Rules for Classification and Construction

I Ship Technology

1 Seagoing Ships

15 Dynamic Positioning Systems

Edition 2013

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Alterations to the preceding Edition are marked by beams at the text margin.

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Section 1 General Requirements and Guidance

A Scope and Application

A.1 Scope

A.1.1 These Rules set out GL's requirements for dynamic positioning (DP) systems installed on board ships and mobile offshore units. Depending on the specific dynamic positioning operational requirements the systems are assigned to one of four DP categories (**DP 0** to **DP 3**).

A.1.2 The class notation of the vessel required for a particular operation should be agreed between the owner of the vessel and the client/ charterer based on an analysis of the consequence of a loss of position.

A.2 Application

A.2.1 These Rules apply to dynamically positioned vessels and mobile offshore units covered by the IMO “Guidelines for Vessels with Dynamic Positioning Systems” (MSC/Circ.645).

A.2.2 During the design of the vessel the operating modes and operating conditions are to be considered with regards to redundancy concept and worst case failure design intent.

A.2.3 Designs deviating from the Construction Rules may be approved if they have been tested for suitability and accepted as equivalent by GL.

B Definitions

For the purposes of these Rules the following definitions apply:

B.1 Common mode failure

A failure in which redundancy is defeated because all apparently separate and redundant elements react adversely to a common stimulus.

B.2 Components

B.2.1 Active components or systems are in particular: generators, thrusters, switchboards, remote controlled valves, compensators, hoses, heat exchangers, filters, etc.

B.2.2 Static component are in particular: cables, pipes, manual valves, etc.

B.3 Computer system

A system consisting of one or several computers including software and their interfaces.

B.4 Consequence analysis

A monitoring function in the DP control system that issues an alarm if the vessel (in its current operation mode) in the current weather conditions would not be able to keep the heading and position in the case that the predefined worst case failure should occur.

B.5 Control mode

Possible control modes of a DP-control system may be:

- automatic mode (automatic position and heading control)
- joystick mode (manual position control with selectable automatic or manual heading control)
- auto track mode (considered as a variant of automatic position control, with programmed movement of reference point)
- manual mode (individual control of pitch and speed, azimuth, start and stop of each thruster)

B.6 DP capability analysis

A theoretical calculation and presented as a polar plot of the vessel's capability to keep the position for particular conditions of wind, waves and current from different directions. These should be determined for different thruster combinations, e.g. all thrusters, loss of most effective thrusters, WCF.

B.7 DP control system

All control components and systems, hardware and software necessary to dynamically position the vessel. The DP control system consists of the following:

- computer system / joystick system,
- sensor system, (e.g. motion reference unit, gyro, anemometer)
- display system (operator panels),
- position reference system and
- associated cabling and cable routeing.

B.8 Dynamically positioned vessel (DP vessel)

A unit or a vessel which automatically maintains its position (fixed location or predetermined track) exclusively by means of controlled thrust.

B.9 Dynamic positioning system (DP system)

A DP system consists of components and systems acting together to achieve sufficiently reliable position keeping capability.

The complete installation necessary for dynamically positioning a vessel comprises:

- power system
- thruster system
- DP control system
- independent joystick (not for **DP 0**)

B.10 Failure/fault

The loss of ability to carry out a function within required limits.

B.11 Positioning reference system

All hardware, software and sensors that supply information and/or corrections necessary to give position and heading reference, including its power supply.

B.12 Position keeping

Maintaining a desired position and heading or following a predefined track within the normal excursions or otherwise specified excursions (e.g. in the DP operation manual) of the DP system and under defined environmental conditions.

B.13 Power system

All components and systems necessary to supply the DP system with power. The power system may include:

- prime movers or main and auxiliary engines with necessary auxiliary systems (e.g. fuel-, lubricating oil- , cooling water-, control air systems) including piping,
- generators
- switchboards
- distributing system (cabling and cable routing)
- UPS
- power management for **DP 2** and **DP 3**

B.14 Redundancy

Ability of a component or system to maintain or restore its function immediately or in an acceptable time for the task of the ship, when a single failure has occurred. Redundancy can be achieved for instance by installation of multiple components, multiple systems or alternative means of performing a required function.

B.15 Redundancy concept

The means by which the worst case failure design intent is assured.

B.16 Reliability

The ability of a component or system to perform its required function without failure during a specified period of time.

B.17 Single failure concept

The single failure concept assumes that only one (single) failure is the initiating event for an undesired occurrence. The simultaneous occurrence of independent failures is not considered. However, common mode failures are to be examined.

B.18 Thruster system

All components and systems necessary to supply the DP system with thrust force and thrust direction. The thruster system includes:

- Thrusters with prime movers and necessary auxiliary systems including piping (e.g. lateral thrust systems, rudder propeller)
- Main propellers and rudders if these are under the control of the DP control system
- Thruster control electronics
- Manual thruster controls
- Associated cabling and cable routeing

B.19 Worst case failure (WCF)

The identified single failure mode in the DP system resulting in maximum effect on DP capability as determined through FMEA study.

This worst case failure is used in the consequence analysis. (See Section 2, B.5.2.4).

