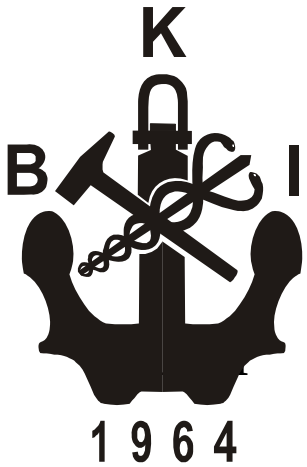
# BIRO KLASIFIKASI INDONESIA




## RULES FOR
## DYNAMIC POSITIONING SYSTEMS

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# Table of Contents

# Section 1

# General Requirements and Guidance

## A. Scope and Application

### 1. Scope

**1.1** These Rules set out BKI'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 1 (one) of 4 (four) DP Categories (**DP 0** to **DP 3**).

**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.

### 2. Application

**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).

**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.

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

## B. Definitions

For the purposes of these Rules the following definitions apply:

### 1. Common mode failure

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

### 2. Components

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

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

### 3. Computer system

A system consisting of 1 (one) or several computers including software and their interfaces.

### 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.

### 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)

### 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 (Worst Case Failure).

### 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.

**8. Dynamically Positioned (DP) vessel**

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

**9. Dynamic Positioning (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

**10. Failure/fault**

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

**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.

**12. Position keeping**

Maintaining a desired position and heading or following a predefined track within the critical excursions or otherwise the specified excursions as specified in the DP operation manual of the DP system and under the defined environmental conditions.

**13. Power system**

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

– 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 routeing)

– UPS

– power management for **DP 2** and **DP 3**

**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 function.

**15. Redundancy concept**

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

**16. Reliability**

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

**17. Single failure concept**

The single failure concept assumes that only 1(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.

**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

**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).

**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.

## C. Documents for Approval

**1. Documents to be submitted**

For 1.1 to 1.5. below the documents are to be submitted in triplicate.

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

### 1.1 General documentation

- Operation description (crane-vessel, pipe laying, drilling, etc.)
- Specification of environmental conditions (wind and sea) for DP operation
- 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.

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
- Percentage of remaining main power after worst case failure
- Power plant configuration for DP operation
- Permissible number of failed thrusters
- Required power sources for DP operation and permissible loss of power sources after one failure.
- Definition of time period for safely terminating a DP operation after a single failure.

### 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
- For **DP 3** the cableways for the different systems have to be identified in different colours.
- 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

### 1.3 Thruster documentation

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

### 1.4 Electric power system documentation

- Documentation according to the relevant Rules, see D.1.
- 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 under the worst case failure
  - power demand for the supply of the vessel (basic load)

### 1.5 Failure Mode and Effect Analysis (FMEA)

A failure mode and effect analysis concerning availability of the DP system after a single failure shall be provided for the Class Notations **DP 2** and **DP 3**.

The DP FMEA shall be performed, based on~~,~~ IEC 60812 or equivalent, according to common DP FMEA industrial requirements.

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

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

### 2. 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 1. which show the final arrangement of the system are to be supplied on board.

## D. Further Rules and Standards to be Considered

### 1. Rules and Guidelines

The following Rules shall apply in conjunction with these Rules:

- Rules for the Classification and Construction of Seagoing Steel Ships :
  - Rules for Machnery Installations, Volume III
  - Rules for Electrical Installations, Volume IV
- Rules for the Classifcation and Contruction of Offshore Installations :
  - Volume 4, Rules for Machinery Installations
  - Volume 5, Rules for Electrical Installations

### 2. National Regulations

National Regulations remain unaffected.

### 3. International Regulations and Codes

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

## E. Classification and Class Notations

### 1. Classification

The provisions in the Rules for the Classification and Surveys, Volume I, Section 2 apply.

### 2. Characters of Classification and Notations

**2.1** Ships equipped with dynamic positioning systems which comply with these Rules will have 1 (one) of the following Notations affixed to the Character of Classification:

– **DP 0**

– **DP 1**

– **DP 2**

– **DP 3**

– **DP 3 (DP 2)**

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

**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 BKI.

**2.3** If the DP control system 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.

**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 possible.

### 3. Surveys for Maintenance of Class

The provisions in the Rules for Classification and Surveys, Volume I, Sections 3 and 4 and in Section 3 of these Rules apply.

## F. Basic Technical Requirements and Guidance

### 1. Environmental conditions

**1.1** The environmental conditions and operational modes for a DP operation shall be defined by the owner /operator (e.g. specification, DP capability analysis). The period for terminating safely a DP operation after a single failure shall be specified by the owner /operator.

### 2. Basic requirements

**2.1** For Class Notation **DP 0**, loss of position may occur in the event of a single fault.

**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.

**2.3** For Class Notation **DP 2**, a loss of position may 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 BKI.

**2.4** For Class Notation **DP 3**, a loss of position may 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 1(one) compart- ment due to fire or flooding.

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

# Section 2

# DP System Requirements

## A. Functional Requirements

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

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

**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 BKI.

**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.

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

**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 1 (one) compartment due to fire or flooding.

**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 are A-0 and with fire load A-60.

**4.2** If the spaces are below the operational waterline, the separation shall also be watertight.

**4.3** DP systems shall be arranged in such a way that in the event of damage to 1 (one) system by fire or flooding, systems intended to provide redundancy will not be affected.

**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.

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

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

**8.** The transfer of failures between redundant subsystems shall be prevented by physical separation or protective functions.

