program may be requested.

10.2.3.5 If the ship is not assigned the additional class notation **E0**, tests of the remote control system for propulsion machinery as well as blackout tests, shall be carried out as required in Ch.2 Sec.2 [5]

10.2.4 Gyro compass

10.2.4.1 The settle point error of the master compass(es) and the alignment with the ship's centre line shall be determined.

10.2.4.2 The bearing repeaters' alignment with the ship's centre line shall be checked.

10.2.4.3 The monitoring functions of the compass system shall be tested.

10.2.4.4 The means for correcting errors caused by speed and latitude shall be tested.

10.2.5 Heading control system

10.2.5.1 The course-keeping performance of the autopilot shall be tested at full sea speed. Adaptive autopilots shall also be tested at reduced speed. The use of the rudder shall be observed.

10.2.5.2 The performance of the autopilot shall be checked for course changes of 10° and not less than 60º to both sides. The overshoot angle shall be observed.

Guidance note:

The overshoot angle should in these cases be less than 2º and 5º respectively.

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10.2.5.3 The off-heading and heading difference alarms shall be tested.

10.2.5.4 The performance of the autopilot in turn radius mode shall be tested.

Guidance note:

For the segment of the turn where a steady ROT is possible the actual ROT should be within 10% of the ROT calculated from the real speed/set radius#.

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10.2.5.5 Change of operational steering mode shall be tested.

10.2.5.6 The take-over of steering control function at the navigating and manoeuvring workstation shall be tested in all steering modes. It shall be verified that all steering modes and steering positions can be overridden from this workstation.

10.2.6 Rudder indicator(s)

10.2.6.1 The rudder indicators on the bridge shall be checked against the indicator on the rudderstock.

10.2.7 Rate-of-turn indicator

10.2.7.1 The rate-of-turn indicator shall be checked during a turn with fixed ROT.

10.2.8 Speed log

10.2.8.1 The speed log accuracy shall be checked during double run speed trials.

10.2.9 Echo sounder

10.2.9.1 Function testing of the echo sounder shall be carried out. Depth shall be measured at a fixed position in shallow waters for exact comparison of accuracy and additionally at full speed ahead on all range scales available.

10.2.10 Radar system

10.2.10.1 Function testing of the radar shall be carried out. The various ranges, presentation modes and the basic radar functions shall be tested.

10.2.10.2 The accuracy of relative and true radar bearings shall be verified while the ship is moored.

10.2.10.3 The accuracy of distance measurement at short range shall be verified as being within ±30 m against a target located at a known distance. To be checked while the ship is moored.

10.2.10.4 The heading marker shall be checked against a visible target dead ahead and be within 0.5º of the observed direction.

10.2.10.5 Inter-switching facilities, including bypass function, if relevant, shall be tested.

10.2.10.6 Performance monitors shall be checked against the instructions in the operating manual.

10.2.10.7 Self-check programs shall be run.

10.2.10.8 The configuration of sensors shall be checked. The data for alignment with common reference system shall be verified.

10.2.10.9 The alignment of the electronic chart overlay shall be checked.

10.2.10.10 The interface and data transfer to the ECDIS shall be tested.

10.2.10.11 The AIS HMI shall be checked.

10.2.10.12 The acquisition and tracking functions shall be tested during manoeuvring of the ship. At least a rapid course change of 60º shall be executed.

10.2.10.13 Indication on the display of the bearing and distance to the object, as well as the heading of own ship, shall be checked.

10.2.10.14 The trial manoeuvre function of the radars shall be tested.

10.2.10.15 Tests shall be carried out to verify that the system gives warning when the limits of CPA and TCPA are exceeded and that a warning is given when the object enters the automatic acquisition zone.

10.2.10.16 Identification of input from speed sensors shall be checked.

10.2.11 Electronic position-fixing systems

10.2.11.1 All electronic position-fixing systems shall be function-tested.

10.2.11.2 The accuracy of the electronic position-fixing systems shall be verified while the ship is moored. The S/N ratio shall be checked.

10.2.11.3 The configuration of the transmission protocol (interface) should be checked.

10.2.12 Bridge navigational watch alarm system

10.2.12.1 The functionality and time settings of the BNWAS shall be checked and transfer of 2nd and 3rd stage BNWAS alarms to the accommodation shall be tested.

10.2.13 Central alert management system

10.2.13.1 The interconnections to the CAM shall be tested and the CAM-HMI shall be checked.

10.2.13.2 It shall be tested that un-acknowledged alarms from the CAM are transferred to the alarm transfer system.

10.2.14 Communication systems

10.2.14.1 The automatic telephone system and internal communication system between workstations shall be tested.

10.2.14.2 The priority function for the telephones in the wheelhouse and engine control room over the other extensions shall be tested.

10.2.14.3 VHF systems shall be tested.

10.2.15 Sound reception system

10.2.15.1 The sound reception system shall be tested. The system shall be calibrated so that it is always muted in the absence of other ship’s whistle signals.

Guidance note:

The fundamental frequency of the sound signal used in testing the system should be within the range 70 to 820 Hz.

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10.2.16 Electronic chart display and information system

10.2.16.1 Function testing of the attributes of the ECDIS shall be carried out.

The following features should be checked:

— the configuration of a common reference system for all sensors
— the data protocol from the GPS including different datum
— alignment of radar targets and AIS targets (as applicable)
— sensor monitoring and alarming
— update and transfer of voyage plan between ECDIS' and radars
— ECDIS system failures to be tested to verify redundancy requirements and the continuing availability of the activated route.

10.2.16.2 Self-check programs shall be run.

10.2.17 Track control system

10.2.17.1 The track control system and additional functions/requirements, including alarm or warning functions, shall be tested along a pre-planned route consisting of different courses.

10.2.17.2 The route shall consist of both straight legs and course changes as needed to verify the system performance and configuration. The route shall include turns to port and starboard respectively with the maximum course change accepted in route planning mode. The minimum turn radius shall be set for both these turns.

Additionally at least the following tests and checks shall be carried out:

— turn with maximum radius
— turn with minimum course change
— turn where autopilot fails
— position jump
— position failure
— heading failure
— ECDIS failure.

The track keeping performance in a turn during speed reduction shall be tested.

The entire route should be run and completed as one continuous test to the surveyor's satisfaction.

10.2.18 Conning display

10.2.18.1 The performance of the conning display following ECDIS failure shall be verified as well as the accuracy and readability of the data displayed.

10.2.19 Weather information system

10.2.19.1 The weather information system shall be subject to a simple function check of software and pertinent subscription of the applicable services.

SECTION 4 NAUTICAL SAFETY - NAUT(NAV)

1 General

1.1 Introduction

The additional class notation **NAUT(NAV)** sets requirements for compliance within the principles and aims of SOLAS V/15 and IMO MSC/Circ.982. This notation comprises the technical requirements for an ergonomic bridge design and arrangement in seagoing vessels; in providing ergonomic solutions for the bridge equipment and layout, in order to provide for consistent, reliable and efficient bridge operations.

1.2 Scope

The scope for additional class notation **NAUT(NAV)** is related to the ergonomic and technical design of the bridge. This notation has been developed to realize a successful ergonomic design of the bridge and the equipment on the bridge, which will improve the reliability and efficiency of navigation. Additionally, these rules contain ergonomic requirements as well as a functionally oriented bridge layout to support watch-keeping personnel in their tasks by a user-centered design of the bridge equipment and layout.

1.3 Application

The additional class notation **NAUT(NAV)** has been established on the supposition that the regulations of international conventions, and the rules for main class have been complied with, and may be assigned when the navigation bridge is configured, arranged and equipped in compliance with these rules. See Sec.3 Table 1 for details of NAUT qualifiers. Applicable to all main workstations, for optimum visibility [field of vision], integrated presentation of information, work environment, presentation of alarms and interactive control.

1.4 Classification

1.4.1 Class notation

1.4.1.1 The vessel may be assigned class notation **NAUT(NAV)** when the navigation bridge is configured, arranged and equipped in compliance with these rules. See Sec.3 Table 1 for details on NAUT qualifiers.

1.4.2 References

1.4.2.1 Mandatory references (normative):

— International Convention for the Safety of Life at Sea (SOLAS), 1974/ Chapter V, as amended
— International Regulations for Preventing Collisions at Sea (COLREG), 1972 as amended
— MSC.191(79) Performance standards for the presentation of navigation-related information on shipborne navigational displays
— A.694(17) General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids.

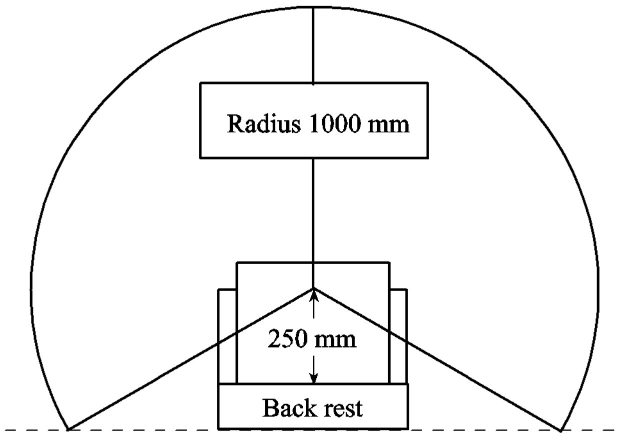
1.4.3 Definitions

Table 1 Definitions

Term	*Definition*
alarm transfer system	functionality of the bridge navigational watch alarm system (BNWAS) to actuate the “emergency call” in case of an unacknowledged alarm after a time defined by the user unless otherwise specified by IMO
BAMS - bridge alert management system	a system that harmonizes the priority, classification, handling, distribution and presentation of alerts, to enable the bridge team to devote full attention to the safe operation of the ship and to immediately identify any alert situation requiring action to maintain the safe operation of the ship
bridge	the area from which the navigation and control of the ship are exercised, comprising the wheelhouse and the bridge wings
bridge wing	the part of the bridge on each side of the wheelhouse, which extends towards the ship ´s side
CAM - central alert management system	harmonized system for the monitoring, handling, distribution and presentation of alerts on the bridge from equipment and systems used for navigation. The CAM may be a stand-alone system or part of an INS. The CAM may be part of a bridge alert management system for the monitoring, handling, distribution and presentation of all mandatory alarms to be displayed on the navigating bridge
CAM-HMI – central alert management – human machine interface	the BAMS interface for presentation and handling of alerts on the bridge
category A alert	alert for which graphical information at the task station directly assigned to the function generating the alert is necessary, as decision support for the evaluation of the alert-related condition
category B alert	alert where no additional information for decision support is necessary besides the information which can be presented at the CAM-HMI.Category
commanding view	location on the bridge from where the visibility criteria of SOLAS V/22 are fulfilled and where the required navigational indicators can be observed
conning position (as required by SOLAS V/22)	place in the wheelhouse with a commanding view providing the necessary information for conning, and which is used by navigators, including pilots, when monitoring and directing the ship’s movements
COG	course over ground. Ship’s course measured relative to the earth surface
DGPS	differential global positioning system
docking workstation	workstation in the bridge wings, from which the ship can be operated during berthing, lock passage, pilot transfer, etc.
EPFS	electronic position fixing system
easily accessible	being both perceptible from and located within 5 m distance from the relevant working position

Term	*Definition*
easily readable	for information to become easily readable at the workstation all relevant indicators and displays are located within the forward 180º view sector seen from the operating position. The indicators and displays are placed with its front perpendicular to the navigator's line of sight seen from the operating position, or to a mean value (angle) if the information shall be used by personnel located at more than one workstation
field of vision	angular size of scenery being observable from a position within the ship's bridge
GNSS	global navigation satellite system
helmsman	designated person who actuates the rudder and controls the heading of the ship under way
INS - integrated navigation system	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 ship
HCS	heading control system
HMI	human machine interface
manual steering workstation	workstation from which the ship can be steered by a helmsman
monitoring workstation	workstation from where equipment and environment can be checked constantly; when several crew are working on the bridge it serves for relieving the navigator at the navigating and manoeuvring workstation and/or for carrying out control and advisory functions by the master, back-up officer and/or pilot
navigating and manoeuvring workstation	main workstation for ship's command 350 mm behind the radar console. It is conceived for working in seated /standing position with optimum visibility and integrated presentation of information and operating equipment. It is designed to operate the ship safely and efficiently, in particular when a fast sequence of action is required
OOW - officer of the navigational watch	person responsible for safety of navigation and bridge operations
planning and documentation workstation	workstation at which voyages are planned and where all facts of ship's operation are documented
radio communication workstation	workstation for external communication distress, safety and general communication
safety workstation	workstation at which monitoring displays and operation elements of systems serving the ship's own safety are concentrated
SDME (WT)	speed and distance measuring device (water track)
SDME (BT)	speed and distance measuring device (bottom track)
ships length	length over all
SOG	speed over ground: Ship's real time speed measured relative to the earth surface
STW	speed through water: Ship's real time speed measured relative to the water surface
totally enclosed bridge	a bridge without open bridge wings, meaning that bridge wings form an integral part of an enclosed wheelhouse
UID	user input device (example: keyboard, tiller, joystick, pushbutton, etc.)

Term	Definition
wheelhouse	closed area of the bridge
within the reach of the officer of the watch in sitting position	operation and control units within the reach of the officer of the watch shall be within a radius of 1000 mm around the seated officer (see Figure 1)
within the reach from standing position	the distance the operator can reach and can use an UID from a standing position next to a console. This distance shall be 800 mm in forward direction and 1400 mm sideways



Within the reach of the officer of the watch in seated position

Figure 1

1.4.4 Documentation

1.4.4.1 Documentation shall be submitted as required by Table 2.

Table 2 Documentation requirements

Object	*Documentation type*	*Additional description*	*Information*
NAUT(NAV)			
Navigation bridge	N011 – Bridge design drawing, extended		AP
	N021 – Vertical field of vision drawing, extended	Calculation from a position 350 mm abaft the radar at the navigating and manoeuvring workstation applying an eye height of 1800 mm.	AP
	N031 – Horizontal field of vision drawing, extended	Calculation from a position 350 mm abaft the radar at the navigating and manoeuvring workstation and monitoring workstation applying an eye height of 1800 mm.	AP

Object	Documentation type	Additional description	Information
	N040 – Nautical workstation arrangement plan	Showing consoles configuration and arrangement of individual equipment UIDs and VDUs within the consoles.	AP
	N050 – Navigation bridge windows framing arrangement plan		AP
	Z030 – Arrangement plan	Window wipers, fresh water wash, sun-screens and de-misting/de-icing system (heating) on the bridge windows.	AP
Navigation systems	Z090 – Equipment list	Type, manufacturer, model name, TA-ref.	AP
	E230 – Power supply arrangement		AP
	I030 - System block diagram (topology)	Showing inter-connections between all main components and equipment.	AP
	Z161 – Operation manual		FI, R
	Z162 – Installation manual		FI, R
For additional qualifier **INS+** documentation requirements are listed in Sec.3 [1.6]			
Info: AP: For approval, FI: For Information, R: On request			

1.4.4.2 For general requirements to documentation, see DNVGL-CG-0550 Sec.6.

1.4.4.3 For a full definition of the documentation types, see DNVGL-CG-0550 Sec.5.

1.4.5 Tests

1.4.5.1 On-board testing
Initial on-board testing of the bridge equipment shall be performed in order to ascertain that the equipment is installed in accordance with approved drawings and operates satisfactorily.

2 Bridge configuration

2.1 Workstations

2.1.1 Workstations

2.1.1.1 These rules apply to the navigating and manoeuvring workstation, the monitoring workstation, the workstation for manual steering and the docking workstations.

Guidance note 1:

For the planning and documentation workstation, the safety workstation and the radio communication workstation, the requirements and guidelines of ISO 8468, IACS REC.95 and MSC/Circ.982 are recommended.

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Guidance note 2:

A combination of workstations may be permitted if reasonable and practical.

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2.1.1.2 At each workstation all information shall be displayed, and all units and appliances be installed, which are required for safe performance of all tasks dedicated to the workstation.

2.1.1.3 Workstations for navigating and manoeuvring and for monitoring should be arranged within an area spacious enough for two persons to carry out the tasks in close cooperation, but sufficiently close together to enable the watch officer to control and safely carry out all the tasks from one working area under normal operating conditions.

2.1.2 Field of vision

2.1.2.1 Line of sight

The view of the sea surface from the navigating and manoeuvring workstation and the monitoring workstation shall not be obscured by more than two ship lengths, or 500 m, whichever is the less, forward of the bow to 10° on either side under all conditions of draught, trim and deck cargo, e.g. Containers (see Figure 2).

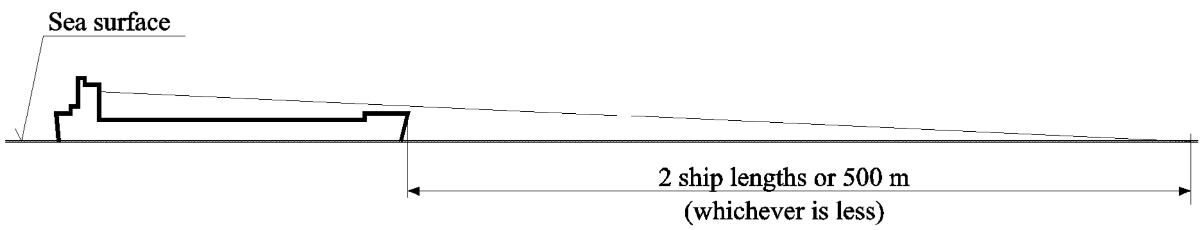

Figure 2 Line of sight

2.1.2.2 Horizontal field of vision

A field of vision around the vessel of 360° shall be obtained by an observer with an eye height of 1800 mm moving within the confines of the wheelhouse.

Guidance note:

A suitable camera system covering any blind sectors aft of the 225° sector may be acceptable on a case-to- case basis, provided pertinent displays/monitors are installed being viewable from the workstation for navigating and manoeuvring.

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2.1.2.3 The horizontal field of vision from the navigating and manoeuvring workstation shall extend over an arc of not less than 225°, that is from right ahead to not less than 22,5° abaft the beam on either side of the ship (see Figure 3).

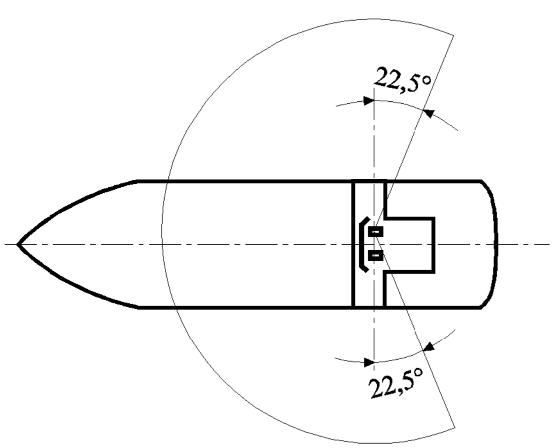

Figure 3 Field of vision at navigating and manoeuvring workstation (example for off-centre location on stb.-side)

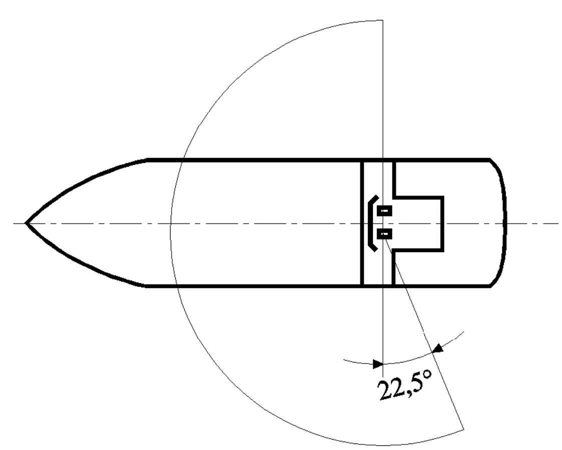

Figure 4 Field of vision from monitoring workstation (example for off-centre location on port-side)

2.1.2.4 The horizontal field of vision from the monitoring workstation shall extend over an arc of not less than 202,5°, that is from 22.5° abaft the beam on one side of the ship through right ahead and to abeam on the other side of the ship (see Figure 4).

2.1.2.5 The 225° field of vision shall not be limited by curtains or other unnecessary obstructions inside the wheelhouse.

2.1.2.6 The straight view directly ahead from the navigating and manoeuvring workstation and monitoring workstation shall not be obscured by obstructions inside or outside of the wheelhouse.

2.1.2.7 From each docking workstation (bridge wing) the horizontal field of vision should extend over an arc of at least 225°, that is at least 45° on the opposite bow through right ahead to right astern.

2.1.2.8 The ship's side should be visible from the bridge wing.

Guidance note 1:

Bridge wings should be provided out to the maximum beam of the ship. This requirement is accomplished when the bridge wings are extended up to 400 mm less than the maximum beam of the ship and the bridge crew can lean over the side to have an unobstructed view. The requirement should also be fulfilled when the sea surface at the lowest draught and a transverse distance of 500 mm and more from the maximum beam throughout the ship's length is visible from the side of the bridge wing (see Figure 5). Ships of specific construction are exempted – see MSC.1/Circ.1350.

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Guidance note 2:

Bridge wings which are extending beyond the vessel's hull are considered as protrusions by the Panama Canal Authority (ACP). Such protrusions may interfere with the safe Panama Canal transit and are therefore subject to all applicable regulations and limitations.

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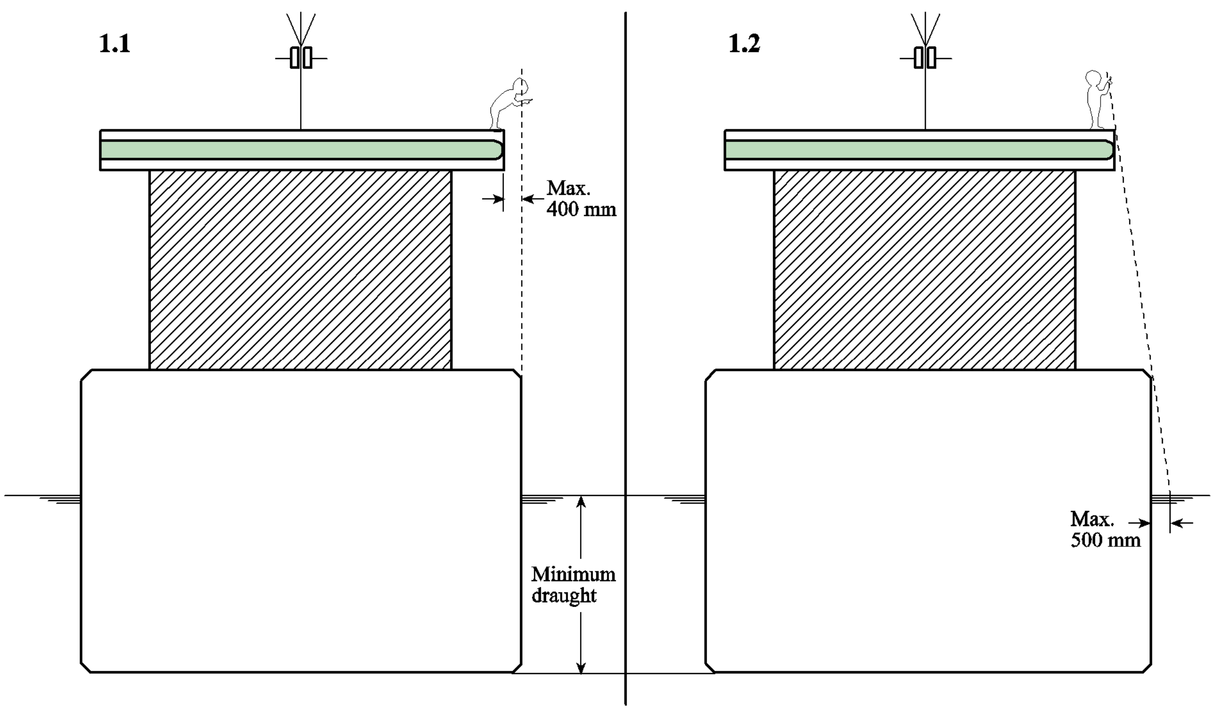

Figure 5 Max. permitted blind sectors at the view of the ships side

2.1.2.9 From the main steering position (workstation for manual steering) the horizontal field of vision shall extend over an arc from right ahead to at least 60° on each side of the ship. No obstruction by cargo, cargo gear or window frames shall be directly ahead of the manual steering workstation.

2.1.2.10 The workstation for manual steering shall preferably be located on the ship's centre-line. If the view ahead is obstructed by large masts, cranes, etc., the steering station shall be located a distance to starboard of the centre-line, sufficient to obtain a clear view ahead. 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.

2.1.2.11 No blind sector caused by cargo, cargo gear or other obstructions outside of the wheelhouse forward of the beam which obstructs the view of the sea surface as seen from the navigating and manoeuvring workstation, shall exceed 10°. The total arc of blind sectors shall not exceed 20°. The clear sectors between blind sectors shall be at least 5°. However, in the view described in [2.1.2.1],each individual blind sector shall not exceed 5°. The total arc of additional blind sectors between the beam and 22.5° abaft the beam on either side should not exceed 10°, allowing a total of 30° within the required total field of vision of 225°. A clear sector of at least 5° shall extend from 22.5° abaft the beam and forward on either side of the ship (see Figure 6).

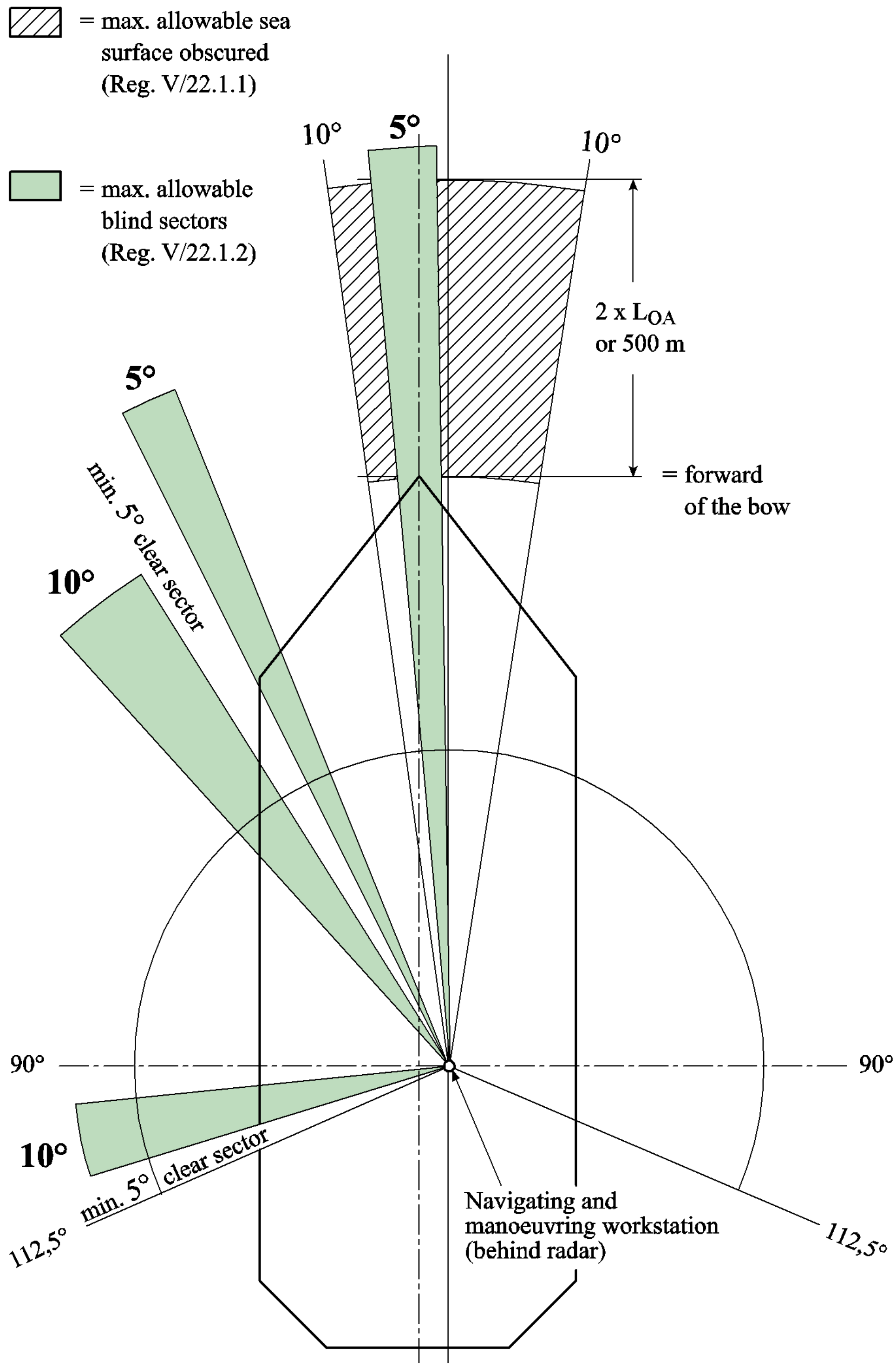

Figure 6 Field of vision

2.1.2.12 The view point to be used for calculation of the required view and field of vision (see Figure 2 and Figure 3) shall be the workstation navigating / manoeuvring which is 350 mm behind the radar screen and based on an eye height of 1800 mm (see Figure 7).