B.20 Worst case failure design intent (WCFDI)

The worst case failure design intent of a DP system is the single failure that has been the basis of the design and operation conditions. This usually relates to number of thrusters and generators that can simultaneously fail. The WCFDI describes the minimum amount of propulsion and control equipment remaining operational following the WCF.

B.21 Time to teminate

This time is calculated as the amount of time required in an emergency to physically free the DP vessel from its operational activity following a DP abort status and allowing it to be manoeuvred clear and proceed safety.

C Documents for Approval

C.1 Documents to be submitted

The following documents are to be submitted electronically via GLOBE[1] or in paper form in triplicate. GLOBE submission is the preferred option.

Operation manuals specified in C.1.1 shall be submitted in a single set for information only.

C.1.1 General documentation

- Operation description (crane-vessel, pipe laying, drilling, etc.) (For information only)
- Specification of environmental conditions (wind and sea) for DP operation with respective DP capability analysis
- DP operation manual (For information only)
- Test program for factory acceptance test (FAT) for DP control system
- Test program for DP control trial (see Section 3, B.1.1)
- For **DP 3** the local distribution of all DP relevant systems and components in a different coloured arrangement description/ drawing for the related systems.

C.1.2 Documentation for control, safety and alarm systems

- Functional block diagram(s) of the control system(s)
- Functional block diagram(s) of the position reference system(s) and the environmental sensor(s)
- Drawings showing the electrical power supply of all units and the internal power distribution
- Drawings and descriptions of monitoring functions of control, sensor and reference systems
- General bridge arrangement drawings, e.g. control panels, control consoles, location of control station
- List of installed equipment with evidence for type-approval
- For **DP 3** the cableways for the different systems have to be identified in different colours.

C.1.3 Thruster documentation

- Documentation according to the relevant Rules, see D.1.

C.1.4 Electric power system documentation

- Documentation according to the relevant Rules, see D.1.
- Single line diagram for main and auxiliary power supply of DP relevant consumers.

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1 Detailed information about Global exchange (GLOBE) submission can be found on GL's website www.gl-group.com.

- For **DP 2** and **DP 3** a power balance with the following information shall be provided:
  - power demand of the DP system under the specified environmental conditions (wind, wave, current) and after the worst case failure
  - power demand for the supply of the vessel (basic load)

C.2 Redundancy concept

With the classification contract for **DP 2** and **DP 3** the following DP operation related information has to be provided:

A redundancy concept document (FMEA of basic design) with worst case failure design intent.

This should include the following information:

- General arrangement (For information only)
- Power plant configuration for DP operation (DP2 or DP3-Mode)
- Permissible number of failed thrusters
- Required power sources for DP operation and permissible loss of power sources after one failure.
- Percentage of remaining main power after worst case failure
- Definition of time period for safely terminating a DP operation.

C.3 Failure mode and effect analysis (FMEA)

C.3.1 A failure mode and effect analysis (FMEA) concerning availability of the DP system after a single failure shall be provided for the class notations **DP 2** and **DP 3** for the desired DP 2 or DP 3 power plant configuration.

The DP FMEA shall be performed, based on IMCA[2] M 166, 178, IEC 60812 or equivalent, according to common DP FMEA industrial requirements.

C.3.2 The results of the FMEA shall be verified during FMEA proving trials.

C.3.3 The relevant test program for the FMEA proving trial has to be provided for approval.

C.4 Documents to be kept on board

When a vessel is commissioned or following major modifications and additions to the electrical and machinery installations, the documents listed in C.1. which show the final arrangement of the system are to be supplied on board.

The FMEA report as well as the DP proving trials report and DP annual trials reports shall be available on board. The DP FMEA shall be kept up to date to cover modifications to the DP system hardware or software.

D Further Rules and Standards to be Considered

D.1 GL Rules and Guidelines

The following GL Rules shall apply in conjunction with these Rules:

- I – Ship Technology, Part 1 – Seagoing Ships
  Chapter 2 – Machinery Installations
  Chapter 3 – Electrical Installations

2 IMCA - International Marine Contractors Association

- IV – Industrial Services, Part 6 – Offshore Technology
  Chapter 5 – Machinery Installations
  Chapter 6 – Electrical Installations

D.2 National Regulations

National regulations remain unaffected.

D.3 International Regulations and Codes

IMO “Guidelines for Vessels with Dynamic Positioning Systems” (MSC/Circ. 645).

E Classification and Class Notations

E.1 Classification

The provisions in the Rules for Classification and Surveys (I-0), Section 2 apply.

E.2 Characters of Classification and Notations

E.2.1 Ships equipped with dynamic positioning systems which comply with these Rules will have one of the following Notations affixed to the Character of Classification:

- **DP 0**
- **DP 1**
- **DP 2**
- **DP 3**
- **DP 3 (DP 2)**
- **DP 2 (ICE)**
- **DP 3 (ICE)**

Installations for these Class Notations have to comply with the requirements laid down in F.2 and Section 2 or Section 4.