**9.** An operational DP system is 1 (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

### 1. General

**1.1** The requirements for the DP-system configuration for the different Class Notations are shown in Table 2.1.

**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.

### 2. Power system

**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 | | – | | 2 NO [1] | 2 NO |
| | Distribution system | | – | | Redundant | Redundant, through separate compartments |
| | Power management (see 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, provided WCF is not exceeded |
| DP-relevant Auxiliary Systems | | | | | Redundant [2] | Redundant, separate compartments |
| 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 where of 1(one) connected to back-up control system |
| | Vessel's sensors | Wind | 1 | | 2 | 2 1(one) of each connected to back-up control system |
| | | VRS | 1 | | 2 | 2 |
| | | Gyro | 1 | | 3 | 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 (NO = normally open, NC = normally closed)

[2] when active components are used

[3] see Section 2, B.6

**2.2** For Class Notation **DP 0** and **DP 1** the power system shall fulfil the Class requirements concerning redundancy (see Rules for Machinery Installations, Volume III, and Rules for Electrical Installations, Volume IV).

**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 1(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.

**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.

**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, Volume IV, 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.

**2.6** For Class Notation **DP 3** at least 2 (two) physically separated systems shall be provided for DP operation.

## 3. Thruster system

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

**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 3.1 after worst case failure.

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.

***Note***

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

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

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

**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.

**3.5** For the electrical components of the thruster system the requirements in the Rules for Electrical Installations, Volume IV, Section 13 have to be fulfilled correspondingly.

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

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

**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 in a manner that supports the worst case failure design intent.

**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.

**4.3** In heavy fuel oil systems, the heating facilities for preheating the fuel oil shall be designed in such a way that if 1 (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.

**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.

**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 1(one) seawater cooling system fails it is possible to operate the redundant power and thruster system when the ship is operating in ice conditions.

**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.

**4.7** For Class Notation **DP 3**, cables for redundant equipment or systems shall not be routed together through the same compartments. Where this is not practicable, such cables may run together in cable ducts of A-60 class including duct ends, which are effectively protected from all fire hazards, except those originating from the cables themselves. Cable connection boxes are not allowed in such ducts.

## 5. DP control system

### 5.1 General

**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.

**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.

**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.

**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.

**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.

**5.1.6** The DP control system shall prevent failures transferred from 1 (one) subsystem to another. The redundant components shall be so arranged that a failure of 1(one) component shall be isolated.

**5.1.7** It shall be possible to control the thrusters manually, by individual levers and by an independent joystick in the event of failure of the DP control system (not for Class Notation **DP 0**). The independent joystick shall be independent of the DP control network and power system. If the complete DP control system fails it shall be possible to take command at a main control station.

**5.1.8** The software shall be developed in accordance with the Regulations for the Use of Computers and Computer Systems or with an appropriate International Quality Standard recognized by BKI.

### 5.2 Computer systems

**5.2.1** For Class Notation **DP 0** and **DP 1**, the DP control system need not to be redundant.

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

**5.2.3** For Class Notation **DP 3**, the DP control system shall consist of at least 2(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, 1(one) back-up DP control system shall be arranged, see 5.2.6. An alarm shall be initiated if any computer fails or is not ready for operation.

**5.2.4** For Class Notation s **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 if the worst case failure occurs. 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 man- ual input of weather conditions.

**5.2.5** Redundant computer systems shall be arranged with automatic transfer of control after a detected failure in 1 (one) of the computer systems. The automatic transfer of control from 1(one) computer system to another shall be smooth and within the acceptable limitations of the operation.

**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 feed- back, 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.

**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 1(one) computer. UPS battery capacity shall provide a minimum of 30 minutes operation following a mains supply failure. See also Rules for Electrical Installations, Volume IV, Section 4, I.7 (not for **DP 0**).

**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 1 (one) system shall in no case be transferred to the other redundant system.

### 5.3 Position reference systems

**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.

**5.3.2** For Class Notations **DP 2** and **DP 3**, at least 3 (three) position reference systems shall be installed and simultaneously available to the DP control system during operation. 1(One) failure shall only lead to the loss of 1 (one) position reference system.

**5.3.3** If 2 ( two) or more position reference systems are required, they shall not be of the same type, based on different principles and suitable for the operating conditions.

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

**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.

**5.3.6** For Class Notation **DP 3**, at least 1(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.

### 5.4 Sensor systems

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

**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 (i.e. this will result in at least 3(three) gyro compasses being installed).

**5.4.3** Sensors for the same purpose, connected to redundant systems, shall be arranged independently so that failure of 1 (one) will not affect the others.

**5.4.4** For Class Notation **DP 3**, 1(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.

### 5.5 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).

### 5.6 DP alert system

A DP alert system shall be provided at the same positions acc. to 5.5 with coloured lights and audible alarms, which indicates the status of the DP system.

## 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 (WCF) 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. BKI 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 is required for power management systems, drive control systems, DP control systems, etc.

## B. Surveys and Tests

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

**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 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)
- Manual override shall be demonstrated during normal operation and failure conditions
- Testing of UPS battery capacity (30 minutes)
- 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)

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 (for Class Notations **DP 2** and **DP 3**) with a FMEA proving trial. This trial shall be based on the approved program as required in Section 1, C.1.1.

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

**1.2** Periodical surveys, at intervals not exceeding 5 (five) years, to ensure full compliance with the applicable parts of the Rules. A complete test program shall be carried out as required by 1.1.

**1.3** Annual Surveys shall be carried out within 3 (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) The documented evidence of the satisfactory condition of the DP system may be accepted by BKI Head Office.

### 1.4 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 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*

**2.** The surveys and tests shall be carried out in the presence of the Surveyor. BKI may entrust the owner of the vessel to carry out Annual and Minor Repair Surveys according to a test programme accepted by BKI.

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