Guidance note:

The Panama Canal pilot conning positions No.1 – No.5, required by the Panama Canal Regulations may be at different locations and are not relevant for SOLAS or **NAUT(NAV)**.

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2.1.2.13 Visibility shall not be obstructed by regular container stowage above the line of visibility, forward of the bridge. Only blind sectors that cannot be avoided due to unusual structure and size of the cargo units on deck and fixed structures necessary for cargo handling or the operation of the ship may be included in the blind sector limits allowed by SOLAS V/22 and [2.1.2.11] of this section.

2.2 Structural arrangements

2.2.1 Wheelhouse height

2.2.1.1 The clear height between the bridge deck surface covering and the underside of the deck head beams shall be at least 2250 mm. The lower edge of deck head mounted equipment shall be at least 2100 mm above the deck in open areas, passageways and at standing workstations.

2.2.2 Windows

2.2.2.1 The height of the lower edge of the front windows above the deck shall allow a forward view over the bow in accordance with B.1. for a person in a sitting position at the workstation for navigating and manoeuvring or monitoring and should not be more than 1000 mm.

2.2.2.2 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 1800 mm at the navigating and manoeuvring workstation and the monitoring workstation when the ship is pitching in heavy seas (see Figure 7). The minimum height of the upper edge of front windows above the deck surface shall be 2000 mm.

2.2.2.3 Framing between windows shall be kept to a minimum and not be installed immediately forward of any workstation. If stiffeners between windows shall be covered, this shall not cause further obstructions of the field of vision from any position inside the wheelhouse.

2.2.2.4 Windows, especially those in front of the navigating and manoeuvring workstations and the monitoring workstations, shall be as wide as possible. The divisions (plate strip) between front windows shall not exceed 150 mm, greater breadths up to 200 mm are acceptable if it is proved that this is necessary for reasons of strength or to avoid vibrations. If stiffeners are used, divisions shall not exceed 100 mm in width and 120 mm in depth.

2.2.2.5 All bridge windows within the required field of vision (225°) from the navigating and manoeuvring workstation and the monitoring workstation shall be inclined from the vertical plane to avoid reflections. Bridge front windows shall be inclined from the vertical plane top out, at an angle of not less than 15° and not more than 25°. Bridge side windows shall be inclined from the vertical plane top out, at an angle of not less than 5°. Windows in the bridge wing doors may be arranged vertically. Windows outside the 225° field of vision, and aft facing windows shall also be inclined not less than 4°~ 5°, if they may cause reflections.

2.2.2.6 The windows shall be of clear glass. The use of polarized or tinted glass or glass causing unreasonable refraction is not permitted.

2.2.2.7 All bridge front windows shall be provided with efficient cleaning, de-icing and de-misting devices. In case of a totally enclosed bridge also the aft facing windows and the side windows (except sliding windows) at the docking stations shall be provided with such devices. The use of clear view screens (rotating windows) is not required. However, if fitted, they shall not be installed in windows in front of any workstation. On windows in the front bulkhead, which are in line with the view from the workstations, wipers may be omitted (Figure 8), unless required for the manual steering workstation and/or the pilot's conning position.

2.2.2.8 To ensure a clear view and to avoid reflections in bright sunshine, sun-screens with minimum colour distortion should be provided at all bridge windows. Such screens should be readily removable and not permanently installed.

2.2.2.9 It shall be possible to watch the area in front of the bridge superstructure from the wheelhouse. Therefore a close approach to at least one front window shall be possible.

2.2.3 Consoles

2.2.3.1 Consoles within the required field of vision of the workstation for navigating and manoeuvring and the workstation for monitoring shall not obstruct the horizontal line of sight in seated position.

Guidance note:

The upper edge of the consoles should not exceed 1200 mm (see Figure 7).

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2.2.3.2 If there are any consoles or installations placed away from the bridge front bulkhead or if a console is separated from other installations, the distance to the front bulkhead or any other console shall be sufficient for two persons to pass each other. The distance of a passageway between the front bulkhead and any consoles should preferably be at least 1000 mm, but in no case less than 800 mm.

2.2.3.3 If access ways are provided between different workstation, these shall in general have a clear width of not less than 700 mm. The workstation operating area shall be part of the workstation and not of the access way.

2.2.3.4 If chairs are provided for the navigating and manoeuvring workstation and the monitoring workstation, they shall be capable of rotating with the foot rest being arrested and adjustable in height and be capable of being arrested on the floor.

Guidance note:

The chairs should also be capable of being moved clear of the operating areas.

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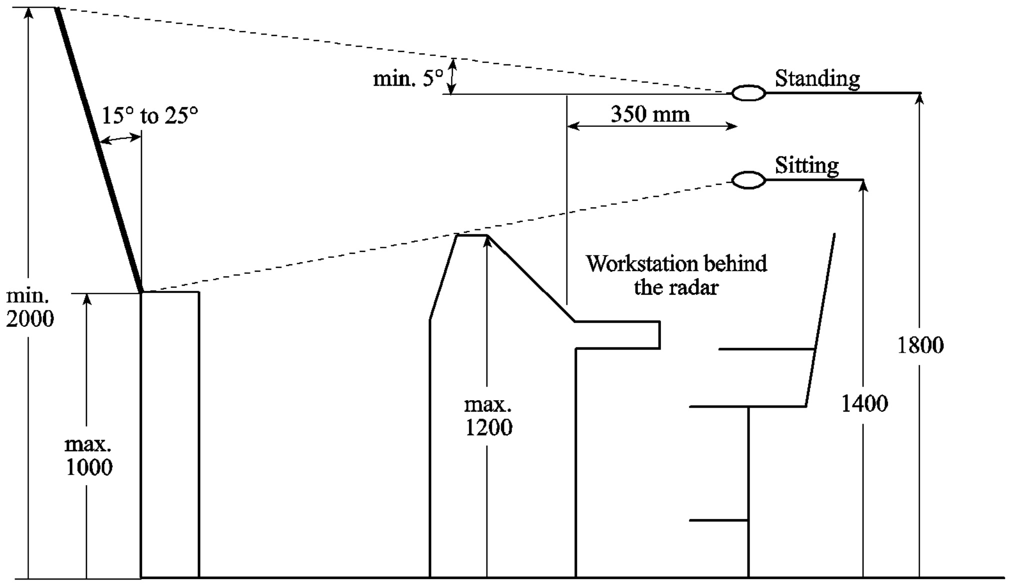

Figure 7 Minimum size of the bridge front window and visibility from the navigating and manoeuvring workstation and monitoring workstation

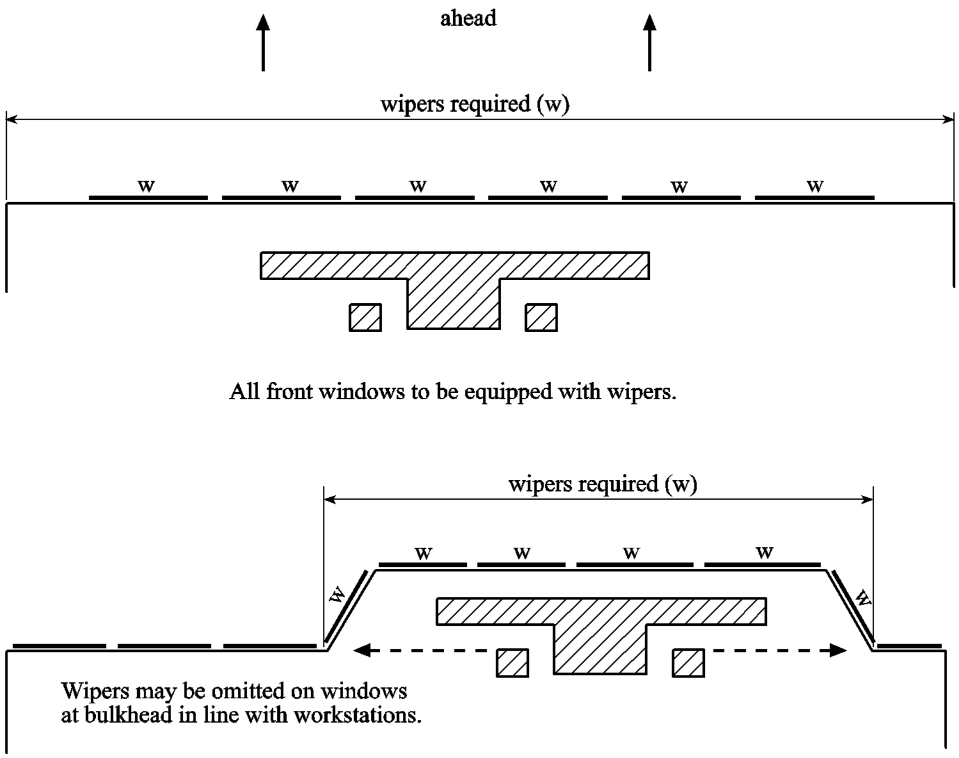

Figure 8 Requirements for cleaning devices (windows wipers)

2.3 Working environment

2.3.1 Working environment

2.3.1.1 Toilet facilities shall be provided on the bridge or within easy access of the navigation bridge deck, primarily for those on duty.

2.3.1.2 Wheelhouse and bridge wing floors shall be on one level, without steps and should have a non-slip surface.

2.3.1.3 There shall be no sharp edges, protuberances, pillars, tripping hazards or other obstacles, which could cause injury to personnel.

2.3.1.4 Sufficient hand or grab rails shall be fitted to enable personnel to move or stand safely in bad weather. Means for securing of stairway openings shall be given special consideration.

2.3.1.5 Red light shall be used to maintain dark adaption whenever possible in areas or on items of equipment, other than the chart table, requiring illumination in the operational mode. This light should be variable from 0 to 20 lux and be provided at all workplaces.

Guidance note:

The requirements and guidelines of MSC/Circ.982 for work environment are recommended.

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3 Bridge equipment

3.1 General

3.1.1 General

Ships shall be equipped in accordance with SOLAS 1974, as amended, Chapter V, as applicable.

3.1.2 Additional equipment

3.1.2.1 In addition to SOLAS carriage requirements, the ship shall be fitted with:

— Second Electronic Position Fixing System (EPFS – e.g. GPS, GLONASS, GALILEO, etc.).
— Electronic Chart Display and Information System - ECDIS and backup ECDIS.
— Second gyro compass, ships of 10.000 GT and upwards.
— Heading control system (HCS).
— Weather information system.
— Wind speed and direction indicator.

3.1.3 Additional sensor requirements

3.1.3.1 The following sensors and functions shall be provided independent of SOLAS carriage requirements:

— ARPA functionality shall be provided for all installed radars on the bridge.
— At least one of the radars shall be capable of displaying parts of electronic navigation charts (ENC) and other vector chart information to aid safety of navigation and position monitoring. Alternatively at least one ECDIS shall be capable of displaying radar overlay.
— At least one of the EPFS shall be a DGPS or other GNSS receiver with the same or better accuracy and availability.
— Anemometer to indicate the relative and true wind speed and direction information.

3.1.3.2 A loss or a failure of one sensor shall not result in a loss of the redundant sensor or fall-back arrangement.

3.1.3.3 A bidirectional alert interface shall be provided by each required sensor to indicate any required alert on an external central alert management system. Each sensor shall have the capability for an immediate remote acknowledgement, except category A alerts, and temporarily silence from an external alert management system.

3.1.3.4 The following back-up and fall-back arrangements of Table 3 shall be observed.

Table 3 Back-up and fall-back arrangements

Sensor	*Data*	*Back-up*	*Fall-back (equipment which may be available in case of a complete sensor loss)*
Gyro	Heading	Gyro 2	Magnetic compass*
EPFS	Position Time, Date	EPFS 2	Dead reckoning and radar bearing
SDME (WT)	Speed	SDME (BT) if provided	EPFS
Echo sounder	Depth		ECDIS and/or Paper Chart
RADAR		RADAR2	AIS
Data interface (if provided)		Data interface (if provided)	
*not to be used for radar and track control			

Guidance note:

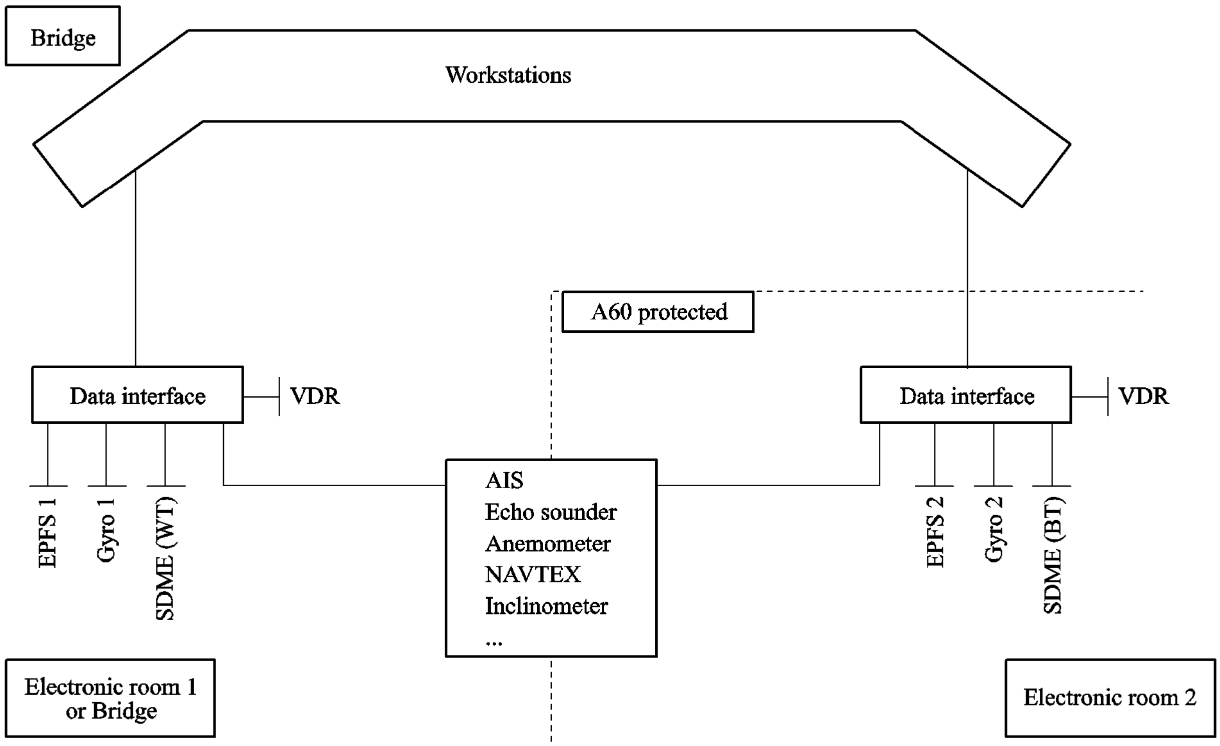

Figure 9 Example for a sensor configuration

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3.2 Arrangement of equipment

3.2.1 Navigating and manoeuvring workstation

3.2.1.1 The following tasks and control functions shall be accessible and within the reach of the officer of the watch from a seated position (see Figure 1):

— 9 GHz ARPA radar with operation controls The 9 GHz radar shall be inter switchable with the 3 GHz radar at the monitoring workstation.
— ECDIS with operation controls and radar overlay
— HCS with manual override
— control of main engine(s), incl. emergency manoeuvre and emergency stop
— steering mode selector switch for steering gear
— intercom to docking workstations (if distance > 10 m)
— call system for master and navigation officers (telephone / internal communication system)
— VHF equipment including GMDSS distress alarm management (external communication)
— automatic identification system (AIS) terminal, if it's a stand-alone system. If the AIS information is shown in the radar or ECDIS it may be positioned within the perception area of the officer of the watch
— control of whistle and manoeuvring light
— acknowledge push button for BNWAS
— control of general alarm

— control of wipers for windows in front of workstation
— control of console lighting.

3.2.1.2 The following equipment shall be within reach from seated or standing position:

— control of thrusters
— rudder pump selector switch for steering gear.

3.2.1.3 The following information shall be easily readable from the navigating and manoeuvring workstation for the officer of the watch. This can be achieved by stand-alone instruments in the bridge console or by a centralized multifunctional conning display, which is recommended:

— gyro compass heading
— rate-of-turn, if available
— rudder angle
— propeller revolutions
— pitch, if a pitch propeller if fitted
— thrust: force and direction
— speed (longitudinal and lateral if provided)
— water depth
— position
— time
— wind: direction and speed
— sound reception device, if totally enclosed bridge
— NAVTEX, if provided without printer.

3.2.1.4 The following instruments, indicators and displays providing information shall be easily accessible from the navigating and manoeuvring workstation:

— whistle automatic control system
— navigation- and signal light controller
— emergency stop of installations to be stopped in case of fire (air condition, ventilation and refrigerating installation)
— remote control and monitoring of watertight doors, external openings and fire doors (open/closed), if available
— remote control of emergency fire pump
— anti-rolling device, if available.

3.2.2 Monitoring workstation

3.2.2.1 The following tasks and control functions shall be provided within the reach of the officer from a seated or standing position (see Figure 1):

— 3GHz ARPA radar with operation controls. This radar shall be inter-switchable with the 9 GHz radar at the navigating and manoeuvring workstation
— control of whistle and manoeuvring light
— acknowledge push button for watch alarm system (BNWAS)
— control of window wipers in front of workstation
— intercom to docking workstations, (if distance > 10 m)
— call system for master and navigation officers (telephone / internal communication system)
— VHF equipment (external communication).

3.2.2.2 The following information shall be easily readable from the monitoring workstation:

— gyro compass heading

— rate-of-turn, if available
— rudder angle
— propeller revolutions
— pitch if a pitch propeller is fitted
— thrust force and direction
— speed (longitudinal and lateral if provided)
— water depth
— time
— wind direction and speed
— sound reception device, if totally enclosed bridge.

3.2.2.3 Instruments, indicators or displays mentioned under paragraphs [3.2.1.1] to [3.2.2.2] and which are required at more than one workstation, shall be arranged so that they can be easily reached, respectively easily readable from all relevant workstations. If this is not achievable such equipment shall be duplicated.

3.2.3 Manual steering workstation

3.2.3.1 The following equipment shall at least be provided within the reach of the helmsman:

— steering wheel or other means of controlling the heading of the ship manually
— control of window wiper in front of workstation
— intercom to docking workstations (if distance >10 m), suitable for hands-free operation.

Guidance note:

The communication equipment may be a suitable wireless system (e.g. UHF) or a PA talk-back system or similar fixed installation.

— dimmer for indicators listed in [3.2.3.2].

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3.2.3.2 The following indicators shall at least be easily readable for the helmsman, when manually steering the vessel:

— rudder angle
— gyro compass heading
— magnetic compass heading
— rate-of-turn, if available.

3.2.4 Docking workstation

3.2.4.1 The following equipment shall at least be provided within the reach of the operating officer:

— control of whistle and manoeuvring light
— intercom to enable two-way communication with wheelhouse workstations for manual steering, navigating and manoeuvring, monitoring and to manoeuvring stations. The intercom shall be capable of hands-free operation
— acknowledge push button for BNWAS
— control of wipers for front and rear windows of workstation (if the ship has a totally enclosed bridge).

3.2.4.2 The following information shall be easily readable from the docking workstation:

— rudder angle
— propeller revolutions
— pitch, if a pitch propeller is fitted
— thruster speed and direction
— gyro compass heading (may be covered by applicable gyro compass bearing repeaters).

Guidance note:

A conning display or multi-function display may be used and is recommended.

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3.2.5 General bridge equipment within wheelhouse

3.2.5.1 Following general equipment shall be provided within the wheelhouse:

1) BNWAS main control unit
2) control of window washing and heating system
3) control of wheelhouse heating and cooling
4) main control unit of whistle
5) weather information system.

Guidance note:

A weather fax or a marine computer including a software application for receipt and displaying of regular weather forecasts may be acceptable.

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3.3 Requirement for instruments and equipment

3.3.1 General

3.3.1.1 With reference to SOLAS V 18.1, all required navigational systems and equipment shall be of an approved type.

3.3.1.2 All electrical and electronic equipment on the bridge or in the vicinity of the bridge, where a type approval is not required, shall be tested for electromagnetic compatibility.

3.3.1.3 Switches, keys and other operating elements shall be designed and fitted so as to ensure their safe and easy operation and to preclude confusion. The direction of motion of operating elements for manoeuvring equipment shall correspond to the direction of the effect on the ship caused by the installations controlled.

3.3.2 Radar installations

3.3.2.1 For the ship borne radar equipment the requirements of the *Guidelines for the Installation of Ship Borne Radar Equipment* (SN1/Circ.271) shall apply. Special attention shall be paid on the radar visibility and the reduced blind sectors.

3.3.3 Master and navigation officers' call-system

3.3.3.1 A call-system shall be fitted by which master and navigation officers can be summoned in their accommodation and public rooms from the navigating and manoeuvring workstation. This call-system may be the general telephone, the internal communication system and or the public address system. The call-system shall be provided with priority control on the bridge.

3.3.4 Bridge navigational watch alarm system

3.3.4.1 A bridge navigational watch alarm system (BNWAS) complying with MSC.128(75) Performance Standards for Bridge Navigational Watch Alarm systems (BNWAS) and IEC Test Standards, IEC 60945, 61924, 62288 and 61162 as amended, including alarm transfer system shall be provided for the following unacknowledged alerts:

— failure HCS
— system failure gyro compass

— loss of position EPFS
— system failure SDME
— depth alarm from echo sounder
— aggregated steering gear alarm
— imminent slow-down or shut-down of propulsion system
— failure/loss of navigation lights.

3.3.5 Power supply

3.3.5.1 The radio and navigational equipment and systems shall be supplied from both the main source of electrical power and the emergency source of electrical power with automated changeover by separate power supply circuits with provision to preclude inadvertent shut-down.

3.3.5.2 In addition at least the following equipment/systems should be supplied from a transitional source of electrical power for a duration of not less than 45s making it available during the loss of main and emergency power:

— one 9 GHz (X-Band) radar including transceiver and antenna
— one Gyro compass
— one EPFS
— one ECDIS at the navigating and manoeuvring workstation
— one SDME.

SECTION 5 NAUTICAL SAFETY – NAUT(OSV)

1 General

1.1 Introduction

The additional class notation **NAUT(OSV)** aims to reduce the risk of collision, contact, grounding, and damage during heavy weather, by regulating the various elements that make up the total bridge system, related to the variety of missions offshore service vessels (OSV) carry out. Certain operations will be performed from both the navigational and the operational bridge, while other operations may be performed from only one of these positions. In order to achieve optimum safety and efficiency in bridge operations, the philosophy addressed in this section includes the technical, human operator, man machine interface and procedural aspects.

1.2 Scope

The scope for additional class notation **NAUT(OSV)** adds an increased level of safety concerning bridge operations and safety of navigation related to: design of the bridge and the working environment, equipment performance and reliability, ergonomic principles and tests and trials. The rules in this section address the elements of the bridge system affecting the safety of navigation, both for the total bridge system, see Figure 1, and for those elements related to bridge system failure, see Figure 1.

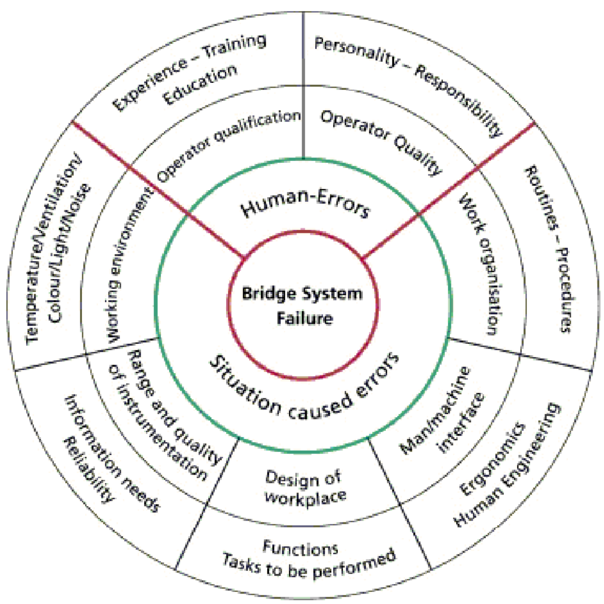

Figure 1 Overview of bridge system areas affecting safe and efficient operations

1.3 Application

The additional class notation **NAUT(OSV)** extends the basic requirements for bridge design and instrumentation, and, in addition, requires further means for safe operation in all waters including areas with harsh operational and environmental conditions, such as the North Sea. In order to offer classification that meets the individual needs of ship owners, related to different types and trades of ships, the notation has two qualifiers: **OSV** and **INS+**. Ships built and equipped in compliance with this section may be assigned the additional class notation **NAUT(OSV)**.

1.4 Objectives and safety philosophy

1.4.1 Objectives of rules

1.4.1.1 The objective of the rules for nautical safety is to reduce the risk of failure in bridge operation causing collision, contact and grounding, and heavy weather damage and in this context, include:

— requirements to specified bridge system elements
— relevant requirements and recommendations adopted by the International Maritime Organization (IMO)
— relevant international standards within the subjects of the rules or indicating the points in which they differ.

1.4.2 Safety philosophy

1.4.2.1 In order to achieve optimum safety and efficiency in bridge operation, the philosophy applied address the total bridge system. The total bridge system is considered to comprise four essential parts, see Figure 2:

— the technical system, which shall deduce and present information as well as enable the proper handling of the ship, including setting of course and speed
— the human operator, who shall evaluate available information, decide on the actions to be taken and execute the decisions
— the man and machine interface, which shall safeguard that the technical system is designed with due regard to human abilities
— the procedures, which shall ensure that the total bridge system performs satisfactorily under different operating conditions.