E.2.2 For ships which allow different DP operating configurations a Class Notation **DP 3 (DP 2)** is possible. For this notation all respective requirements in Section 2 have to be fulfilled and documented independently for both Class Notations, **DP 2** and **DP 3**. Other configurations have to be agreed case by case with GL.

E.2.3 When the DP control system is tested with a special "hardware-in-the-loop" test (during FAT and on board) a respective entry in the Technical File of the Class Certificate is possible.

E.2.4 DP systems which exceed the requirements for Class Notation **DP 2** or **DP 3** (e.g. separate fuel-, cooling water for each diesel engine) a respective entry in the Technical File of the Class Certificate is feasible.

E.3 Surveys for maintenance of class

The provisions in the Rules for Classification and Surveys (I-0), Sections 3 and 4 and in Section 3 of these Rules apply.

F Basic Technical Requirements and Guidance

F.1 Environmental conditions

F.1.1 The environmental conditions and operational modes for the intended DP operation shall be defined by the owner /operator (e.g. included in the building specification or DP capability analysis).

The period for terminating safely a DP operation after a single failure should be specified by the owner /operator, if possible.

F.2 Basic requirements

F.2.1 For class notation **DP 0**, loss of position may occur in the event of a single fault.

F.2.2 For class notation **DP 1**, loss of position may occur in the event of a single fault. The redundancy requirements acc. to Section 2, Table 2.1 are to be fulfilled.

F.2.3 For class notation **DP 2**, a loss of position shall not occur in the event of a single fault in any active component or system. Static components will not be considered to fail where adequate protection from damage is demonstrated and reliability is deemed acceptable by GL.

F.2.4 For class notation **DP 3**, a loss of position shall not occur in the event of a single fault in any active or static component or system.

This applies also for the total failure of one compartment due to fire or flooding.

F.2.5 For class notations **DP 2** and **DP 3**, a single inadvertent action shall be considered as a single fault, if such an action is reasonably probable.

F.2.6 For class notation **DP 2 (ICE)** and **DP 3 (ICE)** the additional requirements are stated in Section 4.

Section 2 DP System Requirements

A Functional Requirements

A.1 Ships with class notation **DP 0** are able to keep their position at least in automatic mode (Section 1, B.5)

A.2 Ships with class notation **DP 1** are able to keep their position at least in automatic mode and joystick mode.

A.3 Ships with class notation **DP 2** fulfil the requirements of **DP 1** and are able to keep their position after a single failure (Section 1, B.17) in an active component.

Static components will not be considered to fail where adequate protection from damage is demonstrated and reliability is to the satisfaction of GL.

A.3.1 Redundant components and systems shall be available with such capacity that the DP operation can be continued for such a period that the work in progress can be terminated safely.

A.3.2 The transfer to the redundant component or system shall be automatic and within acceptable limits of the DP operation.

A.4 Ships with class notation **DP 3** fulfil the requirements of **DP 2** and are able to keep their position after a single failure (Section 1, B.17) in an active or static component. This applies also for the total loss of the equipment in one compartment due to fire or flooding.

A.4.1 Class divisions between spaces for redundant components have to withstand a fire related to the fire load in the respective spaces. The minimum class divisions between e.g. machinery spaces category A are A-60.

A.4.2 If the spaces are below the operational waterline; the separation shall also be watertight.

A.4.3 DP systems shall be arranged in such a way that in the event of damage to one system by fire or flooding, systems intended to provide redundancy will not be affected.

A.5 In order to meet the single failure criteria given in Section 1, B.17, redundancy of components will normally be necessary as follows:

- For class notation **DP 2**, redundancy of all active components.
- For class notation **DP 3**, redundancy of all active and static components and physical separation of DP relevant systems.

A.6 The failure or not availability of redundant components or systems shall be revealed by alarms and where this is not possible periodic testing may be accepted. (e.g. DP redundancy reduced)

A.7 The possibility of hidden failures shall be minimized (e.g. periodical testing).

A.8 The transfer of failures between redundant subsystems shall be prevented.

A.9 An operational DP system is one that is able to reliably keep a vessel in position when working up to the defined environmental conditions, such that the maximum excursion from the vessel motions (surge, sway and yaw) and the position control system accuracy is equal to, or less than, half the critical excursion for the work being carried out (standby redundancy).

B System Configuration

B.1 General

B.1.1 The requirements for the DP-system configuration for the different class notations are shown in Table 2.1.

B.1.2 Specific requirements for the subsystems and components are mentioned under the following paragraphs. Unless otherwise stated, the requirements are applicable to all class notations.

B.2 Power system

B.2.1 The power system shall have an adequate response time to load changes. I.e. the cyclic variations tolerance of frequency caused by regularly repeated loading during DP operation shall not exceed 0,5 % in frequency cyclic variation (See IEC 60092-101 sub-clause 2.8).