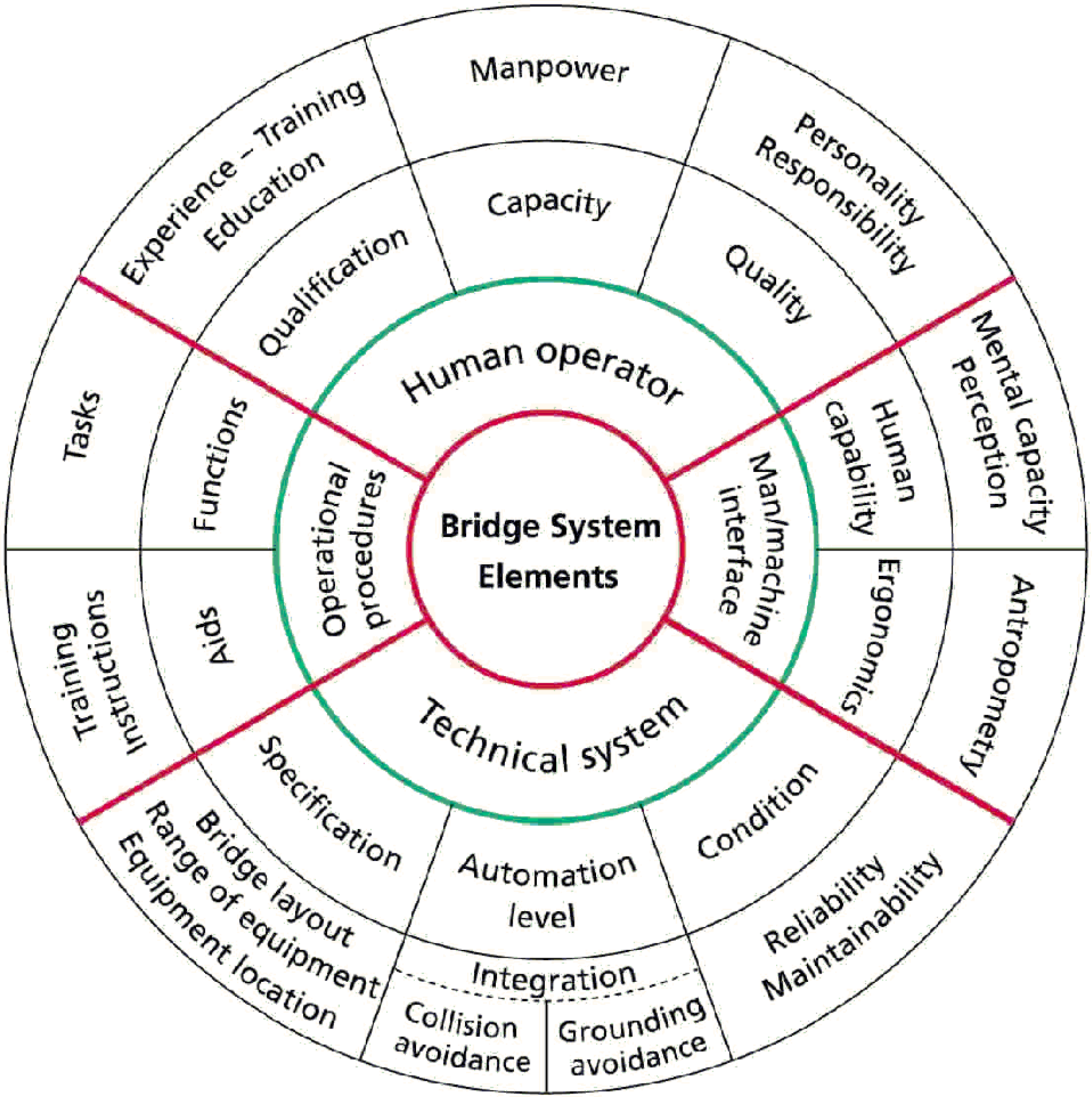

Figure 2 The total bridge system

1.4.2.2 The various elements considered making up the main parts (see Figure 2) of the bridge system are:

— qualifications, capacity and quality of the human operator in relation to the functions to be carried out
— specification, automation level and condition of the technical system in relation to information needs, workloads and reliability
— physical abilities and information processing capacity of the human operator in relation to working conditions and the technical systems he shall operate
— tasks to be performed and technical aids available under various operating conditions as basis for establishing working routines and operating procedures.

With the exception of operator quality, the elements mentioned form the basis for the rules given.

1.4.2.3 The rules take into consideration that the modes of operation and the manning of the bridge will vary in accordance with the condition of internal technical systems and the availability of relevant external systems, and that operating conditions can be influenced by the waters to be navigated, traffic and weather conditions.

1.4.2.4 The rules aim at safeguarding that the officer of the watch, at his workstation, has full control of all the functions he is responsible for. Furthermore, that the bridge enables safe and efficient co-operation by two navigators when required.

Guidance note:

It should be noted that the manning of the navigational watch at all times should be in accordance with the national regulations of the flag state and for the waters in which the ship is operating.

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1.5 Structure of the rules

1.5.1 The rules are structured to:

— establish functional requirements to the greatest possible extent
— give guidance as to how functional requirements can be met by technical solutions or other remedies that safeguard the performance of the function.

1.5.2 A guidance note gives solutions that can be approved, but does not exclude the application of alternative solutions provided the functional requirements are met.

1.5.3 Where rule requirement apply to vessels intended for specified operations such as anchor handling, towing operations, supply operations, oil recovery and fire fighting, the Society will base the approval on the information given in the class request. For vessels designed and prepared for operations that are not visible from class request, such as rescue, relevant rules for such operations will be applied unless written confirmation received from yard and owner.

1.6 Definitions

1.6.1 Terms and abbreviations

Table 1 Terms and abbreviations

Term	*Definition*
abnormal operating conditions:	when internal technical system failures require operation of back-up systems on the bridge or when they occur during an irregular operating condition, or when the officer of the watch becomes unfit to perform his duties and has not yet been replaced by another qualified officer
additional functions	additional functions requiring work tasks not directly related to primary bridge functions or offshore operations
AH	anchor handling
AHTS	anchor handling, tug supply
alarm	an alarm is a high priority alert. Condition requiring immediate attention and action by the bridge team, to maintain the safe navigation of the ship

Term	*Definition*
alert	alerts are announcing abnormal situations and conditions requiring attention. Alerts are divided in four priorities: — emergency alarms — alarms — warnings — cautions.
back-up navigator	a navigational officer who has been designated by the ship's master to be on call to assist or replace the officer of the watch when required
BAM	bridge alert management. Overall concept for management, handling and harmonized presentation of alerts on the bridge
blind sector	an obstruction in a field of vision caused by window divisions, bridge structure or outside construction with a clear sector on both sides
BNWAS	bridge navigational watch alarm system
bridge system	the total system for the performance of bridge functions, comprising bridge personnel, technical systems, human and machine interface and procedures
bridge wing	the part of the bridge on each side of the wheelhouse, which extends to the ship's side
bridge	the area from which the navigation and/or control of the ship are exercised, comprising the wheelhouse and the bridge wings
CAM	central alert management. Functionality for the management of the presentation of alerts on the CAM-HMI, the communication of alert states between CAM-HMI and navigational systems and sensors. (The function(s) may be centralized or partly centralized in subsystems and interconnected via a standardized alert-related communication)
CAM-HMI	human machine interface for presentation and handling of alerts on the bridge
category A alert	alert for which graphical information at the task station directly assigned to the function generating the alert is necessary, as decision support for the evaluation of the alert-related condition
category B alert	alert where no additional information for decision support is necessary besides the information which can be presented at the CAM-HMI
category C alert	alert that cannot be acknowledged on the bridge but for which information is required about the status and treatment of the alert
cargo operations	operations related to transferring or receiving general mixed cargo or liquid cargo between ship and offshore installation, included control and monitoring of own ship and cargo gear. Ships only designed for cargo operation is named platform supply vessel (see PSV)
catwalk	arrangement outside the wheelhouse allowing a person safe access to windows along the bulkhead(s)
CCTV	closed circuit television
coastal waters	waters that encompass navigation along a coast at a distance less than the equivalence of 30 minutes of sailing with the relevant ship speed. The other side of the course line allows freedom of course setting in any direction for a distance equivalent to at least 30 minutes of sailing with the relevant speed
collision avoidance functions	detection and plotting of other ships and moving objects; determination and execution of course and speed deviations to avoid collision

Term	Definition
commanding view	view without obstructions, which could interfere with the navigator's ability to perform his main tasks, at least covering the field of vision required for safe performance of collision avoidance functions
conning information display	a screen-based information system that clearly presents information from sensor inputs relevant to navigation and manoeuvring, as well as all corresponding and upcoming orders given by an automatic navigation system to steering and propulsion systems if connected
conning station or position	place in the wheelhouse with a commanding view providing the necessary information for conning, and which is used by navigators when monitoring and directing the ship's movements
control	either effectuate actions or have orders effectuated
display	an observable illustration of an image, scene or data on a screen
distress situations	loss of propulsion and/or steering, or when the ship is not seaworthy due to other reasons (situation prior to abandon ship situation)
docking	manoeuvring the ship alongside a berth and controlling the mooring operations
DP	dynamic positioning
DPO	dynamic positioning system operator
easily accessible	within 5 m distance from working position
easily readable	within the horizontal angle of 90 degrees to each side and vertical angle of 90 degrees below – to 60 degrees above the horizon from the normal line of sight for the operator
ECDIS	electronic chart display and information system. A navigation information system, which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulation 19 of SOLAS Chapter V, and be accepted as meeting the chart carriage requirements of SOLAS Chapter V, as amended by Res. MSC.99(73), by displaying selected information from a system electronic nautical chart (SENC)
ENC	electronic nautical chart. The database, standardised as to content, structure and format, issued for use with ECDIS on the authority of government authorised hydro graphic offices
emergency call	a function that immediately initate BNWAS second stage alert and subsequently third, stage remote audible alarms
emergency situations	when incidents seriously affect internal operating conditions of the ship and the ability to maintain safe course and speed (fire, technical failure, structural damage)
ergonomics	application of the human factors implication in the analysis and design of the workplace and equipment
external safety operations	assisting other in emergency situations
FOV	field of vision. Angular size of a scene that can be observed from a position on the ship's bridge
FiFi	fire fighting
hand-grasp area	for equipment/control units continuous used. See [3.5.5] for guidance of area
helmsman	person who steers the ship under way
irregular operating conditions	when external conditions cause excessive operator workloads

Term	*Definition*
manoeuvring	operation of thrusters, steering systems and propulsion machinery as required to move the ship into predetermined directions, positions or tracks
MFD	multi-function-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
monitoring	act of constantly checking information from instrument displays and environment in order to detect any irregularities
narrow waters	waters that do not allow the freedom of course setting to any side of the course line for a distance equivalent to 30 minutes of sailing with the relevant ship speed
navigation	planning of the ship's route and determination of position and course of the ship, execution of course alterations and speed changes
navigational bridge	the area of the bridge where transit operation is performed
normal operating conditions	when all shipboard systems and equipment related to primary bridge functions operate within design limits, and weather conditions or traffic, do not cause excessive operator workloads
ocean areas	waters that encompass navigation beyond the outer limits of coastal waters. Ocean areas do not restrict the freedom of course setting in any direction for a distance equivalent to 30 minutes of sailing with the relevant ship speed
oilrec	oil recovery
on hand	for equipment/ control units used frequently or special important. See [3.5.5] for specification of area
OOW	officer of the navigational watch. Person responsible for the safety of navigation and bridge operations until relieved by another qualified officer
operational bridge	the area of the bridge where workstations for offshore operations are located
operational bridge functions	functions related to ship handling in relation to the operation the vessel is engaged in. Such functions are: — manoeuvring functions — deck equipment operation (for anchor handling, oil recovery and cargo transfer operations) — rescue operation — monitoring of internal safety systems — external and internal communication related to safety in bridge operation and distress situations — docking functions.
popliteal height	the vertical distance from the footrest to the underside of the thigh
primary bridge functions	functions related to determination, execution and maintenance of safe course, speed and position of the ship in relation to the waters, traffic and weather conditions. Such functions are: — route 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.

Term	*Definition*
PSV	platform supply vessel. A PSV is a vessel carrying out cargo operations
readable	within a horizontal sector of 225° and vertical sector from 90° below to 60° above the horizon from the operators normal eye position.
rescue	an operation where a defined vessel is, either bringing own personnel being in distress in the water to safety, or is assisting an offshore platform, barge, production module/vessel or another ship in bringing their personnel being in distress in the water to safety
route monitoring	continuous surveillance of the ship's sailing (position and course) in relation to a pre-planned route and the waters
route planning	pre-determination of course lines, radius turns and speeds in relation to the waters to be navigated
rudder angle	rudder angle mean thruster angle when main propulsion is azimuth thrusters
safety operation	handling of emergency and distress situations on board own ship or assisting other vessels and offshore installations in such situations
SAR	search and rescue
screen	a device used for presenting visual information based on one or several displays
SENC	system electronic navigational chart. A database resulting from the transformation of the ENC by ECDIS for appropriate use, updates to the ENC by appropriate means and other data added by the mariner
SOLAS	the *International Convention for the Safety of Life at Sea*, 1974
superstructure	decked structure, not including funnels, which is on or above the freeboard deck
towing operations	an operation including one or more offshore service vessels capable to assist offshore platforms, barges and production modules/vessels in moving from one position to another, or in keeping their defined position
wheel-over-line	the line parallel to the new course line where the ship has to initiate a curved track to eliminate the effect of any offset with respect to the new course, taking into consideration the distance required for the ship to build up the necessary turn rate
wheel-over-point	the point where the ship has to initiate a curved track, taking into consideration the distance required for the ship to build up the necessary turn rate
wheelhouse	enclosed area of the bridge
within easy reach	for equipment/ control units used at the workstation. See [3.5.5] for specification of area
within reach	the distance the operator can reach and use a control unit. See [3.5.5] for specification of areas. For other workstations than workstations for offshore operations the area may be increased to: — From a standing position this distance is regarded to be maximum 800 mm in forward direction and 1400 mm sideways. — From a seated position, at a distance of 350 mm from a console, this distance is regarded to be maximum 1000 mm, and maximum 800 mm for frequently used equipment, which shall be within easy reach.
workstation (WS)	a work place at which one or several tasks constituting a particular activity are carried out and which provides the information and equipment required for safe performance of the tasks

Term	Definition
workstation for communication	a work place for operation and control of equipment for distress and safety communication (GMDSS), and shipboard communication for ship operations
workstation for primary bridge functions	a workplace with commanding view used by navigators when carrying out navigation, route monitoring, traffic surveillance and manoeuvring functions, and which enables monitoring of the safety state of the ship
workstation for safety operations	a workplace dedicated organisation and control of internal emergency and distress operations, and which provides easy access to information related to the safety state of the ship

Guidance note:

Additional terms and definitions may be found in IMO resolution A.918(22) *IMO Standard Marine Communication Phrases*.

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1.7 Class notations

1.7.1 General

1.7.1.1 The rules for nautical safety offshore service vessels have the two qualifiers, **OSV** and **INS+** in order to offer classification that meets the individual needs of ship owners, related to different types and trades of ships.

1.7.1.2 The class notation **NAUT(OSV)** extends the basic requirements for bridge design and instrumentation, and, in addition, requires further means for safe operation in all waters including areas with harsh operational and environmental conditions such as the North Sea.

Table 2 Class notations and qualifiers

Class notation	*Description*	*Qualifier*	*Description*	*Design requirements, rule reference*	*Survey requirements, rule reference*
NAUT	Requirements within bridge design, bridge instrumentation, and workstation arrangement. Vessels with NAUT-notation will comply with the principles and aims of SOLAS V/15 and IMO MSC/Circ.982.	**OSV**	Fundamental requirements targeting ships operating as service vessels for offshore industry.		Pt.7 Ch.1 Sec.6
		INS+	A multifunction workstation arrangement supporting the navigational functions of other **NAUT** qualifier by means of network technology.	Sec.3 [7]	

1.7.2 Contents of class notations and extensions

1.7.2.1 The class notations **NAUT(OSV)** cover the following main areas:

— mandatory and additional workstations
— field of vision from workstations
— location of instruments and equipment

— ergonomics and human machine interface
— range of instrumentation
— alarm management, including watch monitoring and alarm transfer system.
— instrument and system tests.

1.7.2.2 The class notation may upon request be extended with a qualifier **INS+** when the requirements in Sec.3 [7] are complied with.

1.7.3 Documentation of compliance

1.7.3.1 The class notations **NAUT(OSV)** imply that the ship is built and equipped in compliance with the relevant sections of this section.

1.7.4 Class assignment

1.7.4.1 The ship will be assigned class notation **NAUT(OSV)** when the relevant requirements given in this section are complied with.

1.8 Documentation for approval

1.8.1 General

1.8.1.1 The configuration and arrangement drawings submitted for approval shall be shown to scale. All symbols and abbreviations used shall come with a clarification.

Documentation shall be submitted as required by Table 3.

Table 3 Documentation requirements

Object	*Documentation type*	*Additional description*	*Information*
Navigation bridge	N011 – Bridge design drawing, extended		AP
	N021 – Vertical field of vision drawing, extended		AP
	N031 – Horizontal field of vision drawing, extended		AP
	N040 – Nautical workstation arrangement plan		AP
	N050 – Navigation bridge windows framing arrangement plan		AP
	Z030 – Arrangement plan	Window wipers, fresh water wash, sunscreens and de-misting system (heating) on the bridge windows.	AP
	M130– Colour specification	Interior colours for bulkheads, deckheads, framing of windows and consoles indicated by using international standards for colour reference.	AP
Navigation systems	Z090 – Equipment list		AP

Object	*Documentation type*	*Additional description*	*Information*
	E230 – Power supply arrangement	Including wheelhouse distribution board.	AP
	Z030 – System arrangement plan	A document describing how the navigation systems are connected including data interfaces etc. for the equipment as follows: — heading measuring systems — steering control system and propulsion control — steering mode selection system — heading control system (autopilot)/track control system — radar system — ECDIS and ECDIS back-up — CDS — CCTV system — GNSS — BNWAS/AMS.	AP
	Z253 – Test procedure for quay and sea trial		AP
Bridge alert management	I030 – System block diagram (topology)		AP
	I040 – User interface description	CAM-HMI alert list.	AP
	I220 – Interface description	For equipment not compliant with IEC 61162-1.	AP
Bridge navigational watch alarm system	I030 – System block diagram (topology)		AP
Steering control and monitoring system	I020 – Control system functional description	Steering mode selection.	AP
Navigation bridge lighting	Z030 – Arrangement plan	Red and white lighting in wheelhouse and all adjacent corridors, stairways and rooms.	AP
Ventilation systems	Z030 – Arrangement plan	For wheelhouse, including capacity specification.	AP
External communication systems	T030 – Antennae arrangement plan	For satellite communication systems, radars, VHFs, AIS, GPS, TV, etc.	AP
Automatic telephone system	E170 – Electrical schematic drawing		AP
	Z030 – Arrangement plan	Location of centrals and all subunits.	AP
Ultra high frequency (UHF) telephone system	Z090 – Equipment list		AP
For additional qualifier **INS+** documentation requirements are listed in Sec.3 [1.6].			

Object	Documentation type	Additional description	Information
AP = For approval; FI = For information; L = Local handling; R = On request; ACO = As carried out			

1.8.1.2 For general requirements to documentation, see DNVGL-CG-0550 Sec.6.

1.8.1.3 For a full definition of the documentation types, see DNVGL-CG-0550 Sec.5.

1.8.1.4 For navigation equipment and other equipment installed in the wheelhouse, and in the vicinity of the wheelhouse, certification is required. See [4.1].

Certification documentation shall be submitted as required by Table 4.

Table 4 Certification required

Object	*Certificate type*	*Issued by**	*Certification standard***	*Additional description*
Radar equipment	type approval certificate (TA)	Society		
ECDIS equipment	type approval certificate (TA)	Society		
Position system	type approval certificate (TA)	Society		
Gyro/heading system	type approval certificate (TA)	Society		
Speed measuring system	type approval certificate (TA)	Society		
Depth measuring system	type approval certificate (TA)	Society		
Bridge navigation watch alarm system (BNWAS)	type approval certificate (TA)	Society		
Central alert management system (CAS)	type approval certificate (TA)	Society		
Automatic identification system (AIS)	type approval certificate (TA)	Society		
Wiper system	type approval certificate (TA)	Society		
Conning display system	type approval certificate (TA)	Society		
Heading control system (autopilot)	type approval certificate (TA)	Society		
Track control system (TCS) (if provided)	type approval certificate (TA)	Society		
Sound reception system	type approval certificate (TA)	Society		

Object	Certificate type	Issued by*	Certification standard**	Additional description
Internal communication	type approval certificate (TA)	Society		
External communication (including GMDSS)	type approval certificate (TA)	Society		
* Type approval or MED certificates issued by others showing that the equipment complies with the Society's rule requirements may be accepted after a case-by-case evaluation ** Unless otherwise specified the certification standard is the rules				

1.9 Functional tests

1.9.1 The following tests shall be carried out

1.9.1.1 Tests, which give evidence of the satisfactory operation of instruments and integrated navigation and control systems in accordance with the rules, shall be carried out. Failure modes shall be tested as realistically as possible. The tests shall be based on test programmes approved by the Society, see Table 3.

2 Bridge design and configuration

2.1 General

2.1.1 Bridge operations

2.1.1.1 Based on the variety of missions offshore service vessels (OSV) carries out, different operations will be performed from the navigational and the operational bridge. Some operations may be performed from both the operational and the navigational bridge depending on the character of the operation.

Guidance note:

The basis for these rules is the traditional offshore service vessel with the deck aft of the vessel superstructure and rule wording reflect this. Other vessel designs are possible and will be considered to meet these rules when the functional requirements are meet.

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2.1.1.2 Performance of the following operations shall, as applicable, be facilitated from the navigational bridge:

— transit
— docking operations
— towing operations
— search/rescue operations
— fire-fighting (FiFi)
— seismic operations.

2.1.1.3 Performance of the following operations shall, as applicable, be facilitated from the operational bridge:

— docking operations
— cargo operations
— anchor handling

— towing operations
— safety operations
— search/rescue operations
— oil recovery (Oilrec)
— FiFi
— well intervention operations
— cable/pipe laying operations
— windmill installation
— subsea operations.

2.2 Workstations

2.2.1 Navigational bridge

2.2.1.1 The design and location of the workstations shall enable the ship to be navigated and manoeuvred safely and efficiently by one navigator in ocean areas and coastal waters under normal operating conditions, as well as by two navigators in close co-operation when the workload exceeds the capacity of one person, and when under pilotage.

2.2.1.2 The following workstations for primary bridge functions shall be arranged at the navigational bridge as a minimum to achieve safe and efficient operation under all conditions:

— workstations for navigating and manoeuvring
— workstations for monitoring
— workstation for route planning
— workstation for docking/search/rescue operations.

Guidance note:

Workstation for route planning may be combined with workstation for monitoring or workstations for navigating and manoeuvring.

Workstation for docking operations may be part of workstation for rescue or workstations for navigating and manoeuvring and/ or workstation for ship handling.

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2.2.2 Operational bridge

2.2.2.1 In addition to normal bridge functions carried out on a conventional ship in connection with watch duty on the bridge, arrangement for several other functions will have to be taken into consideration on an offshore service vessel serving in multi-roles. These functions are normally carried out from the operational part of the bridge on an offshore service vessel. Separate workstations are required in order to facilitate these functions.

2.2.2.2 The design and location of the workstations shall enable safe and efficient positioning/ manoeuvring of the ship and safe and efficient operation/ monitoring of all deck equipment needed for carrying out the different operations relevant for the ship.

2.2.2.3 The configuration of the workstations shall facilitate performance by one operator under normal operating conditions, as well as by two operators in close co-operation when the workload exceeds the capacity of one person.

2.2.2.4 To allow operations either by one operator alone or by two operators in close co-operation, the following workstations are required at the operational bridge:

— workstation for ship handling
— workstation for aft support.

2.2.3 Additional workstations

2.2.3.1 When functions additional to the primary functions and functions related to cargo operation shall be performed, workstations shall be arranged for these.

Such workstations may include:

— workstation for docking/search/rescue operations
— workstation for fire fighting
— workstation for safety monitoring and emergency operations
— workstation for communication.

Guidance note:

Workstation for safety monitoring and emergency operations may be combined with workstation for communication. Workstation for FiFi may be mobile or located in several different places.

Workstation for docking operations may be part of workstation for rescue or workstations for navigating and manoeuvring and/or workstation for ship handling.

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2.2.4 Required workstations for different types of vessels

2.2.4.1 Based upon the operations the vessel is designed to perform, according to [2.1.1], the following workstations shall be provided:

Table 5 Workstations

Workstation for:	*All*	*Rescue*	*FiFi*	*Seismic vessels*
Navigating and manoeuvring	X			
Monitoring	X			
Route planning	X*			X**
Docking	X*			X**
Ship handling	X			X**
Aft support	X			X**
Search/Rescue		X		X**
Fire fighting			X	X**
Communication	X			
Safety	X			
* The workstations for route planning and docking may be combined with other workstations. ** Workstations may not be applicable for seismic vessels				

Guidance note:

Requirement for workstations fire fighting and rescue will be based upon the information required in Table 3 with respect to intended operation.

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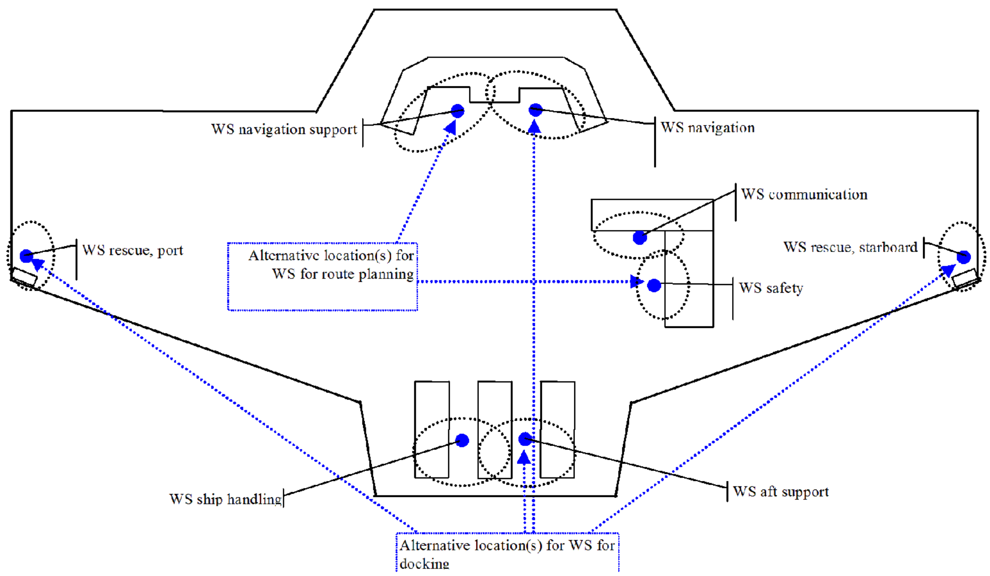

Figure 3 Example of bridge configuration and arrangement of workstations

2.3 Visibility

2.3.1 General

2.3.1.1 The bridge shall be planned with the aim to optimise its location and layout to achieve continuous access to visual information from outside the wheelhouse and easy co-operation between bridge personnel, promoting effective and safe bridge resource management. Particular attention shall be given to optimising the view of the working deck, location of funnel(s), location of workstations and field of vision from workstations.

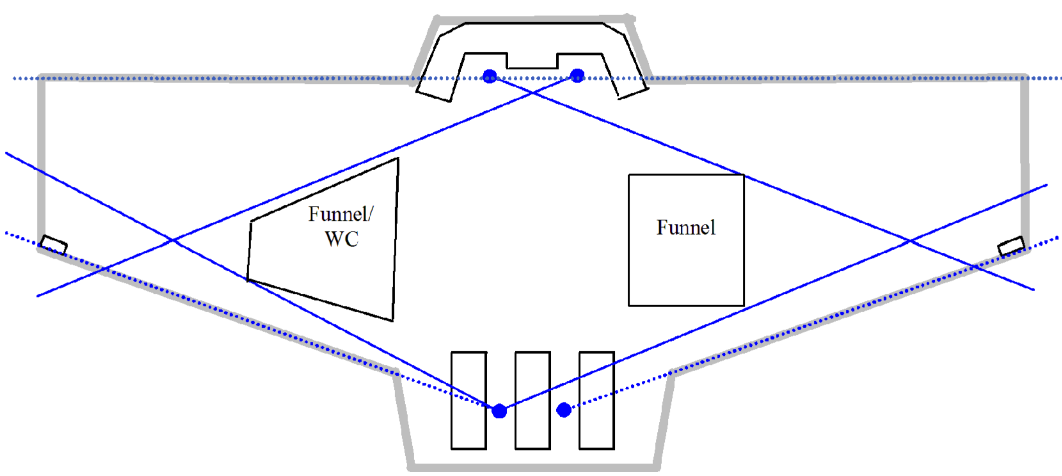

Figure 4 Example of a bridge configuration and possible location of workstations

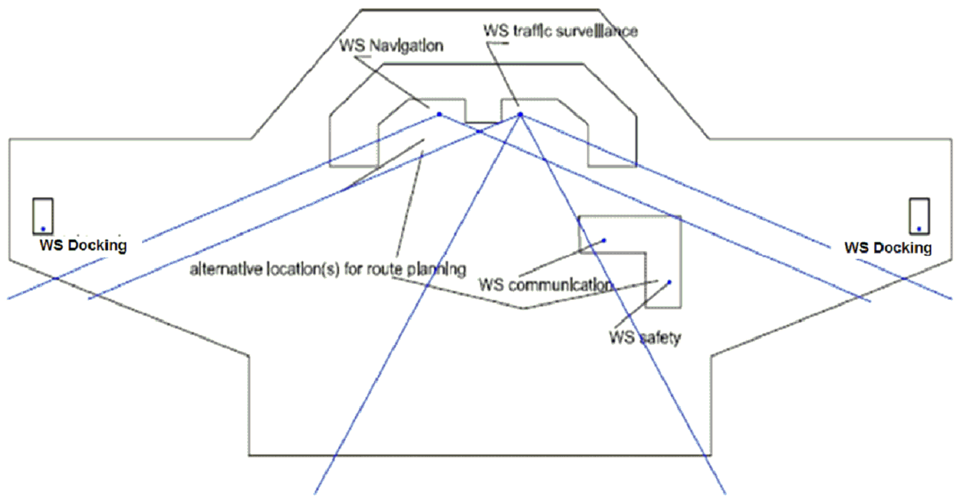

Figure 5 Example of a bridge configuration and possible location of workstations for seismic vessel

2.3.2 Window arrangement

2.3.2.1 Field of vision shall be optimized from each workstation. Bulkheads and window divisions shall as far as possible be arranged in one line seen from relevant workstations. Priority shall be given to the workstations for navigation and ship handling.