Table 2.1 Minimum requirements for DP systems

Subsystem or component			Minimum requirements for Class Notation				
			DP 0	DP 1	DP 2	DP 3	
Power system	Generators and prime mover		–		Redundant	Redundant, separate compartments	
	Main switchboards		1		2	2 in separate compartments	
	Bus-tie breaker between busbar sections		–		2 NO [1]	2 NO	
	Distribution system		–		Redundant	Redundant, through separate compartments	
	Power management (see B.2.5)		–		Redundant	Redundant, separate compartments	
	UPS for DP control system		–	1	2	2+1 in separate compartments	
Thruster system	Arrangement of thruster		–		Redundant	Redundant, separate compartments	
DP-relevant Auxiliary Systems					Redundant [2]	Redundant, separate compartments, provided WCF is not exceeded	
DP-Control system	No. of computer systems		1		2	2+1 in separate compartments	
	Independent joystick with auto heading		–	1	1	1	
Sensors	Position reference systems		1	2	3	3 whereof 1 connected to back-up control system	
	Vessel's sensors	Wind	1		2	2	One of each connected to back-up control system
		VRS	1		3	3	
		Gyro	1		3 [4]	3	

Essential non-DP systems [3]	–	Redundant	Redundant, separate compartments
Printer	Yes	Yes	Yes

1 NC bus-tie breakers may be accepted depending on the findings of the FMEA and additional testing (e.g.: ride-through capability for thruster and auxiliaries) (NO = normally open, NC = normally closed)

2 when active components are used

3 see B.6

4 One of the 3 required gyros may be replaced by a heading 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)

B.2.2 For class notation **DP 0** and **DP 1** the power system shall fulfil the class requirements (see Rules for Machinery Installations (I-1-2) and Electrical Installations (I-1-3)).

B.2.3 For class notation **DP 2** and **DP 3**, the power system shall be subdivided into two or more subsystems such that in the event of failure of one subsystem at least one other subsystem will provide enough power for the DP operation in the defined environmental conditions in Section 1, C.1.1. The power resulted from the load balance acc. Section 1, C.1.4 shall be available after any single failure.

B.2.4 For class notation **DP 3**, the divided power systems shall be located in different spaces separated by A-class divisions depending on fire load.

B.2.5 Where permanent parallel operation of the generator sets is required for DP operation, a power management system shall be installed. Adequate redundancy and reliability shall be demonstrated. Load steps associated with the loss of a supplying generator (acc. redundancy concept) shall be in accordance with the Rules for Electrical Installations (I-1-3), Section 3, B.3.5. Load steps associated with the opening of a normally closed bus tie breaker shall be taken into account as well.

B.2.6 For class notation **DP 3** at least two physically separated systems shall be provided for DP operation.

B.3 Thruster system

B.3.1 The thruster system shall provide adequate thrust in longitudinal and lateral directions and yawing moment for heading control.

B.3.2 For class notations **DP 2** and **DP 3**, the thruster system shall be connected to the power system in such a way to meet the requirements of B.3.1 after worst case failure.

Note

A fail safe design let the thrust in a failure event in a safe condition, as e.g.

- *fail as set (freeze)*
- *fail to zero thrust*
- *trip drive motor or engine*

B.3.3 The values of thruster force used in the consequence analysis (see B.5.2.4) shall be corrected for interference between thrusters and other effects which would reduce the effective force.

B.3.4 A failure of the thruster system, including pitch, azimuth or speed control, shall not result in unintended operation of pitch, speed and direction.

B.3.5 For class notations **DP 2** and **DP 3**, the emergency stop function shall be equipped with line monitoring for each thruster and shall be located at the DP control station.

Where auxiliary energy is required for the function of safety devices, this has to be monitored and a failure has to be alarmed.

B.3.6 The thrust system has to be designed for continuous operation.

B.4 DP relevant auxiliary systems for DP 2 and DP 3 (acc. Table 2.1)

B.4.1 Auxiliary systems whose function have a direct effect on the power and thruster system, for example fuel, lubrication oil, cooling water, control air and uninterrupted power supply systems, shall be provided for each power and thruster system independently of each other with suitable standby units in a manner that supports the worst case failure design intent.

B.4.2 Auxiliary systems whose failure does not have a direct effect on the power and thruster system, such as fuel treatment, starting air supply systems etc. are to be designed to be separate from each other. For these systems no additional standby units have to be provided if interconnection lines are provided between the systems and if the units are designed so that the power and thruster system can be supplied with power and thrust simultaneously without restriction. In the connection lines shut-off valves are to be provided which shall be kept closed during DP operation.

On ships with class notation **DP 3** a shut-off valve shall be fitted on either side of the partition bulkhead between the machinery compartments.

B.4.3 In heavy fuel oil systems, the heating facilities for preheating the fuel oil shall be designed in such a way that if one power and thruster system fails, the required preheating of the fuel oil for the redundant power and thruster system is ensured.

It is not necessary to provide a redundant heating facility if diesel oil storage tanks are provided which allow unrestricted operation for the redundant power and thruster system for the period of time specified in Section 1, C.1.1.

B.4.4 Supply lines from fuel oil service tanks of redundant systems shall be provided with an interconnection fitted between service tank and pump of each system. The interconnection is to be provided with a shut-off device, which shall be kept closed during normal operation.

On ships with class notation **DP 3**, a shut-off valve shall be fitted on either side of the partition bulkhead between the machinery compartments.

B.4.5 The seawater supply of redundant systems may be achieved via a common sea chest connection by means of a pump assigned to each system. The systems shall be capable of being isolated by means of a shut-off valve in the connection line.

On ships with class notation **DP 3**, the sea chests are to be installed in separate compartments. The shut-off valve in the connection line shall be fitted to the partition bulkhead and be capable of being operated either from both machinery compartments or from a position outside the machinery compartments.

On ships which ice class notation, the seawater cooling systems shall be designed so that if one seawater cooling system fails it is possible to operate the redundant power and thruster system when the ship is operating in ice conditions, see also Section 4.

B.4.6 For class notation **DP 3**, redundant piping systems (i.e. piping for fuel, cooling water, lubrication oil, hydraulic oil, etc.) shall not be routed together through the same compartments. Where this is not practicable, such pipes may run together in ducts of A-60 class including duct ends, which are effectively protected from all fire hazards, except those originating from the pipes themselves.

B.4.7 For class notation **DP 3**, cables for redundant equipment or systems shall not be routed together through the same compartments.

B.5 DP control system

B.5.1 General

B.5.1.1 In general, the DP control system shall be arranged in a DP control station from where the operator has a good view of the vessel's exterior limits and the surrounding areas, where such view is necessary for the safe conduct of the main activity of the vessel.

B.5.1.2 The DP control station shall display information from the power system, thruster system, and DP control system. Information necessary to operate the DP system safely shall be always visible. Other information shall be available upon operator request.

B.5.1.3 Display systems and the DP control station in particular, shall be based on ergonomic principles. The DP control system shall provide means for easy selection of the control mode, i.e. manual, joystick, or computer control of thrusters. The active mode shall be clearly displayed.

B.5.1.4 For class notations **DP 2** and **DP 3**, operator controls shall be designed so that no single inadvertent action on the operators' panel may lead to a critical condition.

B.5.1.5 Failure of systems interfaced to and/or controlled by the DP control system shall initiate an audible and visual alarm. Their occurrence and status shall be recorded together with alarm text which clearly identifies the fault.

B.5.1.6 The DP control system shall prevent failures transferred from one subsystem to another. The redundant components shall be so arranged that a failure of one component shall be isolated.

B.5.1.7 The manual control of the thrusters with the respective lever shall be possible after a failure of the complete DP control system.

B.5.1.8 The software shall be developed in accordance with GL Rules for Electrical Installations (I-1-3), Section 10 “Computer Systems” or with an appropriate international quality standard recognized by GL.

B.5.2 Computer systems

B.5.2.1 For class notation **DP 0** and **DP 1**, the DP control system need not to be redundant.

B.5.2.2 For class notation **DP 2**, the DP control system shall consist of at least two independent computer systems. Common facilities, such as self-checking routines, data transfer arrangements and interfaces, shall not cause the failure of all systems.

B.5.2.3 For class notation **DP 3**, the DP control system shall consist of at least two independent computer systems with self-checking and alignment facilities. Common facilities, such as self-checking routines, data transfer arrangements and interfaces, shall not cause failure of all systems. In addition, one back-up DP control system shall be arranged, see B.5.2.6. An alarm shall be initiated if any computer fails or is not ready for operation.

B.5.2.4 For class notations **DP 2** and **DP 3**, the DP control system shall include a software function, normally known as 'consequence analysis', which continuously verifies that the vessel will remain in position even after worst case failures occur.

This analysis shall verify that the thrusters remaining in operation after the worst case failure can generate the same resultant thruster force and direction as required before the failure. The consequence analysis shall generate an alarm if the occurrence of a worst case failure would lead to a loss of position due to insufficient thrust for the prevailing environmental conditions.

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

B.5.2.5 Redundant computer systems shall be arranged with automatic transfer of control after a detected failure in one of the computer systems. The automatic transfer of control from one computer system to another shall be smooth and within the acceptable limitations of the operation.

B.5.2.6 For class notation **DP 3**, the back-up DP control system shall be located in a room separated by A-60 class divisions from the main DP control station. During DP operation this back-up control system shall be continuously updated by input from the sensors, position reference systems, thruster feedback, etc., and shall be ready to take over control. The switch-over of control to the back-up system shall be manual, situated on the back-up computer and shall not be affected by any failure of the main DP control system.

B.5.2.7 An uninterruptible power supply (UPS) shall be provided for each DP computer system to ensure that any power failure will not affect more than one computer and connected sensors. UPS battery capacity shall provide a minimum of 30 minutes operation following a mains supply failure. See also GL Rules for Electrical Installations (I-1-3), Section 4, I.7 (not for **DP 0**).

An alarm shall be initiated in the DP control system for loss of supply power (charger input) and UPS on bypass power.

B.5.2.8 Non-redundant connections between usually redundant and separated systems may be accepted for class notation **DP 2** and **DP 3**, provided that it is shown to give clear safety advantages, and that their reliability is demonstrated and documented. Such connections shall be kept to a minimum and made to fail to the safest condition. Failure in one system shall in no case be transferred to the other redundant system.