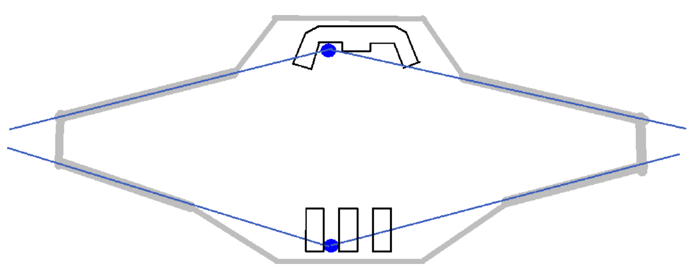

Figure 6 Bridge bulkheads aligned with line of sight from workplaces to minimise blind sectors

See also examples Figure 3 and Figure 4.

2.3.3 Windows

2.3.3.1 Internal light sources shall not cause glare in bridge windows or affect the view required for safe performance of bridge operations. To help avoid reflection (glare) from lights in wheelhouse consoles, all bridge windows shall, as far as practicable, be inclined from the vertical plane top out, at an angle of not less than 15º and not more than 25º.

2.3.3.2 Windows shall be as wide as possible and not less than 1200 mm wide at a height of 1600 mm above the wheelhouse deck within the required field of vision from the workstation for navigating and manoeuvring and workstation for monitoring. Windows shall not be less than 1000 mm wide at a height of 1600 mm above the wheelhouse deck within the required field of vision from other workstations.

Guidance note:

The width of the windows directly forward of the centre consoles may be less than 1200 mm in order to avoid that those window divisions/ stiffeners are located in front of any workstations.

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2.3.3.3 Windows within any required field of vision area shall in general have a minimum height of 2000 mm above the wheelhouse deck and the lower edge shall be maximum 1 000 mm above the wheelhouse deck. See also [3.3.2] and [3.6.2] for additional requirements depending of workstation arrangement.

2.3.4 Blind sectors

2.3.4.1 Blind sectors caused by cargo, cargo gear, divisions between windows and other obstructions appearing in the required field of vision, shall be as few and as small as possible, and in no way hamper a safe lookout from the workstations for primary bridge functions and offshore operations.

Guidance note:

The blind sector calculations should be originated 350 mm aft of the console workstation as defined in [3.3.2], [3.4.2], [3.6.2] and [3.7.2] for the different workstations. The blind sector calculations may be performed with a distance between eyes of 60 mm taken into account.

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2.3.4.2 The front/ aft bulkhead of bridge wings shall be aligned with the line of sight from the relevant workstations in order to avoid excessive blind sectors. See Figure 3, Figure 4 and Figure 5.

2.3.4.3 Divisions and stiffeners between windows shall be kept to a minimum and not be placed immediately in front of any workstation, for example chairs at workstations.

2.3.4.4 The width of divisions between windows, especially within the required field of vision, shall, as far as practicable, not exceed 150 mm. If stiffeners are used, the width between window glasses shall, as far as practicable, not exceed 100 mm and the depth of the stiffeners shall, as far as practicable, be less than 120 mm. If stiffeners between windows shall be covered, this shall not cause further obstruction of the field of vision from any position inside the wheelhouse.

2.3.4.5 Horizontal divisions between windows shall be avoided in required field of vision sectors.

2.3.5 Clear view through windows

2.3.5.1 A clear view through bridge windows within the field of vision required from the workstations for primary bridge functions, offshore operations, rescue and FiFi shall be provided at all times regardless of weather conditions. The following installations are required:

— Sunscreens shall be provided. The sunscreens shall be of type roller blinds and offer anti-glare and heat rejecting properties. Only the outer surface shall be highly reflective while the inner surface shall offer a non-reflective appearance. Anti-glare effect (reduction) better than 80% and heat rejection better than 60% should be achieved.
— Heavy duty wipers and fresh water window washing system to ensure a clear view in rain and stormy seas.
— Efficient de-icing and de-misting systems to ensure a clear view in all operating conditions. Heated glass panels panes shall be used on board ships to be assigned class notation for navigation in ice.
— If two sets of wipers are needed to cover the required wiping area, the wipers shall be arranged so that the distance between the two sets of wipers is minimized. The intention is to minimize any blind sector in the required wiping area.
— Window wipers to be connected to the main and emergency power system.
— Window wipers to be provided within the 225° FOV arc from docking/rescue workstations when manoeuvring is possible e.g. regardless of rescue notation.

— Above systems installed shall comply with appropriate ISO standards.

Guidance note:

It should be noted that sunscreens might also be required for other windows to prevent direct sunlight from obscuring information on monitor screens and displays.

The window wipers should comply with ISO 17899 and be capable of wiping the window centre at a frequency of 0.5 Hz. The window wipers should, as far as practicable, cover 85%, in both vertical and horizontal direction, of the window area necessary to meet the field of vision requirements. (E.g. window size: 200 cm × 120 cm - minimum wiped area: 170 cm × 102 cm).

Reference is also made to ISO 8863 and ISO 3434 for specifications for de-icing/de-misting by hot air and heated glass panes respectively.

Class notations for navigation in ice include **Ice**, **PC** and **Winterized**. Window panes for vessels with class notation **Winterized** shall meet the appropriate power loading in ISO 3434 in accordance with the design temperature.

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2.3.5.2 The glass panes used shall not give any blurred effect to the line of sight. The linearity of the view through the windows shall not be adversely affected by the design of window.

Guidance note:

Taking bearings through the glass pane should not result in more than 0.5° distortion seen within angles of +/- 60°.

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2.3.5.3 A fixed catwalk or similar arrangement with means to prevent an accidental fall shall be fitted at the windows without adjacent deck to enable cleaning of windows and repair work in the event of failure of the cleaning systems.

2.4 Working environment

2.4.1 General

2.4.1.1 Throughout the various design stages of the ship, care shall be taken to achieve an optimal working environment for bridge personnel.

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

2.4.1.3 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.

2.4.2 Deckhead height

2.4.2.1 The clear deckhead height in the wheelhouse shall take into account the installation of deckhead panels and instruments as well as the height of door openings required for easy entrance to the wheelhouse. The following clear heights for unobstructed passage shall be provided:

— clear deckhead height between the wheelhouse flooring and the deckhead shall be at least 2250 mm
— the lower edge of deckhead mounted equipment in open areas and passageways, as well as the upper edge of door openings to open deck areas, shall be at least 2100 mm above the deck
— the height of entrances and doors to the wheelhouse from adjacent passageways shall be at least 2000 mm above the deck
— the lower edge of deckhead mounted equipment shall not degrade the vertical field of vision in the required horizontal sector.

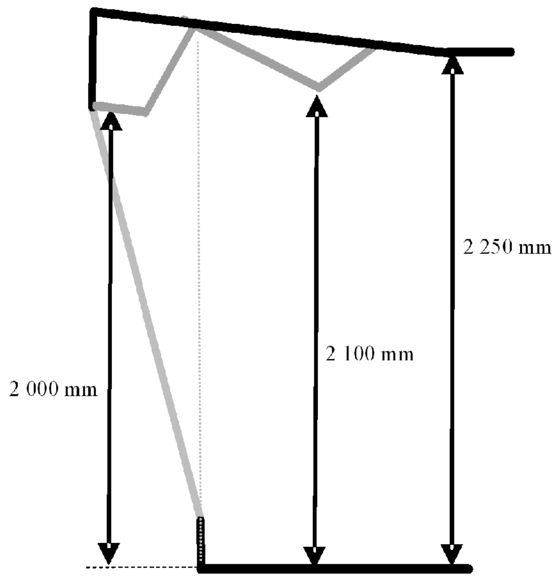

Figure 7 Deckhead height

2.4.2.2 It shall be possible to secure doors to open deck areas in the open position, and it shall be possible to open doors with one hand.

2.4.2.3 Ships with fully enclosed bridge wings shall have at least one door providing direct access to the adjacent area outside the wheelhouse.

2.4.3 Passageways

2.4.3.1 There shall be a clear route between the fore and aft bridge. The width of the passageway shall be 1200 mm and not less than 700 mm at any single point of obstruction.

2.4.3.2 There shall be no obstructions between the points of entry to the bridge from lower decks and the clear route referred to above. This passageway shall be at least 700 mm wide.

2.4.3.3 There shall be a clear route from the workstation(s) for rescue operations to the clear route between the fore and aft bridge defined above. The width of this passageway shall be 1200 mm and not less than 700 mm at any single point of obstruction.

2.4.3.4 If consoles at workstations for primary functions or other consoles are located away from the front bulkhead with the purpose of giving passageway, the width of the passageway shall be sufficient for one person to pass a stationary person and in general, shall not be less than 600 mm.

Guidance note:

The distance may be less for service access to consoles

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2.4.3.5 The distance between separate workstation areas shall be sufficient to allow unobstructed passage for persons not working at the stations. The width of such passageways shall not be less than 700 mm, also considering persons sitting or standing at their workstation.

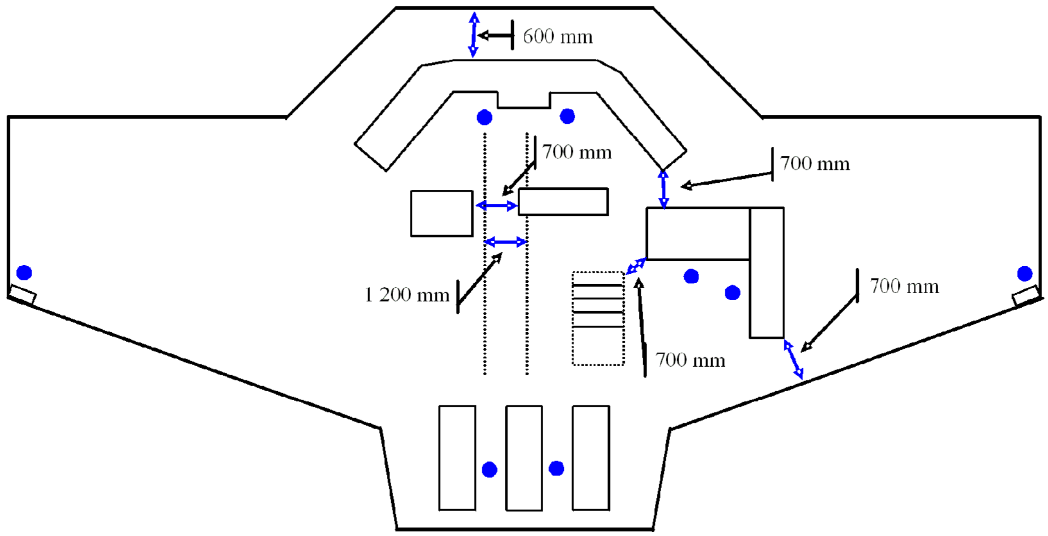

Figure 8 Passageways between workstations

2.4.3.6 Entries to workstations shall be sufficiently wide to allow operators easy access to aft workstations, and their width shall not be less than 700 mm.

2.4.3.7 If a passageway/opening between the WS for navigating/manoeuvring and monitoring is provided for easy movement between the WS's, such passage may be accepted 400 mm wide.

2.4.3.8 If the entries to workstations are between the bridge bulkhead and the workstation consoles, their width shall not be less than 300 mm at deck level and 600 mm at 1000 mm above deck level.

2.4.3.9 Direct access shall be provided for each individual workstation (aft workstations).

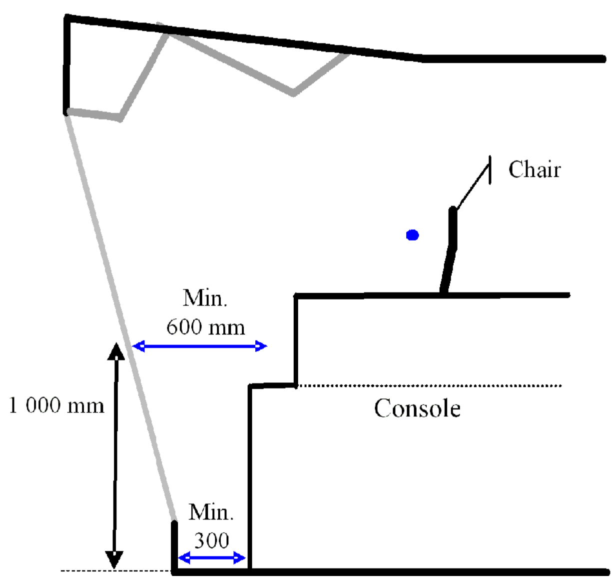

Figure 9 Passageway between console and aft windows

2.4.4 Safety of personnel

2.4.4.1 The bridge area shall be free of physical hazards to bridge personnel. There shall be no sharp edges or protuberances that could cause injury to personnel.

2.4.4.2 The bridge deck shall be free of trip hazards such as curled up carpet edges, loose gratings or equipment. See also [3.1.5.3].

2.4.4.3 The bridge deck covering shall be of anti-slip type.

2.4.4.4 Means shall be provided for properly securing portable equipment.

2.4.4.5 Hand or grab rails shall be fitted to enable personnel to stand and move safely between workstations at navigation bridge, at the aft bridge and in between fore and aft bridge in bad weather. Protection of stairway openings shall be given special consideration.

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

2.4.5 Vibration and noise

2.4.5.1 Uncomfortable levels of noise, or noise which may affect safe and efficient bridge operation, shall not occur in the bridge area.

Guidance note:

Bridge equipment: The noise level for the workplace should not exceed 65 dB(A) in good weather, with workplace instruments in operation.

Noise from ventilation and air intake fans and other noise sources should be excluded from the workplace by suitable situating of the fans and associated trunking.

The vessel's sirens or whistles should be placed as high as practicable and, if possible, forward of any workplace, so that the noise level does not exceed 100 dB(A).

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2.4.5.2 The noise level produced by individual bridge equipment shall not exceed 60 dB(A)/1m.

2.4.5.3 Uncomfortable levels of vibration causing both short and long term effects shall be avoided in the bridge area.

Guidance note:

The workplace should ideally be sited clear of the nodes and anti-nodes of the fundamental mode of vertical hull vibration in order to avoid longitudinal and vertical vibration.

The fundamental frequency of vibration of the superstructure block should not be close to the propeller blade frequency or its harmonics at service speed. Table 6 lists the vibration ranges which should be avoided.

Table 6 Vibration ranges

Range	*Effect*
0.1 to 0.5 Hz	motion sickness, particularly around 0.25 Hz
1.5 to 30 Hz	vision blur, particularly 10 to 25 Hz
10-20 Hz	involuntary increase in muscle tone, leading to difficulty in controlling posture and movement
Sum: 0 to 30 Hz major source of problems	magnitude of effects depends upon vibration amplitude

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2.4.6 Temperature and ventilation

2.4.6.1 The wheelhouse shall be equipped with an adequate temperature control system. The temperature in the wheelhouse shall be according to class notation **COMF(C,3)** as a minimum. External temperature range shall be according to the ship design condition, but as a minimum from -20ºC to 35ºC at a relative humidity of 70%.

2.4.6.2 The wheelhouse ventilation system shall comply with appropriate ISO standards.

Guidance note:

The ventilation system should comply with ISO 8864 and be capable of supplying fresh air to at least 10 persons with fresh air supply of 0.008 m^3/s per person.

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2.4.6.3 Control of temperature and ventilation system shall be possible from bridge or adjacent locations.

2.4.7 Light arrangement in wheelhouse and on deck - general requirements

2.4.7.1 An adequate level of lighting shall be provided, facilitating the performance of all bridge tasks at sea and in port, during daytime and night-time. The lighting shall comprise both general lighting and task related lighting to ensure that illumination is compatible with individual operations and tasks. Workstation areas shall have a greater luminance than the ambient level.

2.4.8 Light arrangements in wheelhouse and on deck - illumination levels

2.4.8.1 The lighting system shall enable the bridge personnel to adjust the illumination level as required in different areas of the bridge and by the needs of individual tasks. See Table 7.

Table 7 Illumination levels

Place	*Colour and illumination*
Wheelhouse, general	white, at least 200 lux
Workstations (day)	white, at least 300 lux
Workstations (night)	red, variable up to 20 lux
Open staircase inside wheelhouse (day)	white, at least 200 lux
Open staircase inside wheelhouse (night)	red, variable up to 20 lux (Alt: fixed indirect red or filtered white light may be provided in the steps)
Chart table (day)	white, variable 100-1000 lux
Chart table (night)	white filtered, variable up to 20 lux
Toilet (day)	white, at least 200 lux
Toilet (night)	red, variable up to 20 lux

Guidance note:

Local arrangement for adjustment of illumination level and direction of light should be provided at all workstations. White ceiling lights for general bridge illumination do not require dimming facilities.

Lighting controls should always be arranged at entrances and exits to adjacent rooms. Light controls should preferably be noticeable in darkness.

The white illumination levels shall be available on the desktops/consoles, (70 cm above the deck surface in the absence of consoles) on a dark rainy day.

The red and filtered illumination levels shall be available during hours of darkness.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.8.2 During hours of darkness the lighting provided to discern control devices and read labels and markings shall preserve the night vision of the OOW. It shall be possible to dim down the illumination intensity to nearly zero.

Guidance note:

Except at the chart table, red light or filtered white light (CIE coordinates x and y equals 0.330) should be used whenever possible in areas or on items of equipment requiring illumination in the operational mode, including bridge wing instruments. Provision should be made to prevent red lights from being visible from outside of the ship. Local lighting with red dimmable narrow beam light fixtures and minimum horizontal stray light should be arranged at each workstation. An example on local lighting may be gooseneck lamps.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.8.3 Lighting of workstations which may be used by personnel other than OOW shall have separate ON/OFF switch (circuit).The lighting and any glare shall be properly shielded at all times. If curtains are provided these shall not obscure the minimum FOV-sectors required for the OOW to maintain a proper lookout including the 360º view from inside the wheelhouse.

2.4.9 Light arrangements in wheelhouse and on deck - Specular reflections and glare

2.4.9.1 Care shall be taken to avoid glare and stray image reflections on windows and deckhead surfaces. High brightness contrast between work areas and surroundings shall be avoided.

Guidance note:

Ceiling mounted night time lighting arrangements should be sufficiently screened or retracted into the ceiling to avoid unwanted horizontal stray of light. A non-reflective surface should be used on the surface of the retraction or screen. Floodlight arrangement should be fitted with a non-reflective raster screen.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

The bridge surface finishes shall have a dull, matt coating and colours with low reflection range in order to reduce specular reflections and glare to a minimum. Ceiling areas above workstations, bulkheads at window heights and consoles are of special importance. See Table 8 for details.

Table 8 Reflection range for some typical colour densities

Reflectance range	*Typical colour densities*
5% to 10%	dark green blue or brown
15% to 30%	mid green blue or red
50% to 60%	pale green blue or yellow
80% to 90%	off white pale yellow

Guidance note:

The following are recommendations to reduce glare and specular reflections in the wheelhouse:

a) The contrast ratio between the luminance of workstations and adjacent areas in the wheelhouse should not exceed 3:1.

b) Light sources should as far as possible not be placed within the FOV sector through a 30 degrees vertical line of sight when the eyes are in the working position.

c) Smooth and polished surfaces shall be avoided inside the wheelhouse.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.9.2 Lighting sources located in adjacent rooms and corridors shall be prevented from illuminating the wheelhouse at night time.

Guidance note:

Automatic door switches preventing white light from flooding the bridge area should be fitted on entrances from adjacent rooms and corridors.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.9.3 It shall be avoided that glaring lights from deck lights and searchlights are dazzling the operator at the workstations.

2.4.10 Colours in wheelhouse

2.4.10.1 Colours shall be chosen to give a calm overall impression and minimise reflections.

Guidance note:

Bright colours should not be used. Dark or mid green colours are recommended; alternatively, blue or brown may be used. See Table 8.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3 Workstation arrangement

3.1 Requirements for the various workstations

3.1.1 General

3.1.1.1 This section gives the functional requirements for the various workstations and defines the tasks to be carried out at each workstation. Minimum field of vision, required equipment and information necessary for safe performance of the tasks are given for each workstation as relevant.

3.1.2 General workstation requirements

3.1.2.1 Workstations and consoles shall be arranged and ergonomically designed to optimise the user’s working conditions and to minimise excessive or unnecessary work.

3.1.2.2 A functional workstation designed in accordance with the established overall operational and ergonomic requirements for safe operation shall provide:

— a sufficient area for performance of the tasks to be carried out by the number of people that may be required to attend
— providing individual workplaces in accordance with the distribution of tasks at maximum bridge manning
— consoles designed for operations at specific workplaces in standing and/ or seated position
— enabling installation of equipment to be within reach from the working position
— avoiding obstruction of the view through bridge windows from operators position

— chairs, if installed, designed in accordance with ergonomic requirements for efficient use of the equipment installed in workstation consoles and adjustable for maintenance of the required fields of vision.

3.1.3 General workstation consoles requirements

3.1.3.1 In principle, consoles shall be divided into two separate areas:

— one for the display of information located in the upper (vertical) part of the console.
— one for the location of equipment necessary for taking action on the information located in the lower (horizontal) part.

3.1.3.2 The height of desktops to be used from sitting positions only shall not be less than 750 mm.

3.1.3.3 The height of desktops to be used from sitting and standing positions shall not be less than 800 mm.

3.1.3.4 The general height of consoles forming a workstation for radio communication or other additional tasks that shall be used by the officer shall not obstruct the field of vision required for maintaining a proper lookout from a sitting position at the console. The height of consoles located at workstations for additional functions, including equipment (e.g. printers) installed on top of the console, shall not exceed 1300 mm.

3.1.4 General overhead consoles requirements

3.1.4.1 Consoles installed in ceiling shall not obstruct required vertical field of vision from the workstations seen from an operator with eye height of 1800 mm. See Figure 10.

Guidance note:

Use eye height of 1800 mm for calculation purposes in order to secure that the lower edge of overhead consoles does not conflict with the field of vision for operators with above average height.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.1.4.2 Overhead consoles shall primarily be used for location of indicators and information displays. Consoles with pertinent and important information shall be located within the easily readable field of vision for the operator.

3.1.4.3 If it is necessary with overhead consoles for the mounting of equipment to be operated frequently, these shall be located within reach from a seated position at the workstation and be available when standing or moving the chair to enable access to other equipment. See Figure 10.

Guidance note:

Within reach in this context mean a radius of 800 mm from eye position 1500 mm above deck.

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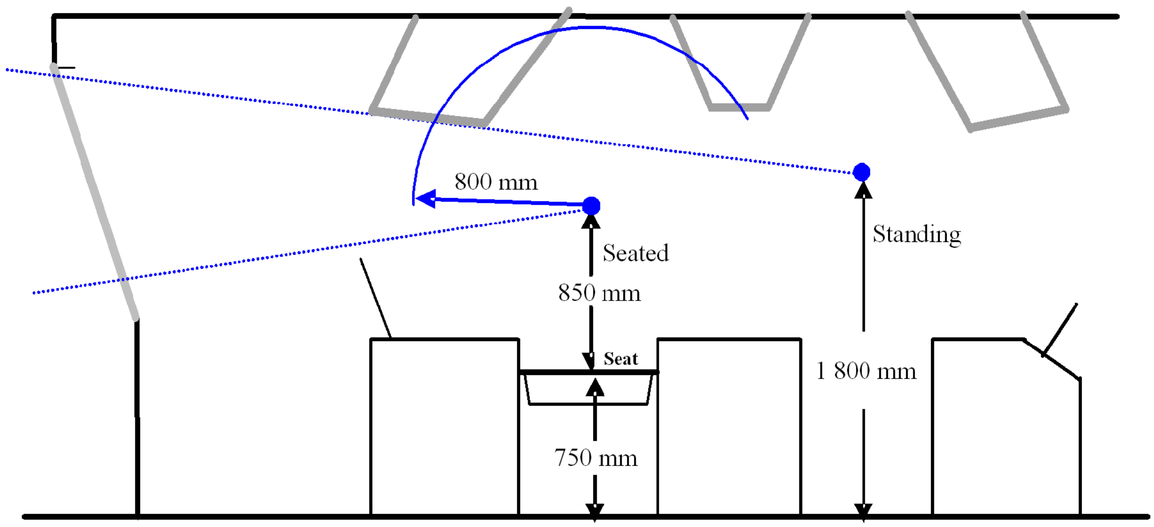

Figure 10 Overhead consoles abeam

3.1.4.4 The overhead consoles shall be tilted to suit the line of sight from the working position. See Figure 11.

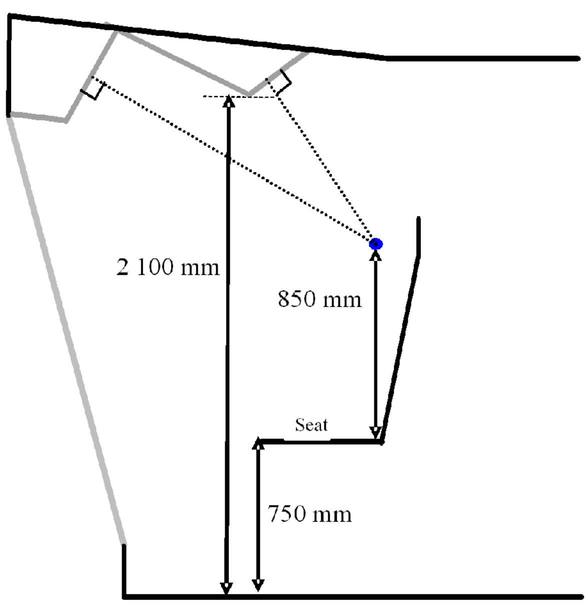

Figure 11 Overhead consoles aft

3.1.5 General chair requirements

3.1.5.1 Chairs shall be installed at the workstations for navigating and manoeuvring, workstations for monitoring, ship handling and aft support. See also [3.2.4] and [3.5.4].

3.1.5.2 It shall be easy to enter and leave the chairs in any position.

3.1.5.3 Deck rails for backward/forward adjustments of the chairs shall be installed flush with the deck surface or with anti-trip skirting board if installed in a passageway area.

3.1.5.4 Backrest inclination shall be within the interval of 102° and 108°.

3.1.5.5 Chair foot-rest shall be provided.

Guidance note:

The chair foot-rest height shall be adjustable according to a popliteal (relating to the area behind the knee joint) height in the interval of 380 mm to 580 mm.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.1.6 Field of vision requirements

3.1.6.1 The field of vision requirements are included in the requirements for each workstation.

3.1.6.2 When controls for steering and manoeuvring of the vessel is installed at the bridge wings the field of vision requirements will be as for WS for search/rescue operations (see [3.9.2]).

3.2 Workstations for primary bridge functions

3.2.1 Principle

3.2.1.1 The design and location of the workstations for navigating and manoeuvring and the workstation for monitoring shall enable safe and efficient traffic surveillance, navigation and manoeuvring of the vessel under all circumstances. The configuration of the workstations shall facilitate performance by one navigator under normal operating conditions, as well as by two navigators in close co-operation when the workload exceeds the capacity of one person.