B.5.3 Position reference systems

B.5.3.1 Position reference systems shall be selected with due consideration to operational requirements, both with regard to the restrictions caused by the manner of deployment and expected performance for the operating conditions.

B.5.3.2 For class notations **DP 2** and **DP 3**, at least three position reference systems shall be installed and simultaneously available to the DP control system during operation. One failure shall only lead to the loss of one position reference system.

B.5.3.3 If two or more position reference systems are required, they shall be based on different principles and suitable for the operating conditions.

Each system shall be independent in view of power, signal transmission and interfaces.

B.5.3.4 The position reference systems shall provide data with adequate accuracy for the intended DP operation.

B.5.3.5 The performance of any position reference systems shall be monitored and warnings shall be provided, if the signals from the position reference systems are either incorrect or substantially degraded.

B.5.3.6 For class notation **DP 3**, at least one of the position reference systems shall be connected directly to the back-up control system and separated by A-60 class divisions from the other position reference systems.

B.5.4 Sensor systems

B.5.4.1 Vessel's sensors shall at least measure vessel's heading, vessel's motions and wind speed and direction.

B.5.4.2 If, for a class notation **DP 2** or **DP 3**, the DP control system is fully dependent on correct signals from vessel's sensors, these signals shall be based on three systems serving the same purpose.

B.5.4.3 Sensors for the same purpose, connected to redundant systems, shall be arranged independently so that failure of one will be alarmed and does not affect the others.

B.5.4.4 For class notation **DP 3**, one of each type of sensors shall be connected directly to the back-up control system and separated by A-60 class division from the other sensors.

B.5.5 Independent Joystick (not for DP 0)

B.5.5.1 It shall be possible to control the thrusters manually by an independent joystick in the event of failure of the DP control system.

B.5.5.2 The independent joystick shall be independent of the DP control network and power system. When the complete DP control system fails it must be possible to take command at a main control station.

B.5.5.3 A failure of the independent joystick shall be alarmed.

B.5.6 Important voice communication

A means of communication shall be provided between the DP control positions, the navigational bridge, the engine control room and other for the DP operation important control positions (e.g. diver control, ROV-control).

B.5.7 DP alert system

A DP alert system should be provided at the same positions acc. to B.5.6 with coloured lights and audible alarms, which indicates the status of the DP system.

B.6 Requirements for essential non-DP systems

For class notations **DP 2** and **DP 3**, systems not directly part of the DP system but which in the event of failure could cause failure of the DP system (e.g. common fire suppression systems, engine ventilation systems, shut-down systems, pipe-lay, crane and drilling power systems), shall also comply with the worst case failure design intent.

Note

Detailed requirements will result from the FMEA of the non-DP systems for the total system.

Section 3 Surveys and Tests

A Factory Acceptance Test (FAT)

Before a new installation is surveyed and tested as specified in B. factory acceptance tests according to Section 1, D.1 shall be carried out at the manufacturer's works. These tests based on the approved test program as required in Section 1, C.1.1 shall demonstrate compliance with the redundancy concept, if applicable. GL may require, depending on the DP class notation, full integration tests of all hardware components, including fault simulation. For class notation **DP 2** and **DP 3** this may be required for power management systems, drive control systems, DP control systems, etc.

B Surveys and Tests

B.1 Each DP vessel is subject to surveys and testing specified below:

B.1.1 Newbuilding survey, which shall include a complete survey of the DP system to ensure full compliance with the rules.

This survey includes a complete test of all DP relevant systems and components (DP control trial).

Tests of the installations according to the requirements of GL Rules (see Section 1, D.1), including:

- Testing of the alarm system and switching logic of the DP control measuring system (sensor, peripheral equipment and reference system)
- Functional tests of control and alarm systems of each thruster in the DP control system
- Tests of the complete DP system (all operational modes, back-up system, joystick system, alarm system and manual override)
- Change of command between DP control system, independent joystick system and individual thruster lever system shall be demonstrated
- Manual override shall be demonstrated during normal operation and failure conditions
- Emergency stop function shall be demonstrated. For **DP 2** and **DP 3** the line monitoring shall be verified.
- Testing of UPS battery capacity (30 min.) and verification of alarms acc. Section 2, B.5.2.7.
- Positioning shall be performed on all possible combinations of position reference systems and on each reference system as a single system
- Accuracy verification of position reference systems (offset). The offset inputs in the DP control system for each position reference system and relevant sensors should be verified and demonstrated to the attending surveyor. The inputs should fit with the actual placing of the respective equipment.
- Failure in the thruster system (pitch, azimuth, speed) shall not result in unintended operation of the thruster. For **DP 0** and **DP 1** this shall be verified during sea trial to the satisfaction of the attending surveyor. (See Section 2, B.3.4)

An endurance trial shall be conducted with full system operation for at least 4 hours without significant alarms of the DP system. The environmental conditions shall be such that the function of the DP system under load conditions can be demonstrated.

For all thruster systems under DP control a heat run test shall be carried out until steady state temperatures have been reached.

Verification of redundancy and independence of the DP system shall be demonstrated for class notations **DP 2** and **DP 3** with a DP FMEA proving trial.

This trial shall be based on the approved program as required in Section 1, C.3. The verification tests shall be based on the simulation of failures and shall be performed under as realistic conditions as practicable.

GL reserves the right to add further tests for the verification of FMEA.

For **DP 0** the scope of tests may be adapted.

B.1.2 Periodical surveys, at intervals not exceeding five years shall be carried out, to ensure full compliance with the applicable parts of the Rules. A complete test program shall be carried out as required by B.1.1.

B.1.3 Annual surveys shall be carried out within three months before or after each anniversary date of the initial survey. The annual survey shall ensure that the DP system has been maintained in accordance with the applicable parts of the rules and is in good working order. Further an annual test of all important systems and components shall be carried out to document the ability of the DP vessel to keep position after single failures associated with the assigned class notation. DP annual trials shall be available on board and documented by attending Surveyor.

B.1.4 The documented evidence of the satisfactory condition of the DP system may be accepted by GL HO.

For **DP 0** this annual trial is optional.

B.1.5 Repair/alteration surveys

A survey, either general or partial depending on the extend of the repair or alteration, shall be made at any time a defect is discovered and corrected or an accident has occurred which affects the safety of the DP vessel, or whenever any significant repairs or alterations are made. After such a survey, tests shall be carried out as necessary to demonstrate full compliance with the applicable provisions of the Rules (see B.1.1)

Note

Major alterations might be:

- *Installation of new position reference systems*
- *Modifications and extensions of power and thrusters system*
- *Software modifications*
- *Structural modifications*

B.2 The surveys and tests shall be carried out in the presence of a GL Surveyor. GL may entrust the owner of the vessel to carry out annual and minor repair surveys according to a test programme accepted by GL.

B.3 After completion of any survey and test, no significant change shall be made to the DP system without the approval of GL, except the direct replacement of equipment and fittings for the purpose of repair or maintenance.

Section 4 Requirements for Dynamic Positioning Systems in Managed Ice Conditions

A Scope and Application

These Rules apply for ships with a DP-Class notation **DP 2** or **DP 3** and an Ice Class Notation of **E1** to **E4** or **PC7** to **PC1**. The dynamic positioning shall be performed in managed ice only.

B Definitions

Managed ice:

Natural ice floes, drifting ridges, etc. will be broken into smaller pieces which size complies with the defined requirements in the capability report.

C Documents for Perusal

C.1 A document defining the purpose of the ship and the expected ice and weather conditions has to be submitted.

C.2 Ice management procedure has to be provided including floe size, alert times for operations, etc.

C.3 The DP capability against managed ice has to be submitted in form of a model test report or by a recognized calculation.

This includes the turning of the ship according to F.8.3.

D Further Rules and Standards to be considered

GL Guidelines for the Construction of Polar Class Ships (I-1-22)

GL Rules for Hull Structures (I-6-1), Section 15

GL Rules for Machinery and Systems (I-6-2), Section 19

E Classification and Class Notation

In addition to the class notation **DP 2** or **DP 3** the appendix **(ICE)** is added, if the ship complies with the requirements of this section.

- **DP 2 (ICE)**
- **DP 3 (ICE)**

F Additional Technical Requirements and Guidance

F.1 Main DP Systems

In addition to the requirements for the intended ice class and DP class notation the following shall be observed.

F.1.1 Systems essential for DP operation shall be protected from the harmful effects of ingestion or accumulation of ice or snow. Where continuous operation is necessary, means shall be provided to purge the system of accumulated ice or snow.

F.1.2 For operation in ice the equipment is necessary to comply with the requirements of the respective DP Class Notation and the Rules for Machinery and Systems (I-6-2), Section 19.

F.1.3 Azimuth thrusters shall be designed accordingly.

F.1.4 Engines are to be capable of running with the propeller in bollard condition.

F.1.5 Positioning reference systems shall be appropriate to the expected environmental conditions.

F.2 Auxiliary Systems

F.2.1 Suitable material for low temperatures shall be used for the pipes, valves and fittings which are exposed to sea water or cold air.

F.2.2 Vent pipes, intake and discharge pipes and associated systems shall be designed to prevent blockage due to freezing or ice and snow accumulation.

F.2.3 Means shall be provided to prevent freezing or salification of pipes where necessary, e.g. by trace heating.

F.2.4 Systems subject to freezing shall be drainable.

F.2.5 Additional heating of lube oil may be needed for equipment located in separate machinery spaces (e.g. bow thruster).

F.2.6 Transverse thrusters shall be designed to avoid self destruction in case the propeller is blocked by ice.

F.2.7 Transverse thrusters used for DP shall be protected against ice accumulation. A reversion of the jet direction shall be considered. The dimensioning of grids shall be performed according to GL Rules for Hull Structures (I-1-1), Section 15, B.8

F.2.8 Battery rooms relevant for DP operation, have to be heated to a temperature of $0\ °C$ at minimum.

F.2.9 Special consideration with regards to the heating of DP relevant systems shall be evaluated in the DP FMEA.

F.3 Sea inlets and cooling water systems

F.3.1 Cooling water systems for machinery installations that are essential for the propulsion and safety of the ship, including sea chest inlets, shall be designed for the environmental conditions applicable to the ice class and intended operation.