3.2.1.2 Workstations for navigating and manoeuvring shall facilitate all functions related to traffic surveillance, navigation and manoeuvring during normal operating conditions.

3.2.1.3 The workstation for monitoring shall facilitate navigation functions during periods with high workload, during degraded functionality at the workstations for navigating and manoeuvring or work as a pilot's workstation when under pilotage.

3.2.2 Layout for workstations for primary bridge functions

3.2.2.1 The workstations for primary bridge functions shall have working positions for navigation, manoeuvring and traffic surveillance as close together as possible for efficient use by the officer of the watch, but also enabling the tasks to be performed by two navigators in close co-operation. The working position for operating the radar with collision avoidance functions shall be regarded as the main working position at these workstations and shall be within reach from a seated position.

3.2.2.2 Controls for heading and speed adjustments shall be located within reach from working position at workstations for navigating and manoeuvring to enable collision avoidance manoeuvres without losing view of the traffic, and electronic chart display and information system (ECDIS) for position-fixing and route monitoring shall be readily available.

3.2.2.3 Manoeuvring functions from seated position are related to heading and speed adjustments for collision and grounding avoidance. Manoeuvring also requiring the use of thrusters may be carried out in standing position at the workstation.

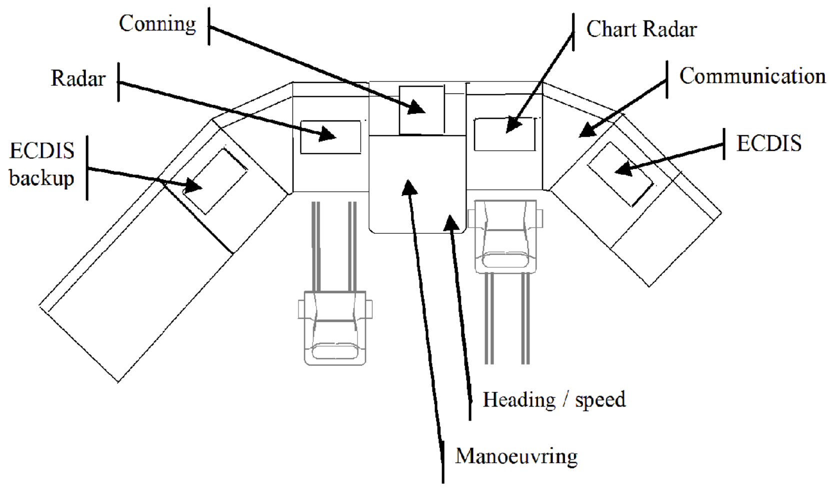

Figure 12 Principle location of main equipment in relation to seated and standing working positions

3.2.2.4 Direct easy access to windows in front of the workstations may be provided by arranging a passageway in front of the consoles, or, if the workstations are installed close to the front bulkhead, by providing direct entry between two consoles at the forward part of the workstation.

Guidance note:

Access to front windows may be provided from the workstation for monitoring. See Figure 13.

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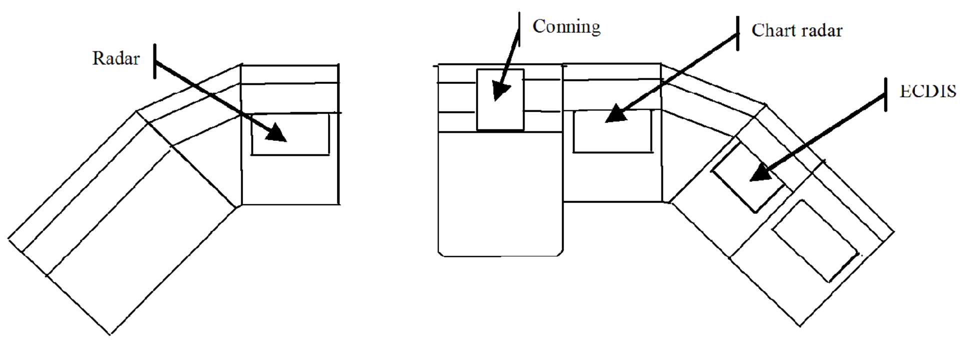

Figure 13 Access to front windows from the workstation for monitoring

Guidance note:

Access to front windows may be provided from the workstations for navigating and manoeuvring between the centre console and a chart radar provided the conning information display is readable from the working position (at the chart radar) and controls for heading and speed adjustments are located within reach. See Figure 14.

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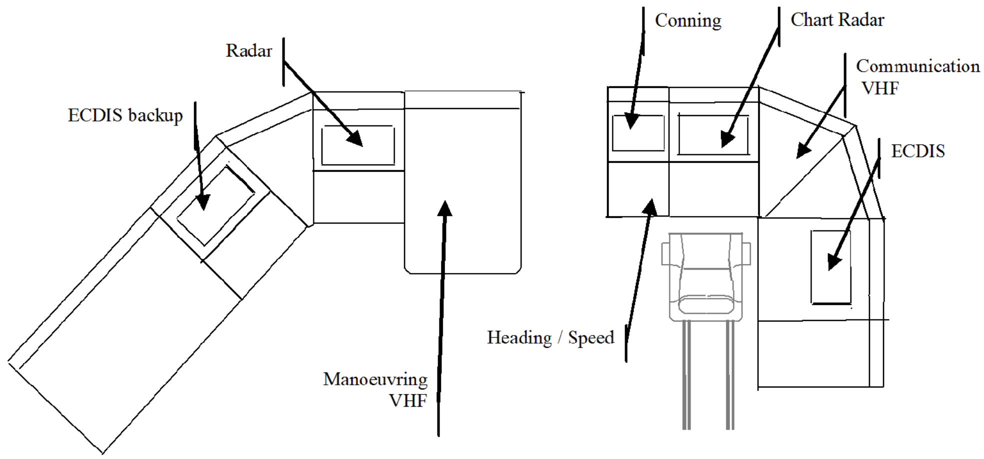

Figure 14 Entrance to front windows may be provided from the workstations for navigating and manoeuvring

Guidance note:

Access to front windows may also be provided from the WS for navigating and manoeuvring between the radar and ECDIS if readability and control of chart information can be maintained from seated position. This may be achieved when the radar is provided with chart facilities. Alternatively, remote control facilities for operation of ECDIS may be used, provided the chart information is easily readable from seated position. Another alternative may be to locate ECDIS in the centre console and the conning display above front windows if monitor screens are readable from seated position. See Figure 15.

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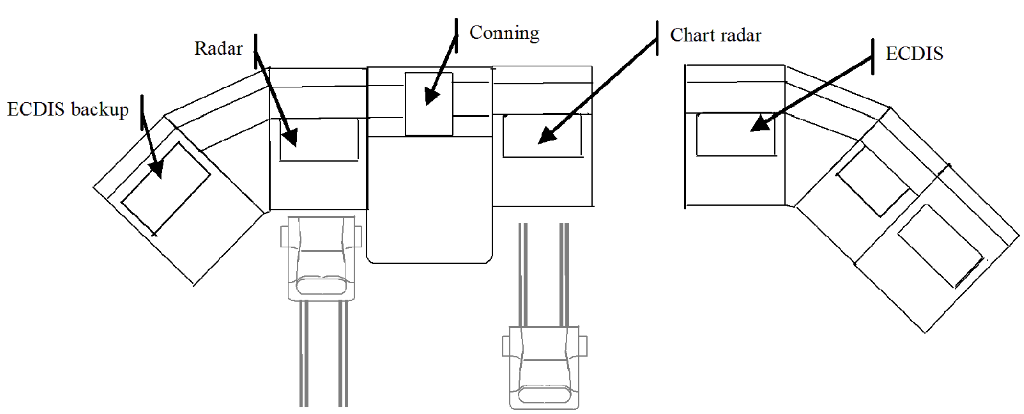

Figure 15 Access to front windows from workstations for navigating and manoeuvring, between chart radar and electronic chart display and information system

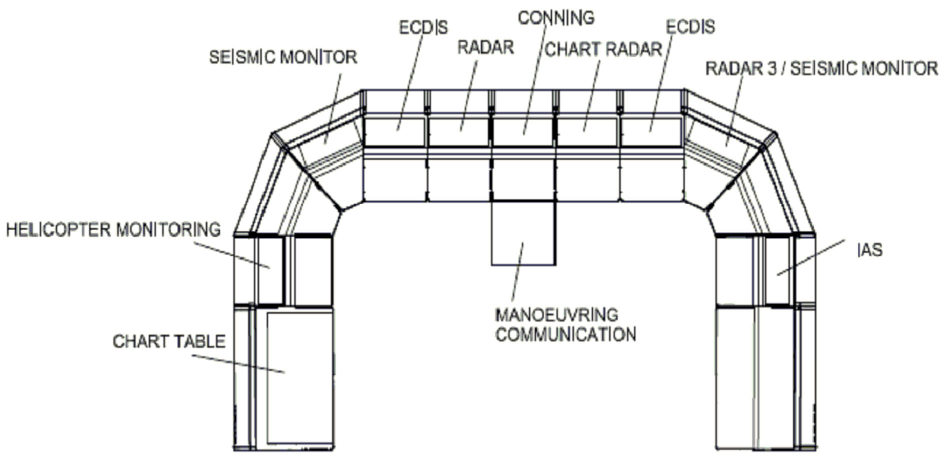

Figure 16 Principle location of main equipment for a vessel engaged in seismic operations, overhead consoles may also be used

3.2.3 Workstation consoles for primary functions

3.2.3.1 For front workstations an eye height of 1500 mm is used. In order not to obstruct the line of sight from a position of 350 mm behind a console of average depth and any passageway in front of consoles, giving a total horizontal distance of maximum 2300 mm between the operator and the steel bulkhead, the console height, including foundation, shall not exceed 1200 mm. See Figure 10.

3.2.3.2 The height of console desktops at bridge workstations shall enable easy use of equipment required for safe performance of the tasks to be performed from sitting position. The console height shall not obstruct the required field of vision.

3.2.3.3 A standard console height of 1200 mm is acceptable even if the top of the console interferes with the line of sight from a sitting eye height of 1500 mm.

3.2.4 Chairs at workstations for primary functions

3.2.4.1 Chairs shall be installed at the workstation for monitoring and at the workstations for navigating and manoeuvring, and it shall be easy to adjust the vertical position of the chairs to suit an eye height of 1500 mm. The seated location shall be 350mm from the console. See Figure 19.

Guidance note:

The vertical adjustment of the seat rest should range from 600 mm to 800 mm above the deck surface.

See also [3.1.5].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.2.4.2 It shall be possible to move the chairs for easy reach of the equipment to be used and to move the chairs away from the consoles to achieve good working conditions from a standing position.

Guidance note:

It should be possible to adjust chairs to a position close to the front console (distance from chair back-rest to console front should be not more than 550 mm) and away from the workstation area to facilitate a passage of 600 mm between chair front and working area including operator.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3 Workstations for navigating and manoeuvring

3.3.1 Workstation tasks

3.3.1.1 The workstations for navigating and manoeuvring shall enable the following tasks to be performed:

— determine and plot the ship's position, heading, track and speed
— monitor the traffic by sight and hearing as well as by all available means
— analyse the traffic situation
— decide on collision avoidance manoeuvres
— alter heading
— change speed
— carry out a change of operational steering mode
— effect internal and external communication related to manoeuvring
— handle other external communication available on the bridge
— operate docking aid systems
— monitor time, heading, speed, track, propeller revolutions, thrust indicator (when available), pitch indicator (if the ship is equipped with pitch propeller), rudder order and rudder angle
— monitor all alarm conditions on the bridge.

3.3.2 Field of vision

3.3.2.1 In order to enable the officer of the watch to carry out his functions in compliance with the international regulations for preventing collisions at sea, the horizontal field of vision from the working position at the workstation for monitoring and from the seated position at the workstations for navigating and manoeuvring shall extend over an arc of not less than 225°, that is from dead ahead to not less than 22.5° abaft the beam on either side of the ship.

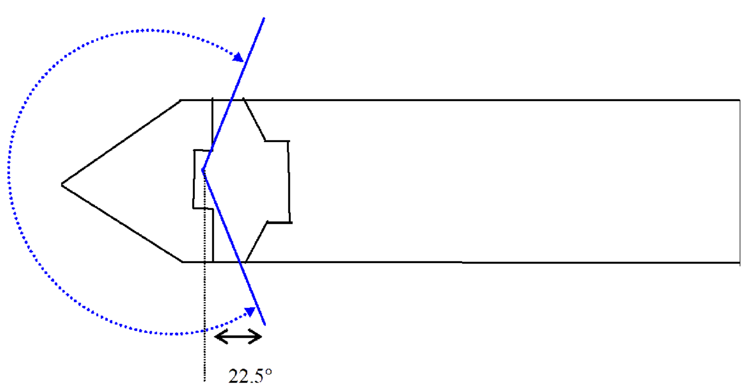

Figure 17 Horizontal field of vision

3.3.2.2 A horizontal field of vision to the horizon of 360° shall be obtained by using not more than 2 positions inside the wheelhouse on either side of the workstations for navigating and manoeuvring, being not more than 15 m apart.

Guidance note:

The maximum distance of 15 m between the two positions inside the wheelhouse may be extended, provided the following conditions are fulfilled:

— suitable cameras are installed capable of viewing the sector(s) astern not being visible within the required 15 meter and pertinent displays/monitors are installed being viewable from the workstation for navigating and manoeuvring
— the workstations for docking are equipped with appropriate means for course and speed alterations, and
— the FOV sectors should overlap with at least 0.5°.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.2.3 In order to be able to perform manoeuvres timely to avoid critical situations, the view of the sea surface from the workstations for navigating and manoeuvring, using an eye height of 1500 mm above deck, 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, under all conditions of draught and trim.

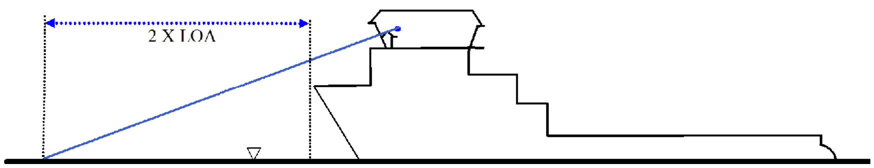

Figure 18 Vertical field of vision forward of the bow

3.3.2.4 When the distance between the windows and the viewing point 350 mm aft of the consoles at the workstation for navigating and manoeuvring is more than 2300 mm, the height of the lower edge of the windows in the sector from ahead to 90° on each side shall be decreased sufficiently to maintain the line of sight from an eye height of 1500 mm above deck.

Guidance note:

The lower edge of window needed to obtain the required field of vision as required in [3.2.3], shall be maintained in the sector from ahead to 90° on each side.

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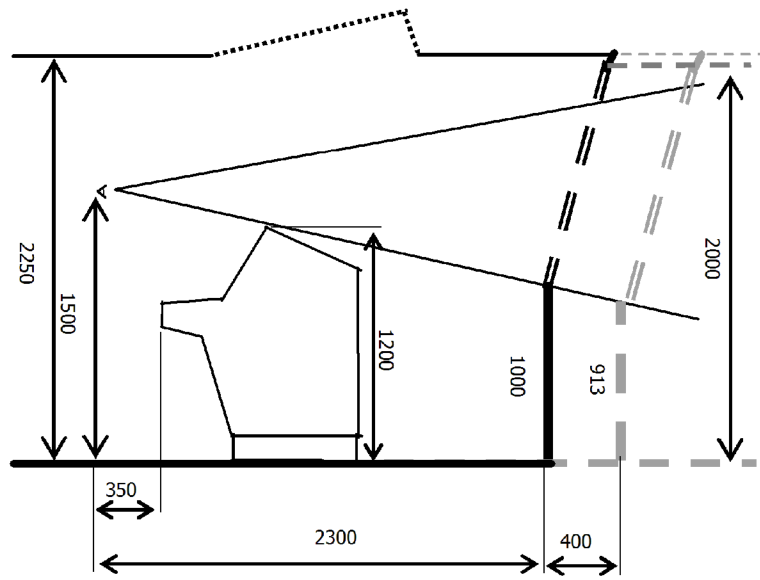

Figure 19 Vertical field of vision over consoles

3.3.2.5 Blind sectors caused by cargo, cargo gear, divisions between windows and other obstructions appearing in the required field of vision of 225° shall be as few and as small as possible, and in no way hamper a safe lookout from the workstations for navigating and manoeuvring. The total arc of blind sectors within this field of vision shall not exceed 30°.

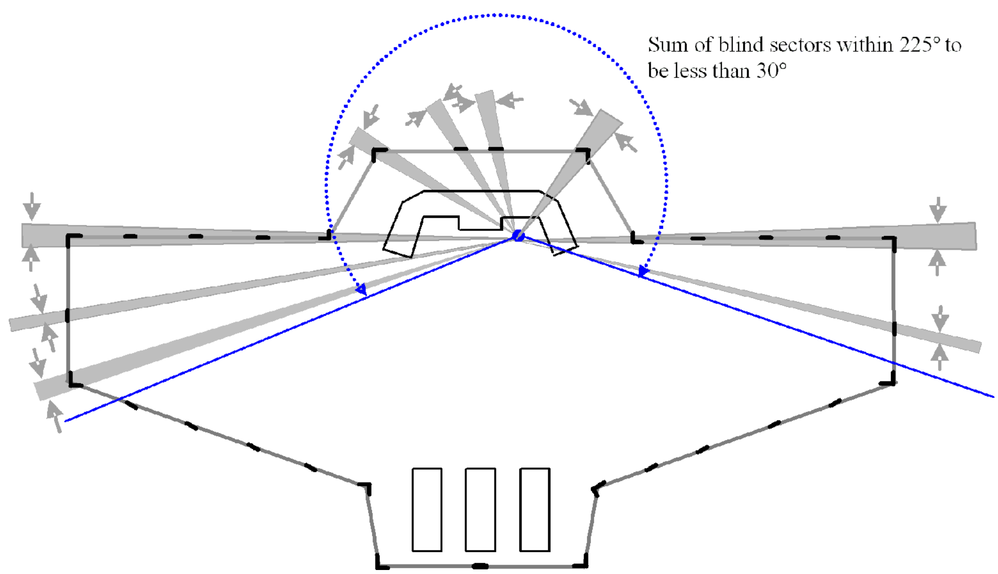

Figure 20 Blind sectors seen from workstations for navigating and manoeuvring

3.3.2.6 Over an arc from dead ahead to at least 10º on each side of the bow, seen from the workstations for navigating and manoeuvring, no blind sector shall exceed 5º. Elsewhere, each individual blind sector within the required field of vision shall not exceed 10º.

Guidance note:

See also [2.3.4] for calculation of blind sectors.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.2.7 The clear sector between two blind sectors shall be at least 5º and not less than the size of the broadest blind sector on either side of the clear sector.

3.3.2.8 If helicopter deck or other platforms are installed above and in front of wheelhouse obstructing the vertical field of vision, a vertical angle of view of not less than 5° above the horizontal plane, extending from eye height in forward direction, shall be provided irrespective of helicopter deck or other structures placed on top of the wheelhouse.

3.3.2.9 It shall be possible to observe the ship bow for reference of ship position/heading from the workstation.

Guidance note:

If direct observation of the ship bow/ forecastle is hampered, a mast can be used as reference.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.2.10 It shall be possible to visually monitor the workstations for offshore operations.

3.3.3 Additional requirements for AH, AHTS and towing

3.3.3.1 From the working position at the workstation it shall be possible to see the sea surface within 600 meters from the ship's stern for monitoring of towing units.

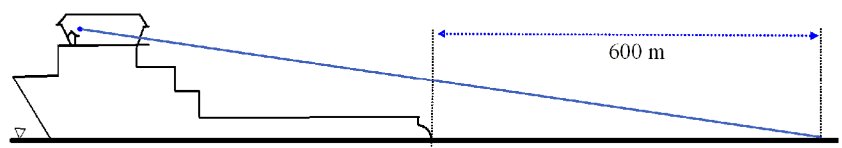

Figure 21 Monitoring of tow

3.3.3.2 The horizontal field of vision from the normal working position aft shall cover a sector not less than ship stern breadth and it shall be possible to see wire stoppers.

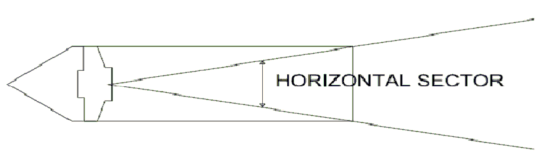

Figure 22 Horizontal field of vision

3.3.3.3 It shall be possible to monitor the spooling of the wire, the towing guide and the relative horizontal angle of the tow wire at the stern roll.

Guidance note:

These requirements may be obtained with use of CCTV system.

These additional requirements are not applicable from workstation monitoring.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.3.4 Additional requirement for seismic vessels:

3.3.4.1 From the working position at the workstation it shall be possible to see the sea surface not less than 1000 meters from the ship's stern for monitoring of towing units.

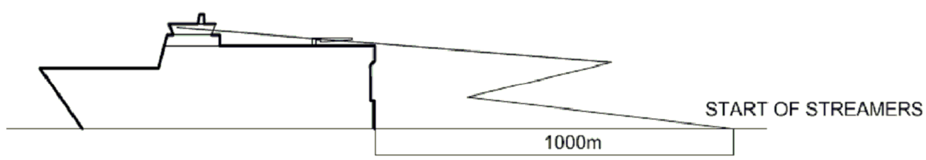

Figure 23 Monitoring of tow for seismic vessels

3.3.4.2 The horizontal field of vision from the normal working position in front shall enable the operator to monitor the start of streamers in a sector not less than ±30°.

Guidance note:

These requirements may be obtained with use of CCTV system.

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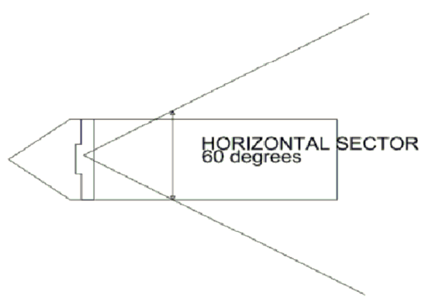

Figure 24 Monitoring of tow for seismic vessels

3.3.5 Equipment to be available

3.3.5.1 Instruments and equipment that shall be operated by the navigator at the workstations for navigating and manoeuvring, and considered essential for safe and efficient performance of the operator’s tasks, shall be within reach from a sitting position at the workstation. Priority shall be given to location of controls for radars, heading and speed.

3.3.5.2 The following instruments and equipment shall be installed within reach from a sitting position:

— chart radar
— ECDIS
— propulsion control

— propulsion back-up control (when provided)
— heading control system or track control system (as provided)
— manual steering control with override control of automatic systems
— mode selector switch and means for take command at workstation (steering, propulsion, thrusters)
— VHF (fixed)
— UHF (fixed)
— automatic telephone
— whistle push button
— emergency stop for propellers/ thrusters
— central alert management system UIDs
— BNWAS control panel and reset function
— window wiper and wash controls for the windows within the required field of vision
— searchlight controls (when provided).

3.3.5.3 The following equipment shall be installed within reach from a standing position at the workstation:

— steering gear control and alarm system.

3.3.5.4 The following equipment shall be installed within reach from a standing position at the workstation where also controls for propulsion and steering can be operated:

— thruster control(s)
— thruster back-up control(s) (when provided)
— joystick control (when provided).

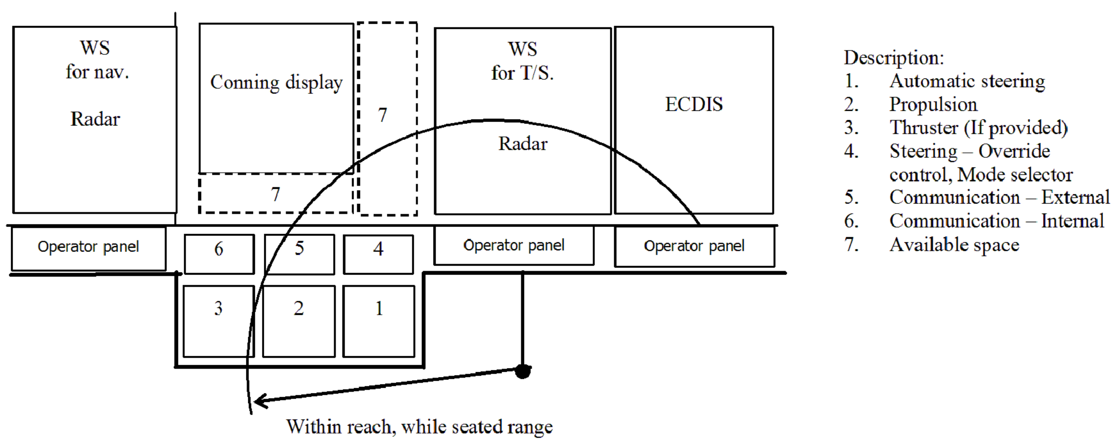

Figure 25 Example of location of important equipment

3.3.5.5 Means to be used at intervals for securing safe heading and speed in the waters to be navigated and for safety of bridge operation shall be easily accessible from the workstations for navigating and manoeuvring and include:

— instruments and equipment installed at the workstation for monitoring
— alarm panel for additional functions, such as fire, emergency, etc.
— dimmer controls for lights to be used at the workstation
— controls for the sound reception system.

3.3.5.6 Additional requirement for AH, AHTS, towing and seismic operations:

— controls for CCTV system (if applicable) shall be installed within reach from a sitting position at the workstations for navigating and manoeuvring.

3.3.6 Information to be provided

3.3.6.1 Information considered essential for the safe and efficient performance of tasks at the workstations for navigating and manoeuvring shall be easily readable, and audible when relevant, from the working position at the workstation. Essential information includes:

— CAM-HMI
— engine alarm panel (engine alarm panel/ E0 alarm panel might be included in central alarm panel)
— propeller revolution and engine rpm/ load as relevant
— thrust indication or alternatively thruster pitch and RPM (as provided)
— propeller pitch (when provided)
— rudder angle
— rudder order, if the steering system is a follow-up system
— ship’s heading (steering repeater with compass card)
— ship’s speed
— water depth
— wind direction and speed
— time
— alarms and warnings
— sound from navigational aids and ship’s whistles
— conning display
— gyro compass monitoring system
— magnetic compass (if provided).

3.3.6.2 Additional requirements for AH, AHTS and towing operations:

— winch tension, wire length and wire speed indication (may be part of conning display)
— monitor(s) for supporting view of tow or wire (if applicable).

3.4 Workstation for monitoring

3.4.1 Workstation tasks

3.4.1.1 The workstation for monitoring support shall enable the following tasks to be performed:

— determine and plot the ship's position, heading, track and speed
— effect internal and external communication related to navigation
— monitor time, heading, speed and track, rudder angle, propeller
— revolutions and propeller pitch (when applicable)
— adjustment of pre-planned route during the voyage.

3.4.2 Field of vision

3.4.2.1 Same requirements as for workstations for navigating and manoeuvring, except the additional requirements for AH, AHTS and towing operations. See [3.3.2].

3.4.3 Equipment to be available

3.4.3.1 The following instruments and equipment that shall be operated by the navigator at the workstation for monitoring, and considered essential for safe operations, shall be within reach from a standing position at the workstation:

— radar
— ECDIS backup arrangement
— chart table (if relevant)*
— relevant position-fixing systems (GPS)
— VHF (fixed)
— automatic telephone
— whistle push button
— BNWAS control panel and reset function
— central alert management system UIDs.

* Ships solely using ECDIS as the official chart system and are not required to carry any paper navigational charts, may not install a front chart table.

3.4.4 Information to be provided

3.4.4.1 Information considered essential for operations at the monitoring workstation shall be easily readable from the working position at the workstation. Essential information includes:

— propeller revolutions and engine rpm/ load as relevant
— propeller pitch (when provided)
— rudder angle
— ship's heading
— ship's speed
— water depth
— time
— distance run
— conning display
— CAM-HMI.

3.5 Workstation for offshore operations

3.5.1 Principle

3.5.1.1 The design and location of the workstation for ship handling and the workstation for aft support shall enable safe and efficient manoeuvring of the vessel under all circumstances and shall facilitate command and control of the vessel's offshore operations.