F.3.2 At least one sea chest is to be arranged as ice box (sea chests for water intake in severe ice conditions) located preferably near centre line. The calculated volume for the ice box shall be at least $1\ m^3$ for every $750\ kW$ of the totally installed power.

F.3.3 Ice boxes are to be designed for an effective separation of ice and venting of air.

F.3.4 Sea inlet valves are to be connected directly to the ice box.

F.3.5 Ice boxes and sea bays are to have vent pipes and are to have shut off valves connected directly to the shell.

F.3.6 Efficient means are to be provided to re-circulate cooling seawater to the ice box. Total sectional area of the circulating pipes is not to be less than the area of the cooling water discharge pipe.

F.3.7 Detachable gratings or manholes are to be provided for ice boxes. Manholes are to be located above the deepest load line. Access is to be provided to the ice box from above. Access hatches may be used instead of manholes.

F.3.8 Openings in ship sides for ice boxes are to be fitted with gratings, or holes or slots in shell plates. The net area through these openings is to be not less than 5 times the area of the inlet pipe. The diameter of holes and width of slot in shell plating is to be not less than 20 mm. Gratings of the ice boxes are to be provided with means of clearing.

F.3.9 Other cooling systems may be accepted, provided that it can be demonstrated how a continuous cooling can be performed independent from worst weather and ice conditions.

F.4 Ballast and other tanks

F.4.1 Efficient means are to be provided to prevent freezing in fore and aft peak tanks, wing tanks, ballast tanks located above the water line and any other tanks where found necessary.

F.4.2 Fresh water, ballast, fuel & lube oil tanks shall be carefully located and fitted with heating facilities where found necessary.

F.4.3 Heating facilities may be needed also for further tanks (e.g. tanks for sludge, leakage, bilge water, sewage, etc.), depending on location and media.

F.5 Ventilation system

F.5.1 The temperature of combustion air is to be suitable for the operation of the machinery. If direct ducting to the engines is provided, own heating facilities shall be considered.

F.6 Conventional Rudders

F.6.1 Rudder stops are to be provided and integrated into the hull. The design ice force on rudder shall be transmitted to the rudder stops without damage to the steering system.

Ice horn shall in general be fitted to protect the rudder in centre position. Design shall be performed according to GL Guidelines for the Construction of Polar Class Ships (I-1-22), Section 2, O.

F.6.2 The effective holding torque of the rudder actuator, at safety valve set pressure, has to be sufficient for the intended operation of the ship.

The design pressure for calculating the scantlings of piping and other steering gear components subjected to internal hydraulic pressure shall be at least 1.25 times the set pressure of the safety valves, but not less than the design pressure according to GL Rules for Machinery Installations (I-1-2), Section 14, A.4.1.

The fast acting relieve system shall not allow to cause more than 50 % increase of pressure above the set pressure of relief valves due to a too slowly acting pressure release system. In some cases, a fast acting relief valve with typically 10 milliseconds response time, or a bursting disc, will be needed.

If the specified angular velocity results in an increase in pressure of greater than 50 % due to constriction of hydraulic flow, means shall be provided to allow for an improved flow. In some cases a dump tank for the hydraulic fluid may be required.

F.7 Clutches

Clutches shall have a static friction torque of at least 1.3 times the peak torque Q_{peak} and a dynamic friction torque of 2/3 of the static one.

F.8 Operational aspects

F.8.1 Ice Monitoring

Suitable systems for ice monitoring shall be provided for the intended DP operation in order to react in advance of a sudden increase of ice force from any direction.

Ice drift information has to be available.

F.8.2 DP Control

DP Control shall be quick enough for the intended operation and in addition to Section 2, B.5.3 suitable for cold climate condition.

F.8.3 Optimal Heading

The ship shall be able to turn in a more favourable position relative to the ice drift in order to minimize the ice resistance in case of larger ice forces (bigger pieces).

G Post Failure Recommendations

G.1 Clutches

Emergency operation of the clutch after failure, e.g. loss of operating pressure, should be established within a reasonably short time. If this is arranged by bolts, they should be situated on the engine side of the clutch in order to ensure access to all bolts by turning the engine.

G.2 Emergency power units

Provisions should be made for heating arrangements to ensure ready starting of the cold emergency power units at expected low ambient temperature.

Emergency power units should be equipped with starting devices with a stored energy capability of at least three consecutive starts at the above mentioned temperature. The source of stored energy should be protected to preclude critical depletion by the automatic starting system, unless a second independent mean of starting is provided. A second source of energy should be provided for an additional three starts within 30 min., unless manual starting can be demonstrated to be effective.

G.3 Propulsion engines

G.3.1 Engines should be capable of being started with the CP propeller in blocked condition.

G.4 Getting stuck in ice

An action plan should be provided, how a trapping in ice is avoided, if e.g. no current and waves are present and low temperatures freeze the water next to the ships hull.

H Additional Tests

Depending on findings in the FMEA or during the DP proving trials additional tests for verification may be required for the respective DP notation.