3.5.1.2 Workstation for ship handling and workstation for aft support shall be so arranged and designed that two qualified operators can work either separately or in close co-operation if the workload exceeds the capacity of one operator or the nature of the operation requires two operators.

3.5.1.3 Workstation for ship handling shall facilitate all functions related to manoeuvring and command during normal operating conditions.

3.5.1.4 The workstation for aft support shall facilitate control of offshore operations and serve as backup for manoeuvring functions if operator at workstation for ship handling becomes inoperative.

3.5.2 Layout for workstations for offshore operations

3.5.2.1 The workstations for offshore operations shall be located close together to allow close co-operation between the two workstations and for efficient use of console space, thereby avoiding duplicate installation of equipment and indicators.

3.5.2.2 Both workstations shall have access to the back-up controllers for manoeuvring.

3.5.2.3 Any consoles/panels located between operator and aft windows shall not obstruct the view of cargo deck and shall be possible to remove instantly if prime access to workstation is hampered by the console.

3.5.2.4 The width of consoles shall be kept as narrow as possible in order to avoid operator stretching over the console in order to reach equipment mounted outside normal reachable area and thus risking unintended activation/ movement of controls.

Guidance note:

The width of consoles intended for use from one side only should not exceed 700 mm. For consoles to be used from both sides, the width may be increased to 800 mm provided that equipment mounted on the far side is not relevant for the operator at the adjacent workstation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.2.5 To ensure optimum area for installed equipment that shall be within reach, the space provided for the chair seat and the operator shall be kept to a minimum.

Guidance note:

The space provided for the chair seat and the operator should not be more than 600 mm wide, chair armrests with equipment are not included in this 600 mm.

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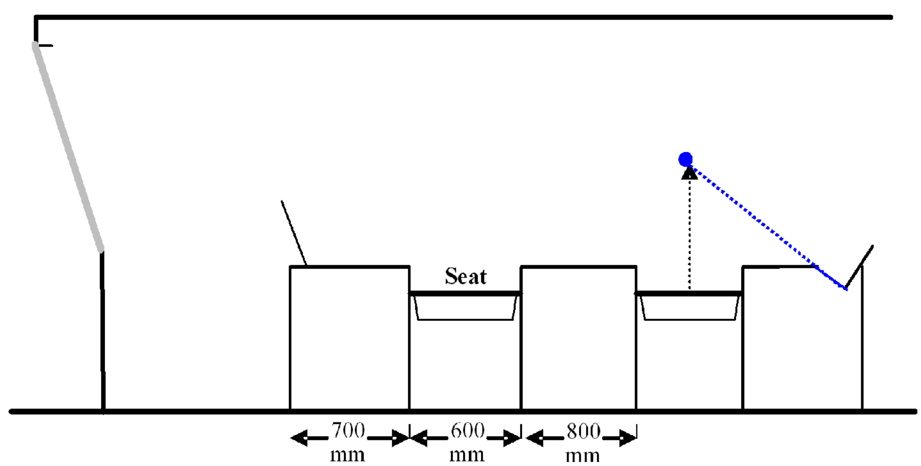

Figure 26 Size of consoles when common centre console is used

3.5.3 Workstation consoles for offshore operations

3.5.3.1 Workstation consoles shall not obstruct the view through windows required for monitoring aft deck operations from sitting position at the workstations for offshore operations. Consoles located in athwart ship direction shall not obstruct the required field of vision from the workstation.

3.5.3.2 The relationship between the total height of the console, the height of desktop for equipment installations and the sitting height is decisive for achieving optimum vertical field of vision, optimum reaching distance and efficient use of equipment when seated. The distance to side windows and the size of windows affect the vertical view. A vertical angle of view not less than +/- 5° in relation to the horizontal line of vision shall be provided by adjusting the size of windows if necessary.

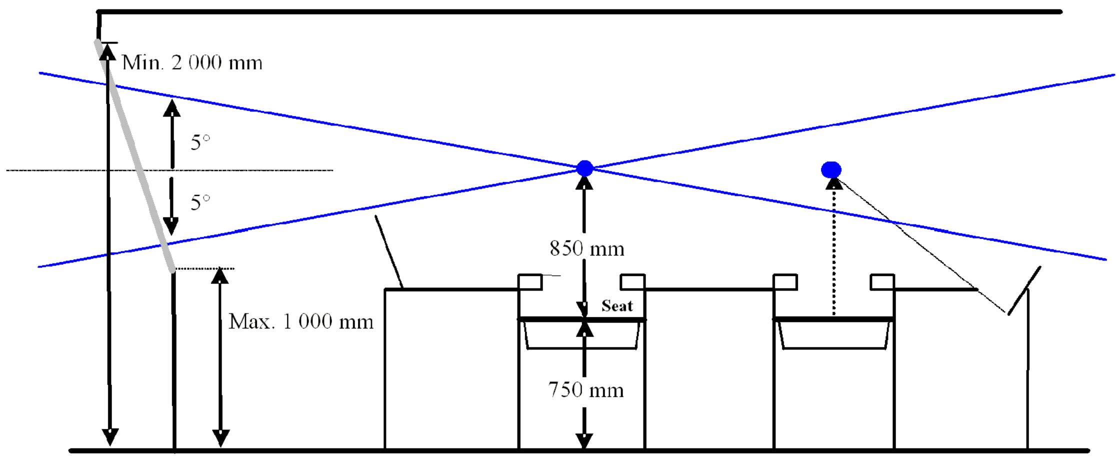

Figure 27 Location of workstation consoles and window size in the FOV arc between abeam and 30° aft of abeam

3.5.4 Chairs at workstations for offshore operations

3.5.4.1 Chairs, with armrests or equivalent, shall be installed at the workstation for ship handling and the workstation for aft support. It shall be easy to adjust the vertical position of the chairs to obtain an elbow height of 50 mm above the level of adjacent consoles.

Guidance note:

It should be possible to adjust the vertical distance between chair seat and adjacent console desktops in the range of +/- 100 mm. This may be obtained by adjusting the height of the chair or the adjacent consoles.

See also [3.1.5].

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3.5.4.2 Chairs and consoles at WS for offshore operations shall be arranged as integrated design in order to obtain the required level of ergonomics and availability of equipment.

3.5.4.3 If it is necessary to move the chair for operation of essential equipment located outside easy reach area, it shall be possible to move the chair instantly without having to leave the chair.

3.5.5 Priority zones for location of equipment and indicators

3.5.5.1 Required equipment and indicators at workstations for ship handling and aft support shall be located according to importance and frequency of operation.

Guidance note:

Tables and figure below indicates priority of some of the equipment and indicators at workstations for ship handling and aft support. Required equipment and information at the workstations are listed in paragraph [3.6] and [3.7].

Priority zones explanation (P):

Indicators meant for reading

A - easily readable within a horizontal sector of 180° and vertical in the area up 60° and down 90° from the operators normal line of sight. See Pt.4 Ch.9 Sec.6. See also [5.4].

B - readable within an horizontal sector of 225° and vertical in the area up 60° and down 90° from the operator's normal eye position.

Equipment meant to be operated

1) on hand
2) within easy reach
3) within reach (possible to reach while seated in working position)
4) easily available (available when standing or when moving chair)
5) other that may require attention during operations.

See Figure 28.

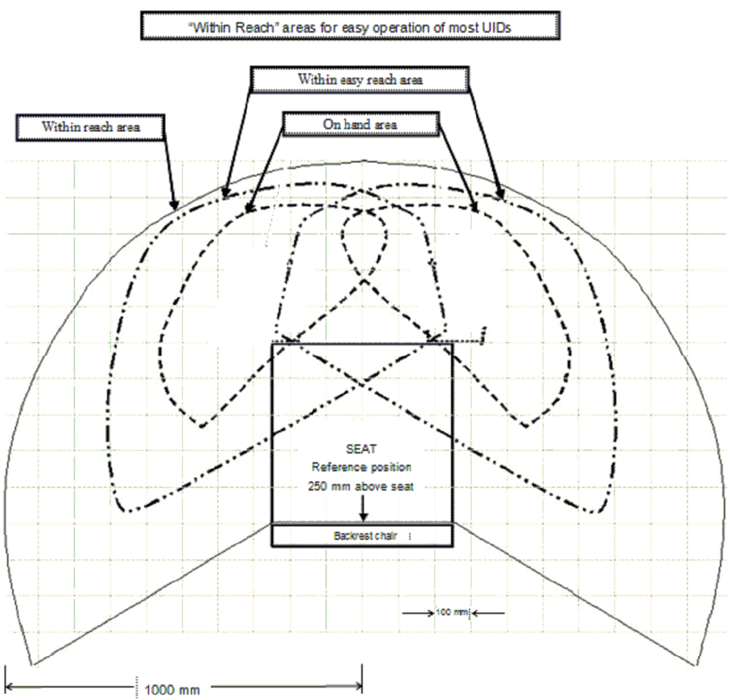

Figure 28 Classification of reaching areas in the horizontal plane

Table 9 Priority zones (P) of different equipment and indicators depending of operation

Operation: Manoeuvring, applicable for all operations							
Workstation - ship handling				Workstation - aft support			
P	Controls	P	Information	P	Controls	P	Information
1	Longitudinal thrust control	A	Thrust/ force indicators	2	Longitudinal thrust control*	B	Thrust/ force indicators

1	Lateral thrust control	A	Thrust/ force indicators	2	Lateral thrust control*	A	Thrust/ force indicators*
1	Main propulsion/ engine systems controls	B	Machinery status awareness information	2	Main propulsion/ engine systems controls*	B	Machinery status awareness information*
1	Rudder controls	A	Rudder angle	2	Rudder controls*	A	Rudder angle*
3	Steering gear control and alarm system	B	Status info				
2	Thruster systems control	B	Status info				
2	DP System	B	DP System status info	2	DP System*	B	DP System status info*
1	Joystick	A	Joystick order and response	2	Joystick*	A	Joystick order and response*
1	Independent joystick system (when provided)	B	Joystick status	2	Independent joystick system*	B	Joystick status*
1	Mode selector switch	B	Mode indication	2	Mode selector switch*	B	Mode indication*
1	VHF	B	Channel indication/ plan	1	VHF	B	Channel indication
1	UHF	B	Channel indication/ plan	1	UHF	B	Channel indication
1	Search light						
1	Whistle						
1	Telephone	B	Telephone list	2	Telephone	B	Telephone list
1	Window cleaning controls						
3	Deck light control						
1	CAM UID	B	CAM-HMI	2	CAM UID	B	CAM-HMI
3	Intern light ctrl (incl. dimming)	A	Conning display			B	Conning display
3	Sound power telephone	B	Clock			B	Clock
		A	Speed indication			A	Speed indication
		B	Depth indicator			B	Depth indicator
		B	Wind direction and speed indication			B	Wind direction and speed indication
		A	Heading indication			A	Heading indication
3	arrangement for placement of papers as instructions, procedures and plans			3	arrangement for placement of papers as instructions, procedures and plans		
Operation: Cargo, applicable for vessels intended for cargo operations							
P	Controls	P	Information	P	Controls	P	Information
2	Cargo control system	B	Cargo information monitor	1	Cargo control system	B	Cargo information monitor
2	Telephone			1	Telephone		

Operation: Anchor handling, applicable for vessels intended for AH							
P	Controls	P	Information	P	Controls	P	Information
		B	Tension indicator	1	Tension controllers	A	Tension indicators
		B	Wire speed indicator	1	Winch speed control	A	Wire speed indicator
				1	Wire spooling controller		
		B	Camera monitor	1	Surveillance camera controller	A	Camera monitor
1	Jaw shaft controller			1	Jaw shaft controller		
1	Towing pins			1	Wire lock controller		
3	Chart radar controller	B	Chart radar				
2	Anchor handling position surveillance system control	B	Anchor handling position surveillance system monitor				
3	DGPS						
Operation: Fire fighting, applicable for vessels intended for FiFi							
P	Controls	P	Information	P	Controls	P	Information
				1	Fire monitor controllers	B	Pressure indicator
						B	Wind indicator
1	Longitudinal thrust control	A	Thrust/ force indicators	2	Longitudinal thrust control*	B	Thrust/ force indicators
*The main principle is that the workstation for aft support shall always be able to instantly take over the manoeuvring function from workstation for ship handling and this may be either by joystick, DP or by manual means.							

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3.6 Workstation for ship handling

3.6.1 Workstation tasks

3.6.1.1 The workstation for ship handling shall, as applicable, facilitate the following tasks:

— control main propulsion
— control of thrusters not being part of the main propulsion, e.g. side thrusters
— monitor status on main and auxiliary machinery
— control and monitor DP system (when provided)
— communicate with other ships, platforms and internally on own ship
— monitor and silence alarms from equipment serving other functions located on the bridge requiring action or attention from the operator (e.g. fire alarms, GMDSS alarms, engine alarms)
— visually monitor cargo operations
— monitor workstation for aft support
— monitor workstations for navigating and manoeuvring and ship handling
— berth the ship
— operate necessary supporting equipment.

3.6.2 Field of vision

3.6.2.1 In order to enable the operator(s) at the workstations for offshore operations to carry out the required functions, the horizontal field of vision from the workstation shall extend over an arc of not less than 180° that is from right astern to not less than the beam on either side of the ship.

3.6.2.2 For monitoring of vessels side by side, platforms when lying alongside and other relevant situations, it shall be possible to monitor a horizontal field of not less than 5° beside the broadest part of the wheelhouse.

Guidance note:

This 5° field of vision may either be before or behind the broadest part of the wheelhouse, see Figure 29.

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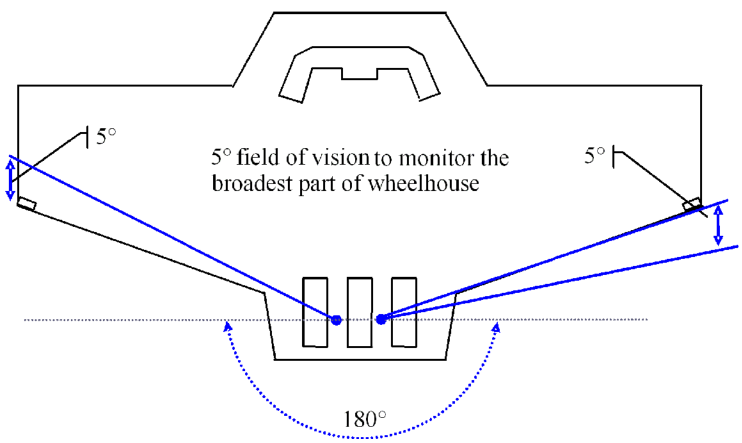

Figure 29 Horizontal field of vision from workstations for offshore operations

3.6.2.3 In order to maintain a horizontal field of vision when the ship is rolling in heavy seas, there shall be an unobstructed view at an angle of at least 5° above and below the horizontal plane from the workstation for offshore operations in the sector from abeam to 30° abaft the beam. The height of the upper edge of the windows shall be at least 2000 mm under all circumstances.

3.6.2.4 The heights of consoles and lower edge of windows above the bridge deck shall not obstruct the line of sight passing 5° below the horizontal plane. The height of the lower edge of the windows shall be maximum 1000 mm above deck under all circumstances.

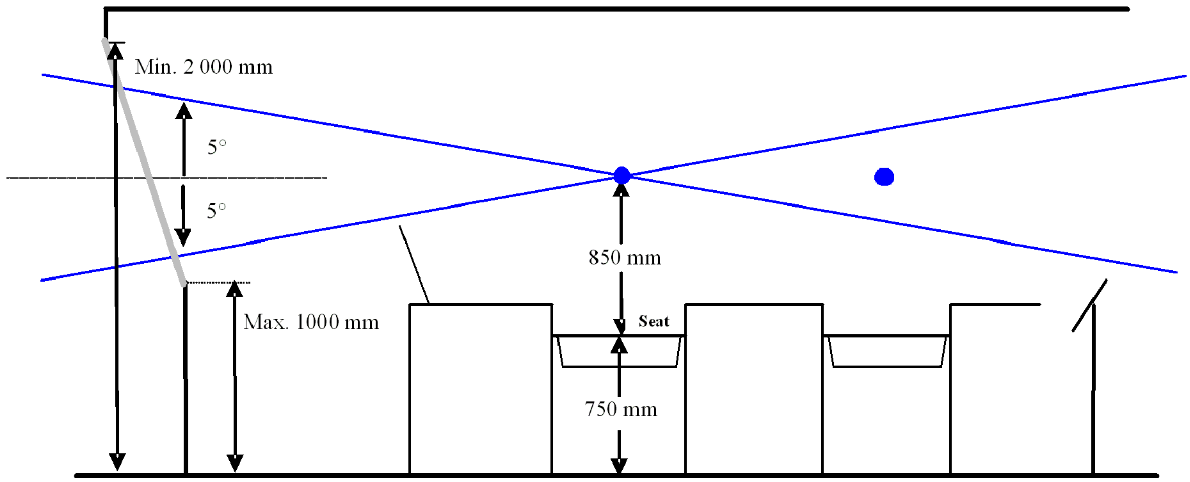

Figure 30 Vertical field of vision in the sector from abeam to 30° aft

3.6.2.5 From the workstations for offshore operations there shall be a view of the cargo rail and working deck. Any obstructions in this view shall be kept to a minimum. Over an arc of not less than 120°, i.e. from right astern to not less than 30° abaft the beam on either side of the ship, the height of the lower edge of the windows above the bridge deck shall be so that the bulkhead below the windows does not obstruct the view of the cargo deck.

3.6.2.6 In order to see cargo arriving at the aft deck from cranes and other nearby constructions, there shall be view at an angle of at least 20° above the horizontal plane from the workstation for offshore operations over an arc of 120°, that is from right astern to not less than 30° abaft the beam on either side of the ship. See Figure 31 and Figure 32. For ships not engaged in cargo handling to/ from platforms, or other operations requiring equivalent vertical view, the above vertical view can be reduced to not less than 10° above the horizontal plane.

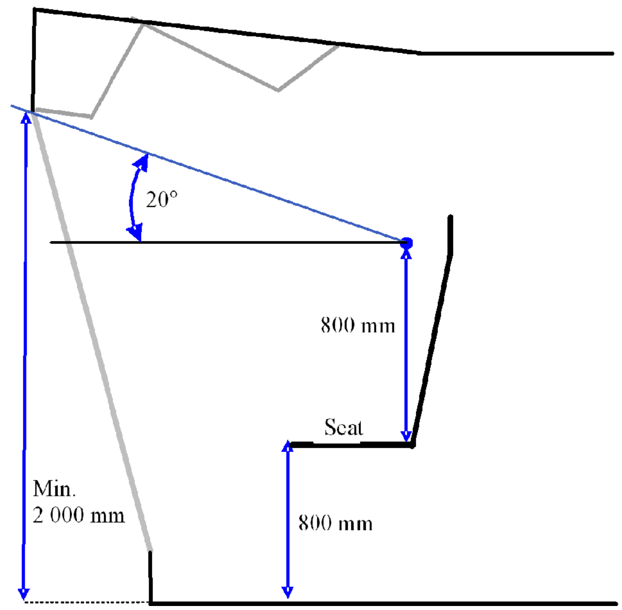

Figure 31 Vertical field of vision in the sector of 120° astern

3.6.2.7 No blind sector caused by cargo, cargo gear, divisions between windows and other obstructions appearing in the required field of vision shall exceed 10°.

The total arc of blind sectors within the required 180° field of vision at the workstation for offshore operations shall not exceed 20°.

3.6.2.8 The clear sector between two blind sectors shall be at least 5º and not less than the size of the broadest blind sector on either side of the clear sector.

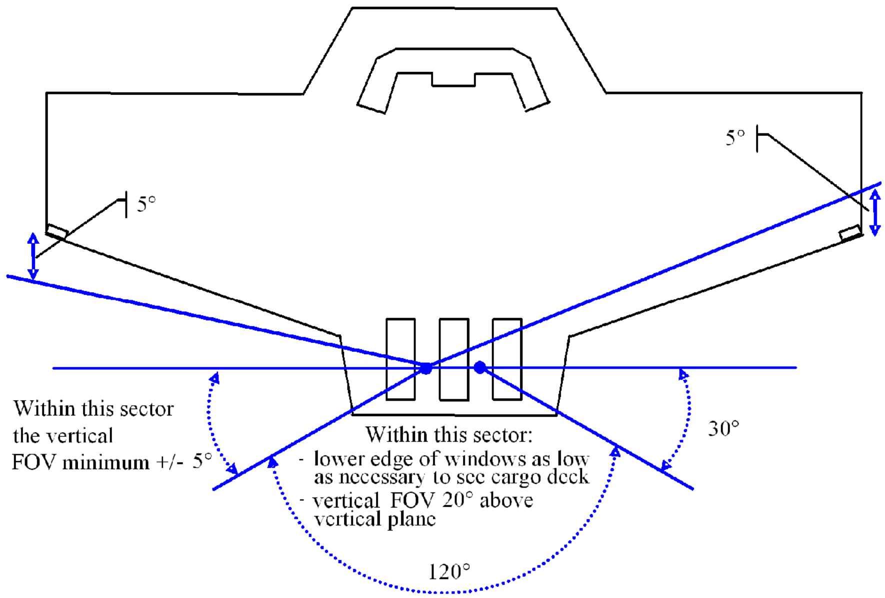

Figure 32 Overview of the fields of vision required from workstations for offshore operations

3.6.2.9 The applied eye position of the operator(s) at the workstations shall be 1600 mm above deck with the seat in the normal working position (for calculation purposes).

3.6.2.10 From workstation for ship handling it shall be possible to visually monitor the workstations for navigating and manoeuvring.

3.6.3 Equipment to be available

3.6.3.1 The following instruments and equipment that shall be operated by the navigator at the workstation for ship handling, and considered essential for safe and efficient performance of his tasks, shall be within reach from a sitting position at the workstation:

— dynamic positioning system (when provided)
— joystick
— independent joystick system (when provided)
— manual steering control (including any back-up mode)
— steering gear control and alarm system
— longitudinal thrust control
— lateral thrust control
— propulsion control
— propulsion back-up control (when provided)
— thruster control(s)
— thruster back-up control(s) (when provided)
— extension alarm panel
— mode selector switch and means for take command at workstation (steering, propulsion, thrusters)
— whistle push button
— VHF (fixed)
— UHF (fixed)
— automatic telephone

— search light controls
— window wiper and wash controls for the windows within the required field of vision
— deck light controls
— central alert management system UIDs
— means for controlling the chart radar (or radar and ECDIS). See [4.2.6.9]*
— means for controlling towing pins and jaw (when provided)
— arrangement for placement of papers as instructions, procedures and plans.

* Not required for pure platform supply vessels.

3.6.3.2 Main manoeuvring controls shall be defined by the owner and these controls together with communication controls shall be on hand when seated.

3.6.3.3 Priority shall be given to location of controls for joystick, DP (if installed), propulsion throttles, rudder controls, thrusters and necessary communication (UHF, VHF and telephone systems).

See [3.5.5] for priority of equipment.

3.6.3.4 Equipment that might require attention from the operator during operation shall be installed sufficiently close to the operator's working position, so that it is not necessary to leave the chair for taking appropriate action. The following equipment shall be considered:

— alarm panel for additional functions, such as fire, emergency, cargo, etc.
— GMDSS equipment that may require attention
— alarm systems included in the bridge alert management system may not necessarily be located at the workstation.

3.6.3.5 Additional requirements for AH and AHTS:

— anchor handling position surveillance system control (system for aiding the ship to find the correct anchor position, often received from rig before operation).

3.6.4 Information to be provided

3.6.4.1 Information considered essential for safe and efficient performance of tasks at the WS for ship handling shall be easily readable, and audible when relevant, from the working position at the workstation. Essential information includes:

— propeller revolution and engine rpm/ load as relevant
— propeller pitch (when provided)
— thrust indication or alternatively thruster pitch and RPM (as provided)
— rudder angle
— rudder order, if the steering system is a follow-up system
— ship's heading
— ship's speed
— water depth
— wind direction and speed
— time
— essential status information of main and auxiliary machinery, as relevant
— CAM-HMI
— conning display
— chart information*
— traffic information*
— collision warning *
— grounding warning*.

* Not required for pure platform supply vessels.

See [3.5.5] for priority of information.

3.6.4.2 Additional requirements for AH, AHTS and towing:

— essential winch information (tension, length, wire speed)
— CCTV monitors for monitoring of winch equipment and spooling apparatus.

3.7 Workstation for aft support

3.7.1 Workstation tasks

3.7.1.1 The workstation for aft support shall facilitate the following tasks:

— control main propulsion for backup of manoeuvring function
— control of thrusters not being part of the main propulsion, e.g. side thrusters, for backup of manoeuvring function
— monitor status on main and auxiliary machinery, as relevant
— communicate with other ships, platforms and internal on vessel
— monitor and control cargo operations
— emergency stop of cargo operations
— control and monitor winch operations, as relevant
— monitor workstation for ship handling.

3.7.2 Field of vision

3.7.2.1 Same requirements as for workstation for ship handling, see [3.6.2].

3.7.3 Equipment to be available

3.7.3.1 The following instruments and equipment that shall be operated by the navigator at the workstation for aft support, and considered essential for safe and efficient performance of his tasks, shall be within reach from a sitting position at the workstation:

— joystick*
— manual steering control (including any back-up mode)*
— propulsion control*
— propulsion back-up control (when provided)*
— thruster control*
— mode selector switch and means for take command at workstation (steering, propulsion, thrusters)*
— VHF (fixed)
— UHF (fixed)
— automatic telephone
— central alert management system UIDs
— means for controlling towing pins and jaw (when provided)
— cargo operation system (when provided)
— auxiliary equipment needed for the relevant operations
— arrangement for placement of papers as instructions, procedures and plans.

* The main principle is that the workstation for aft support shall always be able to instantly take over the manoeuvring function from workstation for ship handling and this may be either by joystick, DP or by manual means.

3.7.3.2 Priority shall be given to location of controls for propulsion, steering and thrusters and equipment necessary for the relevant operations. Equipment shall be prioritized in order of frequency in use and importance.

See [3.5.5] for priority of equipment.

3.7.3.3 Equipment that might require attention from the operator during operation shall be installed sufficiently close to the operator's position so that it is not necessary to leave the workstation for taking appropriate action.

3.7.3.4 Additional requirements for AH, AHTS and towing:

— winch control system
— auxiliary systems for use during AH, AHTS and towing operations
— controls for CCTV monitors for winch and spooling apparatus monitoring.

3.7.4 Information to be provided

3.7.4.1 Information considered essential for safe and efficient performance of tasks at the WS for aft support shall be easily readable, and audible when relevant, from the working position at the workstation. Essential information includes:

— propeller revolution and engine rpm/load as relevant
— propeller pitch (when provided)
— thrust indication or alternatively thruster pitch and RPM (as provided)
— rudder angle
— rudder order, if the steering system is a follow-up system
— ship's heading
— ship's speed
— water depth
— wind direction and speed
— time
— conning display
— CAM-HMI.

See [3.5.5] for priority of information.

3.7.4.2 In addition, information regarded necessary for the relevant operations shall be easily readable from the operator's position at the workstation.

3.7.4.3 Additional requirements for AH, AHTS and towing:

— relevant winch information for safe operation of winch system
— CCTV monitors for winch and spooling apparatus.

3.8 Workstation for firefighting

3.8.1 Workstation tasks

3.8.1.1 The workstation for fire fighting shall facilitate the following tasks:

— monitor the vertical and horizontal sectors where the fire monitors are effective
— operate controls for FiFi equipment
— cooperate with the workstation for ship handling or workstations for navigating and manoeuvring (visual view of operator at workstation).

3.8.1.2 The workstation may be mobile or located at several different places for covering the field of vision requirement.

3.8.2 Field of vision

3.8.2.1 In order to enable the officer at the workstation for FiFi to carry out his tasks in a safe manner, the field of vision from the workstation(s) shall extend over an arc equivalent to the sector the fire monitors are meant to operate.

3.8.2.2 In addition, it shall be possible to monitor the workstations for navigating and manoeuvring and workstation for ship handling.

3.8.3 Equipment to be available

3.8.3.1 Operational controls for the FiFi monitors shall be either fixed at one designated location, or the controls may be portable if the acquired field of vision demands alternative working positions. Portable equipment shall have fixed stands at the workplace, ensuring correct direction when in use.

Guidance note:

If the portable Fi-Fi panel has clear indication of the direction of the ship, the fixed stands may be omitted.

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3.8.4 Information to be provided

3.8.4.1 Displays, instruments and indicators providing information considered essential for safe and efficient performance of the tasks at the workstation for FiFi shall be easily readable, and audible when relevant, from the working position at the workstation.

3.9 Workstation for docking/search/rescue operations

3.9.1 Workstation tasks

3.9.1.1 The workstation for docking/search/rescue operations shall facilitate the following tasks:

— monitor the rescue area along the ship side
— control main propulsion
— control of thrusters not being part of the main propulsion, e.g. side thrusters
— communicate with other ships, platforms, and internally on ship
— cooperate with workstation for ship handling or workstations for navigating and manoeuvring (visual view of operator at workstation)
— supervision of docking operations.

Guidance note:

Workstation for docking operations may be part of workstation for rescue or workstations for navigating and manoeuvring and/ or workstation for ship handling.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.9.1.2 If co-operation with workstation for ship handling or workstation for navigation is impracticable, all tasks necessary for carrying out rescue operations safely and efficiently shall be carried out from workstation for rescue operations.

3.9.2 Field of vision

3.9.2.1 In order to enable the officer at the workstation for rescue operations to carry out his tasks in a safe manner, the field of vision from this workstation shall extend over an arc of not less than 225°, that is from right ahead to right astern through the side of the ship on which the workstation is located and then to 45° on the opposite stern.

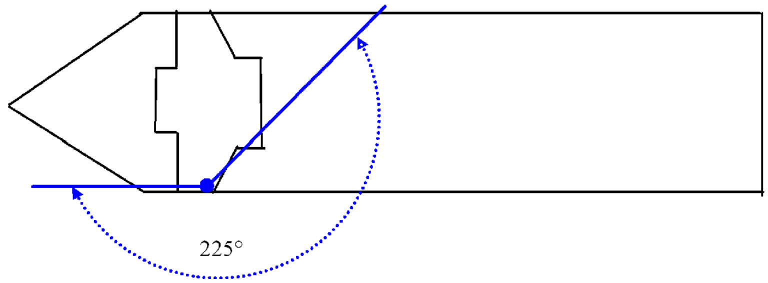

Figure 33 Horizontal field of vision

3.9.2.2 From the workstation for rescue operations there shall be an unobstructed view of the ship’s side and the water surface along the ship’s side, particularly with respect to monitoring of the rescue area.

3.9.2.3 In addition it shall be possible to monitor the workstations for navigating and manoeuvring or workstation for ship handling.

3.9.3 Equipment to be available

3.9.3.1 The following instruments and equipment that shall be operated by the navigator at the workstation for rescue operations, and considered essential for safe and efficient performance of his tasks, shall be within reach from a standing, or sitting position if a chair is installed, at the workstation:

— searchlight controls
— manual steering control*
— propulsion control*
— thruster control*
— mode selector switch and means for take command to workstation (steering, propulsion, thrusters)*
— emergency stop of propellers/ thrusters
— VHF (fixed)
— UHF (fixed)
— automatic telephone
— CAM-HMI
— window wiper control
— whistle push button.

* A joystick control system may replace individual steering, propulsion and thruster control units, if the joystick control enables de-activation of individual propellers and thrusters by the navigator.

3.9.3.2 Priority shall be given to location of the manoeuvring controls (steering, propulsion and thrusters) and search light controls.

3.9.4 Information to be provided

3.9.4.1 Information considered essential for safe and efficient performance of the tasks at the WS for rescue operation shall be easily readable, and audible when relevant, from the working position at the workstation. Essential information includes:

— propeller revolution
— propeller pitch (when provided)

— thrust indicator or alternatively thruster pitch and RPM (as provided)
— ship's speed
— wind direction and speed
— rudder angle.

3.10 Workstation for communication

3.10.1 Workstation tasks

3.10.1.1 Where other external communication equipment than that related to the safe operation of the vessel is installed on the bridge, it shall be located in a separate workstation for communication. Other functions related to safe and efficient operation of the vessel may be located adjacent to this workstation.

3.10.2 Field of vision

3.10.2.1 In order to enable the officer of the watch to use workstations for communication and additional bridge functions for short periods of time, the field of vision from these workstations shall extend at least over an arc from 90° on port bow, through forward, to 22.5° abaft the beam on starboard side.

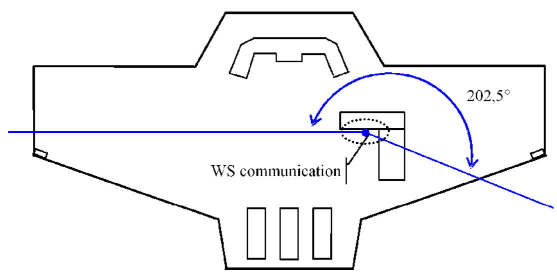

Figure 34 Field of vision from workstation for communication

3.10.2.2 The arrangement at the workstation shall facilitate effective lookout and the minimum operator eye height shall be considered to be 1500 mm. above wheelhouse deck. If the workstation is lowered compared to wheelhouse deck, the chair(s) at the workstation shall be of a long-legged type allowing for equivalent eye height.

Guidance note:

Maximum lowering of the workstation is 200 mm.

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3.10.2.3 Blind sectors caused by deck supports and other obstructions located inside or outside of the wheelhouse shall be minimized. Each individual blind sector caused by any obstruction whether inside or outside of the wheelhouse shall not exceed 10°.

3.10.3 Equipment to be available

3.10.3.1 All communication equipment required for GMDSS shall be provided at this workstation and additional communication equipment supplied shall preferably be available at this workstation. Provisions shall be made to provide the operator at workstation for ship handling with means for accepting GMDSS alarms remotely. Navtex shall be located at this workstation.

3.10.4 Information to be provided

3.10.4.1 Information such as telephone directories, channel plans, emergency contacts and other relevant contact points shall be provided.

3.11 Workstation for safety monitoring and emergency operations

3.11.1 Workstation tasks

3.11.1.1 The workstation for safety monitoring and emergency operations shall enable monitoring of the safety state of the ship as well as planning and management of emergency operations. The workstation shall enable storage and use of relevant drawings, safety plans, ship safety systems and internal communication equipment. The workstation shall be located close to the workstation for communication/GMDSS equipment enabling use of all available means for external communication. Direct visual and audible contact with the workstations from which the vessel is manoeuvred shall be provided.

3.11.2 Equipment to be available

3.11.2.1 Equipment and means to be available include:

— bookshelves and drawers of sufficient size
— internal communication systems
— navigation light controls.

3.11.3 Information to be provided

3.11.3.1 Information related to safety operations shall include:

— fire alarm status
— emergency procedures
— safety plans
— watertight doors
— fire doors (if applicable).

4 Bridge equipment

4.1 General bridge equipment requirements

4.1.1 Scope and application

4.1.1.1 This section contains general requirements pertaining to all bridge equipment to be fitted in accordance with this section as well as other bridge equipment to be situated in the wheelhouse or in the vicinity of the wheelhouse as deemed applicable.

4.1.2 Certification

4.1.2.1 All navigational and radio equipment installed shall comply with IMO Res. A.694(17) *General requirements for ship borne radio equipment forming part of the GMDSS and for electronic navigational aids*. See also Table 3.

Guidance note:

Equipment should meet the requirements specified in IEC 60945.

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4.1.2.2 All navigational equipment installed shall come with a certificate showing compliance with applicable IMO performance standards.

Any non-type-approved equipment shall be certified in accordance with the systematic of Pt.4 Ch.9, or MED module G if deemed applicable, for verification of compliance with appropriate international standards.

Guidance note:

It is assumed that all navigational equipment to be installed for compliance with SOLAS and/or these rules comes with a valid type approval certificate issued by a recognized certification authority.

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4.1.2.3 Equipment installed in addition to both SOLAS and the carriage requirement of this section shall comply with performance requirements not inferior to the rules or associated IMO performance standards as deemed applicable.

Navigational equipment or systems that may affect the steering or propulsion shall be certified in accordance with the systematic of Pt.4 Ch.9 (or MED module G if deemed applicable) for verification of compliance with the rules and relevant international standards unless the applicable function is already incorporated by the type approval certificate. Additional equipment installed should at least meet the requirements in IEC 60945 or DNVGL-CG-0339.

4.1.2.4 Additional bridge equipment, not required by the rules or international regulations that may have an impact on the safety of main functions shall comply with the applicable requirements of Pt.4 Ch.9.

4.1.3 Location and installation of equipment

4.1.3.1 All instruments, panels, etc. shall be permanently mounted in consoles or at other appropriate places, taking into account both operational and environmental conditions. All other items, such as safety equipment, tools, lights, pencils, etc., to be used by bridge personnel, shall be stored in designated places.

4.1.3.2 Any equipment, antennas and arrangement shall be installed in such a manner that the designed efficiency is not substantially impaired and, unless otherwise specified, follow the instructions and recommendations detailed by the manufacturer.

4.1.3.3 Radar antennas shall be installed to enable detection of targets within 360°. Blind sectors occurring in one radar system shall, as far as practicable, not occur in the other system.

4.1.4 Interference

4.1.4.1 When placing equipment that shall be used in an exposed position, special care shall be taken to ensure that the location does not impair the performance of the equipment.

4.1.4.2 The antennas for radars, position-fixing receivers and VHF communication systems shall be installed in such a manner that interference is avoided and the designed efficiency is not substantially impaired.

Guidance note:

VHF operating performance is highly dependent upon antenna location and height, and each antenna should be erected as high as possible, away from obstacles, wires, radar beams, etc. To avoid direct VHF-to-VHF radiation, the antennas should be vertically separated from each other at a distance not causing harmful interference.

The antennas for navigation receivers should be mounted in a location permitting a high degree of vertical or horizontal polarised isolation against MF/HF transmitter antenna configuration. The GPS antenna should be positioned outside the main lobe of INMARSAT-C, VHF and transmitting radar antennas.

The S-band radar antenna should preferably be located at heights, which do not interfere with other shipboard obstructions. Nearby location of satellite communication antenna should not degrade the radar performance.

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4.1.4.3 Transmitting and receiving antenna cables shall be widely separated.

4.1.5 Radiation hazard

4.1.5.1 Antenna units shall be located so as not to constitute a hazard to personnel working in the vicinity.

Guidance note:

The site of radar wave guides, satellite communication and HF transmitter feed lines should be safeguarded, so as to protect personnel against open wave-guide radiation power and accidental contact with high voltages, by means of isolating trunks or fences.

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4.1.5.2 Satellite communication or radar antenna units are required to have a warning label, detailing safe distances, posted in the vicinity or on the equipment.

4.1.6 Vibration and shock isolation

4.1.6.1 Above deck equipment shall be sited so as to prevent the installation from being affected by vibration.

4.1.6.2 The antenna system and instrument installation shall withstand vibration to an extent that includes known standards for vibration environment according to the ship's construction, speed trim and the sea state.

4.1.6.3 Antenna systems including active elements shall be provided with a mount design configured to withstand potential shock damage.

4.1.7 Temperature protection

4.1.7.1 Instruments to be installed shall be located away from excessive heat sources, such as a heating vent or equipment heat exhaust.

4.1.7.2 Instruments to be fitted into a bridge instrument console shall be protected from excessive heat by conduction or, if necessary, by forced air flow.

Guidance note:

Redundant systems should be installed in consoles where two or more systems are located and forced air flow is necessary to ensure proper function of the equipment.

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4.1.8 Interface to central alert management system

4.1.8.1 All equipment that gives audible alarms or audible warning signals shall be provided with a communication interface in compliance with the BAM concept of the IMO.

Guidance note:

The communication interface protocol should comply with MSC.302(87) module C. For protocol details reference is made to the latest version of IEC 61162-1.

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4.2 Equipment requirements

4.2.1 Heading information system

4.2.1.1 Two separate and independent gyro compasses or other means having the capability to determine the ship’s heading in relation to geographic (true) north shall be provided. At least one of the compasses shall be a gyro compass.

Guidance note:

One of the gyro compasses can be replaced by a transmitting heading devices type approved according to ISO 22090.

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4.2.1.2 The system shall enable distribution of heading information to other systems.

4.2.1.3 The system shall identify which of the compass that is in use.

4.2.1.4 The Gyro compass system shall be provided with means for automatic correction of the errors caused by speed and latitude.

4.2.1.5 Means shall be provided for comparing the two compasses and an alarm shall be given if the difference between the compasses exceeds the set value.

4.2.1.6 The heading information system and the distribution system shall be so arranged that no single failure in power supply or distribution units may cause loss of heading information to consumers depending of heading information for function.

Guidance note:

The following equipment is depending of heading information for normal function:

— heading/ bearing repeaters
— heading control system/ track control system
— joystick system
— DP system
— radar system
— ECDIS.

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4.2.2 Position system

4.2.2.1 Two separate and independent position fixing systems shall be provided. At least one of the position receivers shall be a GPS.

Guidance note:

The independence of the two position-fixing systems may be achieved by separate antenna systems, display/control units, power supply and digital interface output/distribution units.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2.2 At least one of the position-fixing systems shall be capable of receiving and decoding of differential data broadcasted for navigational purposes by maritime radio beacons.

4.2.2.3 The position system and the distribution system shall be so arranged that no single failure in power supply or distribution units may cause continuous loss of position information to consumers depending of position information for function.

Guidance note:

The following equipment is depending of position information for function:

— track control system
— DP system
— chart radar system
— ECDIS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.3 Steering and manoeuvring systems

4.2.3.1 The ship shall be equipped with means for manual and automatic steering of the ship.

4.2.3.2 The automatic steering system may be either heading control system, track control system, joystick system or ynamic positioning control system.

4.2.3.3 Seismic vessels:

For seismic vessels, a low speed (1 to 5 kn) track control is required to enable the ship to automatically follow a pre-planned seismic route.

The system shall at least give;

— cross track limit alarm (XTE)
— new course change alarm
— failure of sensors alarm.

4.2.3.4 Steering override control enabling instant take-over in case of failure in any of the automatic steering systems mentioned in [4.2.3.2] including the mode switch itself, shall be provided adjacent to the automatic steering control position.

4.2.3.5 A Common mode selector switch controlling all propulsion and thrusters shall be provided as applicable at each workstation. Means shall be provided for controlling steering, propulsion and thrusters as applicable.

Guidance note:

It should be possible to take command at workstations where steering and/or manoeuvring is arranged for. The mode selector should enable the operator to select mode of all propulsion and thrusters with one action. E.g. when selecting autopilot, manual mode (transit or manoeuvring as applicable for any azimuth thrusters system), joystick or DP with this selector switch, all the propellers and thrusters should be controlled in the selected mode. Settings should be the same as on the previous workstation in command or with neutral settings.

This switch should be approved according to Pt.4 Ch.9.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.3.6 It shall be a clear indication when a workstation is in command. A characteristic warning shall be sounded whenever command is taken on a workstation. The warning shall be audible at all workstations provided with a common mode selector switch. A clear status message shall be displayed on the workstation in command.

4.2.3.7 Any back-up control of thrusters and propulsion shall have same user interface as the normal controls.

4.2.3.8 If any steering/propulsion means is provided not required by these rules, this shall be selectable and necessary indicators for operation to be installed at this location.

4.2.4 Speed measuring system

4.2.4.1 A speed log measuring speed through water shall be provided.

4.2.4.2 Sensor(s) for speed log shall have means for ice protection or be fitted with gate valve for sensor replacing at sea without need for dry docking.

4.2.5 Depth measuring system

4.2.5.1 Echo sounder system for measuring the water depth under the keel shall be provided.

4.2.5.2 Sensor(s) for echo sounder shall have means for ice protection or be fitted with gate valve for sensor replacing at sea without need for dry docking.

4.2.6 Radar systems

4.2.6.1 Two separate and independent radar systems enabling inter-switching of the main components shall be provided.

Guidance note:

See [4.1.2.3] with respect to radar antenna installation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.6.2 One of the radars shall operate in X-band. The second radar shall operate in S-band or, where considered appropriate based on operational aspects, in X-band.

4.2.6.3 Each individual radar system installed shall be equipped with a performance monitor.

4.2.6.4 If the radar inter-switching is so designed that one single failure may have an impact on both radars, then sufficient bypass facilities shall be provided and user instruction for by-passing shall be posted adjacent to the inter-switch.

4.2.6.5 Both radars shall be CAT 1 radars.

4.2.6.6 The radar at workstations for navigating and manoeuvring shall be interfaced to automatic identification system (AIS) for graphical display of AIS reported targets in accordance with relevant IMO standards and guidelines.

4.2.6.7 The radar at workstations for navigating and manoeuvring shall be a chart radar with the ability to display selected parts of SENC. This radar shall also be able to display the ship's position and the route used on the ECDIS.

Guidance note:

A chart radar is a radar able to display selected parts of electronic navigational chart (ENC) in accordance with IEC 62388.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.6.8 One of the radar systems shall be provided with additional slave display (for installation at workstation for ship handling) with possibility for displaying selected parts of ENC in accordance with [4.2.6.7]. This slave system shall have means for controlling the range and adjust tuning, anti sea clutter, anti rain clutter and gain.

Guidance note:

This requirement is not applicable for pure platform supply vessels.

This requirement is related to workstation for ship handling in [3.6]. Alternative means to chart radar, can be slave radar + slave ECDIS.

Radar display shall have a daylight display with a minimum effective diameter of not less than 250 mm.

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4.2.6.9 Seismic vessels: The radar installation shall provide coverage of the seismic tow without blind sectors. This may be achieved by the required navigation radar installation or by installing additional radar for such purposes.

4.2.7 Electronic chart display and information system

4.2.7.1 ECDIS shall be provided.

4.2.7.2 Electronic back-up for ECDIS shall be provided and shall be independent of ECDIS.

Guidance note:

Conning display, a second chart radar or a second ECDIS may serve the ECDIS back-up function when located at workstation monitoring.

See IEC 61174 Annex G for further details about ECDIS Back-up.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.7.3 ECDIS shall be able to transfer route information to chart radar for enabling display of active route on the chart radar.

Guidance note:

Route information shall be in accordance with IEC 61162 and should be possible to send directly to chart radar without use of external media such as diskettes.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.8 Automatic identification system (AIS) minimum keyboard display (MKD)

4.2.8.1 The ECDIS and/or the radar installed at the workstation for navigating and manoeuvring shall support the AIS MKD (possibility to operate the AIS from the workstation).

4.2.9 Bridge navigational watch alarm system

4.2.9.1 The ship's wheelhouse shall be equipped with a surveillance system continuously monitoring the presence of an alert OOW. The BNWAS shall maintain supervision of the wheelhouse to ensure the navigational watch being attended when the ship is underway at sea. The BNWAS system shall be type approved according to requirements in IMO performance standard for bridge navigational watch alarm system, an in addition comply with the requirements in these rules.

Guidance note:

The surveillance system should be able to detect human activity (motion).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.2 Surveillance of the navigational watch

Means for activating the BNWAS reset function by automatic detection of human motion shall be provided at workstation for navigating and manoeuvring, workstation for monitoring and workstation for conning. If motion detection is provided at workstation for offshore operation and workstation for offshore support, it shall be possible to select/deselect the bridge area in use (I.E select between fore and aft bridge).

Guidance note:

The most common method by which motion can be automatically detected employs use of sensors processing infrared images, microwave reflections, ultra sonic sound reflections or image recognitions systems.

Sensors may use one or several of these technologies in combination. Sensors approved for alarms systems for intrusion and hold-up systems according to EN 50131 may be used provided that the BNWAS can comply to following functional requirements

— Timer is reset if a forearm is moving 0.5 to 1 m/s at the working position.
— Failure or tamper of the motion sensor is deactivating the timer reset function due to automatic motion detection.
— Timer are not reset due to shifting sunlight, moving objects or surfaces as expected onboard a moving ship.
— Potential masking of sensor detection area to obtain detection in areas providing proper outlook only is done internally in the sensor.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.3 Facilities shall be provided for the OOW to select individually any of the navigation officers, including the captain, as being the assigned back-up officer for receiving the second stage remote audible alarm.

4.2.9.4 It shall be possible to configure the BNWAS to always include the captain's cabin and captain's office in the second stage remote audible alarm.

Guidance note:

The configuration should be protected so that access is restricted to the captain only.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.5 The third stage remote audible alarm shall be activated in the following locations:

— captain's cabin and office
— officers' office
— officers' mess
— officers' day room
— cargo control room (if provided)
— gymnasium (if provided)
— sky lobby (if provided)
— other public lounges and areas (if provided).

Guidance note:

To extend the accessible area for back-up personnel the alarms may additionally be transferred by means of a wireless system to call the assigned back-up navigator on the condition that it is possible for the assigned person to reach the bridge within 2 minutes.

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4.2.9.6 The BNWAS second and third stage remote audible alarms shall not be acknowledged by the motion detection system.

Guidance note:

Activation of the BNWAS motion detection function should only reset (acknowledge) the first stage audible alarm on bridge.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.7 BNWAS shall include the possibility for the OOW to initiate emergency call by a single operator action.

Guidance note:

Accidental activation of emergency call should be avoided. Protective measures should be implemented to avoid inadvertent operation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.8 BNWAS shall provide facilities to immediately actuate the emergency call from other equipment capable of transferring an unacknowledged alarm.

Guidance note:

Such facilities may be contact closure or IEC 61162 interface or similar circuit. An emergency call initiated by other equipment may only be deactivated by acknowledging the alarm at the source of the alarm or the CAM system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.9 The BNWAS second and third stage remote audible alarms shall be inter-connected with the alert transfer system without influencing on the alarm handling of the CAM.

Guidance note:

The user operation of the CAM-HMI may reset the BNWAS, but the BNWAS reset device should not be able to acknowledge the CAM-HMI.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.10 Alarm transfer system

4.2.10.1
The ship shall be provided with a system for transferring of un-acknowledged alarms from CAM and BNWAS to dedicated areas in the accommodation.

4.2.11 Bridge alert management

4.2.11.1 Integration of equipment:
The ship shall be equipped with a central alert management system (CAM) centralising and handling the alerts of all equipment and functions generating alerts in the wheelhouse. The CAM shall handle alert priorities and categories supporting the bridge team in the immediate identification of abnormal conditions and present alerts as individual alerts or as aggregated alerts on the CAM-HMI.

Guidance note:

The conning information display may act as CAM-HMI.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.11.2 The number of alerts shall be kept as low as possible and be classified in accordance with the BAM concept.

Guidance note:

Alerts additional to the alerts required by applicable IMO/IEC standards should be assigned to a priority level using the BAM criteria for classification (MSC.302(87))

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.11.3 Alerts of the same kind, for which individual presentation is anyway necessary at the alert releasing equipment, shall be presented on the CAM-HMI as as an aggregated alert. Other non-required IMO alerts of the same kind shall be subject for aggregation where possible.

4.2.11.4 All navigational equipment that gives audible alerts shall be provided with a communication interface in compliance with the BAM concept of the IMO.

Guidance note:

The interface should comply with MSC.302(87) module C. For protocol details reference is made to the latest version of IEC 61162-1.

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4.2.11.5
For other equipment which does not support the BAM protocol for alert handling, the CAM-HMI shall present their alerts in accordance with the BAM concept.

Guidance note:

Reference is made to IMO resolution MSC.302(87) module A for presentation and handling of alerts on the bridge, and module C for interfacing to the CAM.

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4.2.11.6 The CAM-HMI shall present the alert messages in English language using standard maritime terminology where such exists. Proprietary messages shall be clear text allowing for prompt comprehension of the message and pertinent actions to be taken.

4.2.11.7 The CAM shall provide a suitable interface for transmitting un-acknowledged alarms to the alarm transfer system.

Guidance note:

In this context un-acknowledged alarms is the announcement state "active-unacknowledged"; hence not including other alarms with status "active-silenced", "active-responsibility transferred" nor "rectified-unacknowledged" - see IEC 61924-2.

The interconnection may be contacts, serial, ethernet or other.

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4.2.11.8 Un-acknowledged alarms shall be transferred to the alarm transfer system within 30 seconds of the alarm occurrence unless otherwise stated in the performance standards applicable for the equipment.

Guidance note:

Applicable equipment standards comprise IMO, IEC and ISO standards.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.12 Conning display system

4.2.12.1 Conning displays shall be provided.

Guidance note:

Conning displays should provide the operator with information about the operational status of the vessel. Conning information as part of DP displays can be accepted at workstations for offshore operations provided readability for operators and that the conning information is available continuously.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.12.2 Information required for efficient monitoring of the status of the operation and safe performance of bridge functions, shall be systematised and displayed for easy and continuous viewing from the positions where navigation and manoeuvring are performed. Information not related to safe operation shall be avoided.

Guidance note:

Conning display should display the following information:

— steering mode (manual, autopilot, DP, joystick, transit/ docking mode, as applicable)
— essential information from the power management system or equivalent information
— heading
— speed
— rudder angle
— water depth
— thruster status indications
— individual thruster indications or alternatively individual thruster pitch and RPM (as provided)
— propulsion status indication
— propeller revolutions
— pitch indication, when relevant
— winch load (and available force), wire length and wire speed, when relevant
— wind indication.

If the vessel is equipped with track control system, see IMO performance standard for additional information.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.12.3 To enable easy viewing, the conning information display shall utilise graphical display technique and locate relevant sensor input data appropriately around and on a symbol illustrating own ship.

4.2.12.4 The orientation of the conning picture shall be consistent with the ship orientation as seen from the operator position.

4.2.12.5 Parts of the display area might be dedicated to user interface for the BAMS (CAM-HMI).

4.2.12.6 Provision of independent indicators for equipment (typically rudder, propulsion, thrusters) may be omitted when the required information is provided in mutually redundant conning displays at the required workstations. See the rules Pt.4 Ch.9.

Guidance note:

Rudder, pitch and RPM indicators are required to be type approved as such and use of conning display to replace such indicators will imply that the conning need to be approved for this. For vessels applicable for EC MED this implies wheel marking.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.13 Internal communication equipment

4.2.13.1 Automatic telephone system

a) An automatic telephone system shall be installed and shall provide two-way voice communication between the bridge and:
   - all officers cabins
   - all deck hand cabins
   - all public rooms
   - all normal working spaces and
   - all emergency working positions.

b) The telephone network shall be designed with a minimum capacity of four simultaneous calls.

c) The wheelhouse shall be fitted with at least two independent telephone extensions.

d) The telephone extensions in the wheelhouse and engine control room shall have priority function over any other extension.

e) Incoming calls on adjacent telephones shall be distinguishable by lights and/or different ring tones.

f) The automatic telephone system shall be supplied by mains and emergency sources of power.

4.2.14 External communication system

4.2.14.1 At least two fixed independent VHF systems shall be provided for simultaneously use from relevant workstations.

4.2.14.2 At least two fixed independent UHF systems shall be provided for simultaneously use from relevant workstations.

4.2.15 Closed circuit television systems

4.2.15.1 CCTV system shall provide the operator with true colour pictures of relevant areas for compensating lack of direct visual viewing.

4.2.15.2 CCTV system used for compensating lack of direct visual viewing shall be connected to the main and emergency power system.

4.2.15.3 The monitor size shall be adequate for easy viewing from the operator's position.

Guidance note:

Picture size should be: The minimum length of the shortest side of the picture should be 1/9 of the reading distance in cm. i.e. if the distance from the operator to the monitor is 3 meters, the monitor's shortest side should be 33 cm (33 × 33 cm display if square and 33 × 44 cm if 4:3 format).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.15.4 All cameras which are required by these rules and which are mounted on open deck exposed to sea water mist, shall be equipped with fresh water lens wash and wipers for cleaning.

4.2.16 Weather information system

4.2.16.1 The ship shall be equipped with an anemometer providing information about wind speed and direction.

4.2.16.2 Ships engaged in worldwide trade shall be equipped with a shipboard weather station providing information about air temperature, air humidity and barometric pressure.

4.2.16.3 Ships shall be equipped with a weather information system.

Guidance note:

A marine computer including a software application for receipt and displaying of regular weather forecasts, or a weather fax may be acceptable.

Ships not engaged in worldwide trade may, if found unreasonable, be exempted from this requirement provided an alternative suitable system or method for receiving relevant weather information is provided.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.17 Search lights

4.2.17.1 At least 2 remotely controlled searchlights shall be provided to illuminate areas of interest in a horizontal sector of 360° around the vessel with vertical adjustment allowing view of the sea close to the ship’s side and up to 20° above the horizon.

4.3 Electrical power supply

4.3.1 Main electrical power supply

4.3.1.1 Navigational equipment shall be individually connected to distribution board(s) being supplied from both main and emergency sources of power by separate circuits. Such distribution boards shall be located at or adjacent to the bridge deck.

4.3.1.2 The power supplies to the distribution boards shall be arranged with automatic changeover facilities between the two sources. Failure of one of the power supplies to the distribution board(s) shall initiate an alarm (audible and visual signal) in the wheelhouse (CAM-HMI).

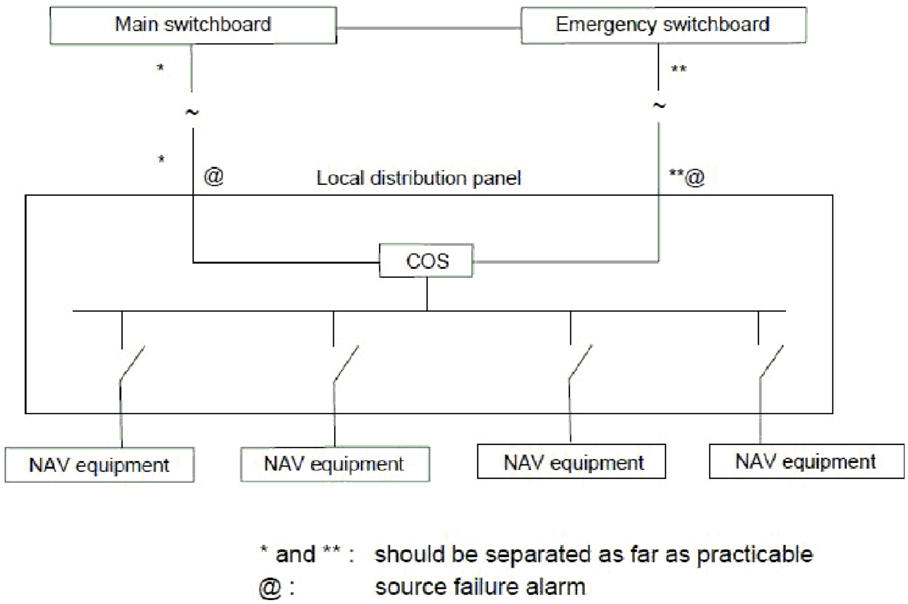

Figure 35 Power supply for navigation equipment operated by AC

4.3.2 Transitional source of power

4.3.2.1 Essential equipment shall be provided with a transitional source of power with a capacity to keep the equipment running during a loss of main and emergency power of at least 10 minutes. The equipment regarded essential in this context is at least:

— radar (including the antenna) installed at workstation for navigating and manoeuvring
— ECDIS installed at workstation for navigating and manoeuvring
— GNSS
— CAM and CAM-HMI
— BNWAS
— speed log.

4.3.2.2 In addition to the requirements of [4.3.2.1] at least one gyro compass shall be provided with a transitional source of power with a capacity to keep it running for 30 minutes.

4.3.2.3 The UPSs used to supply bridge equipment shall have automatic bypass functionality.

4.3.2.4 Appropriate means for bypassing an UPS manually, in case of failure in the automatic bypass, shall be provided.

4.3.2.5 Failure of an UPS shall initiate an alarm (audible and visual signal) in wheel house at the CAM-HMI.

Guidance note:

A battery in compliance with the above requirements is considered as equivalent arrangement to UPS.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5 Ergonomics and human-machine interface

5.1 Human - machine interface

5.1.1 General

5.1.1.1 All equipment and indicators shall be designed with due regard to the human operator. Controls and indicators shall be in accordance with relevant rules in Pt.4 Ch.9 and be so constructed that they can be efficiently operated by suitably qualified personnel.

5.1.1.2 Human factor principles shall be an integrated part of engineering from early design phase for equipment, controls and indicators.

5.1.1.3 During all operations, it shall be possible to observe the ship’s status, the state of systems in use and other essential data.

5.1.1.4 Operation of controls and equipment shall either give the user feedback of the action through the control itself or through an indicator/ display adjacent to or in the natural vicinity of where the operation takes place.

5.1.1.5 Information and controls shall be arranged in logical groups, and shall be coordinated with the geometry of the vessel, when this is relevant.

5.2 Controls

5.2.1 Control devices

5.2.1.1 The number of operational controls, their design and manner of function, location, arrangement and size shall provide for simple, quick and effective operation.

5.2.1.2 Controls shall be arranged in functional groups.

5.2.1.3 Revolving controls for changing values up or down shall be designed so that clockwise turn increase value and vice versa. If push buttons are used, the push button at right shall increase value and vice versa.

5.2.1.4 Controls shall give clear feedback when passing stepwise positions or neutral positions.

Guidance note:

Levers should give noticeable resistance when passing neutral position. Switches should give clear feedback when in new position.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.1.5 Controls for thrusters and propulsion shall use consistent user interface.

5.2.1.6 For main control devices regulating the ship’s heading during normal navigation in transit mode, a clockwise or starboard movement shall turn the ship’s bow towards starboard and vice versa. For thrusters being used during manoeuvring, the control device movement shall correspond to the resulting thrust force.

Guidance note:

When azimuth thrusters are main propulsion system, means should be provided for control of these in transit mode as described above and this tiller, lever or joystick should be clearly distinguish in shape/ form from the main azimuth thruster control. This means may not necessarily control the thruster(s) more than +/- 35°.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.2 Operation of controls

5.2.2.1 All operational controls shall permit normal adjustments to be easily performed and shall be arranged in a manner which minimises the possibility of inadvertent operation. Controls not required for normal operation shall not be readily accessible.

5.2.2.2 The operation of a control shall not obscure the related indicator where observation of the indicator is necessary for making the adjustment.

5.2.2.3 In all operations, there shall be a clearly marked or consistent simple action to recover from a mistaken choice or to leave an unwanted state. It shall be possible for the user to start, interrupt, resume and end an operation. Incomplete or interrupted manual inputs shall not inhibit the operation of the equipment.

5.2.2.4 Controls shall be designed and arranged to avoid inadvertent operation. If controls are designed with special operation (e.g. double click or long time press) they shall be clearly distinct from other similar controls with similar design.

5.2.3 Identification of controls

5.2.3.1 All operational controls and indicators shall be easy to identify and to read from the position at which the equipment is normally operated. The controls and indicators shall be identified in English and marine terminology shall be used.

Guidance note:

Symbols as specified in IEC 60417 or in the other relevant standards may be used in addition to the identification in English.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3 Presentation of information

5.3.1 General

5.3.1.1 Displays and indicators shall present the simplest information consistent with their function, information irrelevant to the task shall not be displayed, and extraneous text and graphics shall not be present.

5.3.1.2 During all operations, the system’s state shall be observable with essential data displayed.

5.3.1.3 All information required by the user to perform an operation shall be available on the current display.

5.3.1.4 The mode of the systems in use shall be displayed.

5.3.1.5 It shall be possible at any step of a screen supported operation to return to the original display status prior to initiation of operations by single operator action.

5.3.1.6 Feedback timing shall be consistent with the task requirements. There shall be clear feedback from any action within a short time. Where a perceptible delay in response occurs, visible indication shall be given.

5.3.2 Menus

5.3.2.1 Menus shall be grouped according to the task.

5.3.2.2 Items of any kind which appear the same shall behave consistently.

5.3.2.3 The user shall not have to remember information when moving from one part of a menu to another.

5.3.2.4 Frequently used operations shall be available in the upper menu level, on dedicated software or hardware buttons.

5.3.2.5 Main display shall be available with a single operator action.

5.3.3 Text/ symbols

5.3.3.1 Displayed text shall be clearly legible to the user and easy to understand.

5.3.3.2 Simple natural language shall be used wherever possible. The equipment shall employ marine terminology.

5.3.3.3 Where additional on-line help is available it shall be in task dependent form, easy to search and list the steps to be carried out.

5.3.4 Illumination

5.3.4.1 All information shall be presented on a background of high contrast, emitting as little light as possible at night, so that it does not degrade the night vision of the officer on watch.

Guidance note:

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

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.4.2 Each instrument shall be fitted with an individual light adjustment. In addition, groups of instruments normally in use simultaneously may be equipped with common light adjustment.

5.3.4.3 Warning and alarm indicators shall be designed to show no light in normal position that is indication of a safe situation. Means shall be provided to test the lamps.

Guidance note:

Alarm indicator lights should be equipped with red lights of wavelength 620 nanometres or higher.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.4.4 Colour coding of functions and signals shall be in accordance with international standards.

Guidance note:

ISO 2412 *Shipbuilding: Colours of indicator lights*, Table A4 lists recommended colour codes for system functions.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.4.5 Means for adjusting the display and operating panel brightness shall be provided. Operator panels and other functional controls shall be illuminated to ensure ease of operation in the dark. Night vision shall be secured by considering the following:

— warning and alarm indicators shall show no light in normal position (indication of a safe situation). All instruments shall be fitted with permanent internal or external light source to ensure that all necessary information is visible at all times
— means shall be provided to avoid light and colour changes upon, e.g. start-up and mode changes, which may affect night vision
— all information shall be presented on a background of high contrast, emitting as little light as possible by night.

5.4 Readability of information

5.4.1 General

5.4.1.1 Instruments or displays providing visual information to more than one person shall be located for easy viewing by all users concurrently. If this is not possible, the instruments or displays shall be duplicated.

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

5.4.2 Location

5.4.2.1 The information presented shall be clearly visible to the user and permit easy and accurate reading at a practicable distance in the light conditions normally experienced at the location of the workstation by day and by night.

5.4.2.2 Instruments meant to be operated or fitted in connection with controls shall be readable from a distance of at least 1 000 mm. All other instruments shall be readable from a distance of at least 2 000 mm.

Guidance note:

Character height in mm should be not less than 3.5 times the reading distance in m. Letter width should be 0.7 times the letter height, e.g.:

— character height for reading distance 2 m: 2 × 3.5 = 7 mm
— character width for letter height 7 mm: 7 × 0.7 = 4.9, i.e. 5 mm
— resulting minimum character size: 7 mm × 5 mm.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

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

5.4.2.4 Instrument letter type shall be of simple, clear-cut design:

a) Internationally used and recommended letter type is Helvetica medium. However, light-emitting diode text matrices are acceptable.
b) In descriptive text, lower case letters are easier to read than capitals.

6 Bridge equipment tests

6.1 Onboard testing of bridge equipment

6.1.1 General

6.1.1.1 On-board testing of the equipment shall be performed after it is installed in order to ascertain that the equipment, as installed, operates satisfactorily.

6.1.1.2 It should be noted that reliable figures for all aspects of equipment performance or accuracy cannot be established by the on board testing required for classification. Therefore, to ensure that equipment performance is in accordance with specifications, ship owners and ship yards are advised to choose equipment that is type approved.

6.1.2 Test program

6.1.2.1 A detailed program for the on board testing of this equipment shall be submitted for approval at the earliest possible stage before sea trials.

6.1.2.2 The test program shall be in accordance with the requirements for on board testing given in this section, and shall specify in detail the tests to be performed for each type of equipment.

6.1.3 General requirements for the testing of all types of bridge equipment

6.1.3.1 Prior to testing, all equipment shall be checked and calibrated by a representative of the manufacturer or the equipment supplier.

6.1.3.2 Prior to testing, all equipment, etc., necessary for the observation and recording of test results, shall be made available. Charts for the area where the sea trials shall take place shall be available. Large-scale charts for the area where the ship is berthed shall be available.

6.1.3.3 Equipment and systems that shall be subject to the tests are required to ascertain that all controls, indicators, displays, etc. operate in accordance with their specifications and meet the rule requirements.

6.1.3.4 Failure conditions shall be simulated on equipment and systems.

6.1.3.5 Power supply alarms, UPS capacity/battery discharge test and bypass functionality shall be tested.

6.1.3.6 A demonstration including start-up of the individual systems and changeover from normal conditions to failure conditions shall be carried out.

6.1.3.7 Failure conditions of computer system(s), especially power failure, shall be simulated as realistically as possible. Manual re-starts and, if relevant, automatic re-start and automatic back-up shall be tested. Successive power breaks shall be simulated.

6.1.3.8 If computer system(s) is used to carry out secondary functions, testing of the system shall be carried out with all primary functions in operation and with maximum load from both primary and secondary functions.

6.1.3.9 Tests, additional to the approved test program, may be required carried out by the surveyor.

6.1.4 Heading measuring and information system

6.1.4.1 The settle point error of the master compass(es) and the alignment with the ship's centre line shall be determined using e.g. the bearing (direction) of the quay at which the ship is berthed.

6.1.4.2 The bearing repeaters' alignment with the ship's centre line shall be checked. A bearing diopter shall be available.

6.1.4.3 The divergence between No. 1 master compass and the gyro repeaters shall be checked. After switching to No. 2 master compass, the divergence with the gyro repeaters shall be checked again.

6.1.4.4 The monitoring functions of the compass system shall be tested.

6.1.4.5 The means for correcting errors caused by speed and latitude shall be tested.

6.1.5 Steering system

6.1.5.1 Proper functioning, including ergonomics/HMI and effect of failures, of the following shall be tested:

— take command functionality at workstations

— steering mode selector(s) in all modes at all workstations
— manual steering devices
— joystick (if installed).

6.1.6 Automatic steering system

6.1.6.1 The heading-keeping/track keeping performance of the autopilot/Track control system shall be tested at full sea speed. Adaptive autopilots shall also be tested at reduced speed.

6.1.6.2 The performance of the autopilot shall be checked for a change in heading of 10° and 60° to both sides. The overshoot angle shall be observed.

6.1.6.3 The off heading alarm/off track alarm shall be tested.

6.1.6.4 The rate-of-turn or radius function shall be tested.

6.1.6.5 Change of operational steering mode shall be tested.

6.1.6.6 The override function shall be tested in all steering modes.

6.1.6.7 The low speed track control system shall be tested at speed for seismic operations (typically 2 to 5 knots).

6.1.7 Rudder indicator(s)

6.1.7.1 The rudder indicator(s) on the bridge shall be checked against the indicator on the rudderstock.

6.1.8 Speed log

6.1.8.1 The speed log shall be checked for accuracy and, if necessary, calibrated.

6.1.9 Echo sounder

6.1.9.1 Function testing of the echo sounder shall be carried out. Depth shall be measured at a fixed position for exact comparison of accuracy and at full speed ahead on all range scales available.

6.1.9.2 The depth warning or alarm shall be tested.

6.1.10 Radar system

6.1.10.1 Function testing of the radar shall be carried out. The various ranges, presentation modes and the basic radar functions shall be tested.

6.1.10.2 Testing of the chart radar functionality shall be performed to verify consistent reference position, orientation and scale. Official ENC data shall be loaded before testing.

6.1.10.3 The accuracy of bearing of the radars shall be tested by the reading of at least 4 fixed positions on the display at a known position of the ship.

6.1.10.4 The accuracy of range measurement shall be tested by measuring the distance to at least 2 fixed positions at each range while the ship is in a known position.

6.1.10.5 The heading marker shall be checked against a visible target dead ahead and adjusted if necessary.

6.1.10.6 Failure mode by disconnecting a fuse shall be observed.

6.1.10.7 Inter-switching facilities, including bypass function, shall be tested.

6.1.10.8 Performance monitors shall be checked.

6.1.10.9 Self-check programs shall be run.

6.1.10.10 Indication on the display of the bearing and distance to the object, as well as the heading of own ship, shall be tested.

6.1.10.11 When manoeuvring the ship, the normal functioning of the radars, including automatic acquisition, shall be checked.

6.1.10.12 The trial manoeuvre function of the radars shall be tested.

6.1.10.13 Tests shall be carried out to verify that the system gives warning when the limits of CPA and TCPA are exceeded and that a warning is given when the object enters the guard ring.

6.1.10.14 Input from speed sensors shall be checked.

6.1.10.15 Coverage of the sector for seismic tow shall be checked (seismic vessels).

6.1.11 Sound reception system

6.1.11.1 The sound reception system shall be tested by measuring and comparing the sound level outside and inside the wheelhouse. The directional indication shall be tested.

Guidance note:

The fundamental frequency of the sound signal used in testing the system should be within the range 70 to 820 Hz.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.1.12 Electronic position-fixing systems

6.1.12.1 All electronic position-fixing fitted system(s) shall be function-tested.

6.1.12.2 The accuracy of the electronic position-fixing system(s) shall be checked.

6.1.12.3 Interference from transmitting systems such as VHF’s, radars, active VHF TV antennas shall be tested.

6.1.13 Automatic identification system

6.1.13.1 The AIS shall be function tested to verify proper interconnection to own ship navigational sensors.

6.1.13.2 The correct setting of static information (ship name, call sign, MMSI number, etc.) shall be verified.

6.1.14 Electronic chart display and information system

6.1.14.1 The accuracy, functionality and the alarm or warning functions of the ECDIS shall be tested. Performance of automatic functions, such as positioning of the ship by means of dead reckoning and GPS, plotting of the track and updating of the data base, shall be included in the tests together with the following operations:

— route planning
— altering of the route while underway
— positioning by bearings and ranges
— manual adjustment of the ship’s position on the screen

— scale changes and zooming functions.

Official ENC data to be loaded before testing.

6.1.14.2 The ECDIS back-up system shall be tested for proper interconnection with the primary ECDIS. Route planning, route monitoring, including alarms, shall be tested.

6.1.14.3 Self-check programs shall be run.

6.1.15 Conning display

6.1.15.1 The performance of conning display(s) function shall be tested, including the accuracy and readability of the data displayed.

6.1.16 Propulsion system

6.1.16.1 Proper functioning, including ergonomics/HMI and effect of failures, of the propulsion system shall be tested.

6.1.17 Communication systems

6.1.17.1 The communication systems shall be tested for proper function.

6.1.17.2 The automatic telephone system and internal communication system between workstations shall be tested.

6.1.17.3 The priority function for the telephones in the wheelhouse and engine control room over the other extensions shall be tested.

6.1.17.4 VHF systems shall be tested.

6.1.17.5 UHF systems shall be tested.

6.1.18 Central alert management system

6.1.18.1 The interconnections to the CAM shall be tested and the CAM-HMI shall be checked.

6.1.18.2 It shall be tested that all equipment providing alerts on the bridge is connected to the CAM and provides two-way communication for silencing of audible alarms in accordance with approved drawings and interface protocols.

6.1.18.3 It shall be tested that un-acknowledged alarms from the CAM are transferred to the alarm transfer system.

6.1.19 Watch monitoring and alarm transfer system

6.1.19.1 The functionality and time settings of the BNWAS shall be checked.

6.1.19.2 Transfer of 2nd and 3rd stage BNWAS alarms to the applicable parts of the accommodation ref. [4.2.9] and the motion sensor(s) shall be tested.

6.1.20 Closed circuit television system

6.1.20.1 The CCTV system shall be tested for verifying appropriate reproduction on the indoor monitor, including colour correctness, brightness, dimming facilities (if the monitor can degrade the OOW's night vision) and display size. It shall further be verified that the picture is free of flickering.

6.1.20.2 Means for cleaning the camera lens to be tested for cameras located in areas exposed to salt-mist.

6.1.21 Window clear view devices

6.1.21.1 The means for maintaining clear view through bridge windows shall be tested.

CHANGES – HISTORIC

July 2018 edition

Amendments July 2018

Only editorial changes have been made.

January 2018 edition

Changes January 2018, entering into force 1 July 2018

Topic	*Reference*	*Description*
DNVGL-RU-SHIP Pt.6 Ch.3 Sec.1 Dynamic positioning systems - DYNPOS and DPS	Sec.1 [1.3] and Sec.1 Table 1	Reference to IMO MCS.1/Circ. 1580 *Guidelines for vessels and units with Dynamic Positioning (DP) Systems* included. Sec.1 Table 1 now indicants how the DNV GL class notations relate to these new IMO guidelines.
	Sec.1 [1.6.7]	d) Failure mode and effect analysis: It is now specified that the identified technical prerequisites for achieving the required failure tolerance and redundancy shall be presented in a collected list. h) Failure mode and effect analysis: More detailed specification of the requirements for separation analysis.
	Sec.1 [1.6.8]	Specification of documentation requirements for the FMEA test program is included.
	Sec.1 [3.7.2]	Improved wording in the guidance note to better clarify the requirements for verification of separation requirements.
	Sec.1 [8.5.4]	Updated guidance note with specification of auxiliary functions which may be accepted to ride through based upon stop and automatic restart/standby start.
	Sec.1 [8.8.3]	New requirement that in case the independent joystick is supplied by UPS, this UPS will have the same monitoring requirements (monitoring by the independent joystick system) as the UPSs supplying the DP control system.
	Sec.1 [9.2.4] and Sec.1 [9.3.1]	Improved wording for accepting normally closed cross over in auxiliary systems belonging to different redundancy groups for **DYNPOS(AUTR)**.
	Sec.1 Table 3	Improvement in the wording for the definition of hidden failure.
DNVGL-RU-SHIP Pt.6 Ch.3 Sec.2 Dynamic positioning systems with enhanced reliability - DYNPOS(E, ER)	Sec.2 [1.5.7]	d) Failure mode and effect analysis: It is now specified that the identified technical prerequisites for achieving the required failure tolerance and redundancy shall be presented in a collected list. h) Failure mode and effect analysis: More detailed specification of the requirements for separation analysis.
	Sec.2 [1.5.8]	Specification of documentation requirements for the FMEA test program is included.

Topic	*Reference*	*Description*
	Sec.2 [3.7.1]	Improved wording in the guidance note to better clarify the requirements for verification of separation requirements.
	Sec.2 [9.3.2]	Improved wording in the specification of power supply arrangement to auxiliary functions.
	Sec.2 Table 2	Improvement in the wording for the definition of hidden failure.
Update of DocReq	Sec.3 Table 3	Documentation types N070 - Wheelhouse poster and N080 - Pilot card for **NAUT(AW)** notation have been changed from approval (AP) to for information (FI).
	Sec.4 Table 2	Documentation types Z161 - Operation manual and Z162 - Installation manual have been updated with information that the documents need only be submitted on request (R).

July 2017 edition

This document supersedes the January 2017 edition of DNVGL-RU-SHIP Pt.6 Ch.3.

Changes July 2017, entering into force 1 January 2018

Topic	*Reference*	*Description*
Alarm transfer	Sec.3 [6.8.2.1]	Inserted "alarm" instead of "alert".
	Sec.3 [6.9.2], Sec.3 [6.9.2.1], Sec.3 [6.9.2.2]	Inserted new number and more detailed requirements for the alarm transfer system as required by Sec.3 [4.2.9].
	Sec.3 [10.2.13.2]	Inserted "alarm transfer system" instead of "BNWAS for initiation of BNWAS 2nd and 3rd stage alarms".
	Sec.5 [4.2.11.7], Sec.5 [4.2.11.8]	Inserted new paragraph and more detailed requirements for the alarm transfer system as required by Sec.5 [4.2.9.9]. Previously un-acknowledged alerts with category A was to be transferred to the accommodation. This has been changed to un-acknowledged "alarms", where un-acknowledged is defined as the announcement state "active-unacknowledged". The un-acknowledged alarms shall be transferred within 30 seconds of the alarm occurrence unless otherwise stated in the performance standards applicable for the equipment
	Sec.5 [6.1.18.3]	Inserted "alarm transfer system" instead of "BNWAS for initiation of BNWAS 2nd and 3rd stage alarms".

January 2017 edition

Main changes January 2017, entering into force 1 July 2017

• Sec.1 Dynamic positioning systems - **DYNPOS** and **DPS**

— Sec.1 Table 4: It is specified that the redundancy design philosophy document shall specify the redundancy groups and dynamic positioning (DP) zone plan with ventilation arrangements.

— Sec.1 Table 4: Electrical load balance calculations are required to include situations representing failure of each redundancy group.
— Sec.1 [1.6.6] and Sec.1 [10]: Requirement for station keeping capability assessment changed from "environmental regularity numbers; ern* calculations" to "Station keeping capability calculations according to new DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*".
— Sec.1 [1.6.7]: Requirements to the vessel DP failure mode and effect analysis (FMEA) is updated to more clearly specify that an FMEA report, containing the updated FMEA and the updated FMEA test program with actual results shall be submitted for information after trials.
— Sec.1 [4.6.1] Guidance note 3: Specification that for column stabilized units, watertight separation will be required below the freeboard deck.
— Sec.1 [4.6.2]: The requirement that watertight separation shall also be provided in areas above the bulk-head deck where large quantity of liquids may occur as a consequence of leakage is moved to a separate rule instead of being a guidance note under the general separation requirement.
— Sec.1 [8.4.1]: One of the functional requirements to power management systems has been changed from "if load dependent stop of running generators is provided, facilities for disconnection of this function shall be arranged" to "it shall be possible to set a minimum number of connected generator sets in each redundancy group".

• Sec.2 Dynamic positioning system with enhanced reliability - **DYNPOS(E,ER)**

— Sec.2 [1.3.2], Sec.2 [1.5.6] and Sec.2 [10]: Requirement for station keeping capability assessment changed from "environmental regularity numbers; ern* calculations" to "Station keeping capability calculations according to new DNVGL-ST-0111 *Assessment of station keeping capability of dynamic positioning vessels*".
— Sec.2 Table 3: It is specified that the redundancy design philosophy document shall specify the redundancy groups and DP zone plan with ventilation arrangements.
— Sec.2 Table 3: Electrical load balance calculations are required to include situations representing failure of each redundancy group.
— Sec.2 [1.5.7]: Requirements to the vessel DP FMEA is updated to more clearly specify that an FMEA report, containing the updated FMEA and the updated FMEA test program with actual results shall be submitted for information after trials.
— Sec.2 [4.2.2]: It is specified that enhanced reliability DP systems shall in general be based on redundancy groups consisting of two or more equally sized generator sets, and with equal number of generator sets in each group. It is specified that other arrangements might be accepted on special request and will be subject to case-by-case evaluation.
— Sec.2 [4.5.3]: Specification that for column stabilized units, watertight separation will be required below the freeboard deck.
— Sec.2 [4.5.4]: The requirement that watertight separation shall also be provided in areas above the bulk-head deck where large quantity of liquids may occur as a consequence of leakage is moved to a separate rule instead of being a guidance note under the general separation requirement.
— Sec.2 [8.3.6]: Rule requirement to battery power and capacity, when batteries are used in combination with stand-by generator sets, are introduced.
— Sec.2 [8.4.2]: One of the functional requirements to power management systems has been changed from "if load dependent stop of running generators is provided, facilities for disconnection of this function shall be arranged" to "it shall be possible to set a minimum number of connected generator sets in each redundancy group".

• Sec.3 Nautical safety **NAUT(OC)** and **NAUT(AW)**

— Sec.3 [6.9]: The requirements for what was previously named bridge alert management system (BAMS) have been updated. The intention is to require a central alert management system compliant with the bridge alert management (BAM) philosophy of IMO as stated in MSC.302(87). In this process previous BAMS requirements have been replaced with requirements for a central alert management system (CAM).

— Sec.3 [6.9]: With reference to the above definitions and document requirements have been added and the testing of BAMS is replaced with procedures for CAM.

• Sec.5 Nautical safety **NAUT(OSV)**

— Sec.5 [4.2.10]: As in Sec.3. The requirements for what was previously named bridge alert management system - BAMS have been updated in a similar way.
— Sec.5 [4.2.10]: The requirement for overlap of window wipers when two sets are used to cover the full height of a window is updated. It is no longer required with an overlap.

July 2016 edition

Main changes July 2016, entering into force 1 January 2017

• Sec.2 Dynamic positioning system with enhanced reliability - **DYNPOS(E,ER)**

— Table 6 - Main switchboard: The erroneous text requiring switchboards to be installed in separate compartments for DYNPOS(E) has been removed.

October 2015 edition

This is a new document.

The rules enter into force 1 January 2016.

Amendments January 2016

• General

— Only editorial corrections have been made.

About DNV GL
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