Guidelines on Surveys for Dynamic Positioning System

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BEIJING

CONTENTS

Chapter 1 GENERAL

1.1 General requirements

1.1.1 The Guidelines applies to the installation of dynamic positioning system onboard vessels or on mobile drilling unit at sea (hereinafter referred to as “vessels”).

1.1.2 Dynamic positioning system arranged on vessels in accordance with the Guidelines can be assigned appropriate class notation.

1.1.3 In addition to the Guidelines, relevant provisions of the Administration of flag States and / or of the Administration, where intending to operate within the sea areas under their jurisdiction, are to be noted.

1.1.4 Where the vessels with dynamic positioning system do not apply for class notations, their design and equipment may be referred to the requirements of the Guidelines.

1.1.5 The Society is to give appropriate consideration to those newly designed dynamic positioning vessel or relevant equipment. If the new design complies with the intention of the Guidelines, it is to be approved.

1.1.6 The Guidelines is based on the following suppositions, i.e. operation and maintenance of the dynamic positioning system, the guidelines is to be carried out by qualified crew.

1.2 Class notation

1.2.1 In accordance with the different redundancy degree of the dynamic positioning system, the Society, upon request by owners, is to assign class notations[①] to the followings:

DP – 1 Vessels with dynamic positioning system can keep the position and heading of the vessels under the specified environmental conditions. And at the same time, independent, concentrated manual control of vessels position and automatic heading control is to be fitted.

DP – 2 Vessels with dynamic positioning system can automatically keep the position and heading of the vessel when single failure (excluding loss of a cabin or cabins) appears under the specified environmental conditions and in specified operating fields.

DP – 3 Vessels with dynamic positioning system can automatically keep the position and heading of the vessel when any failure (including entirely loss of a cabin caused by fire or flood) appears under the specified environmental conditions and in specified operating fields.

[①] For the equipment and system not in compliance with the class requirements, the Society shall, upon request, issue a fitness declaration indicating the whole or partial vessel / system in compliance with the Guidelines. The society shall not monitor or trace the vessel’s status after issuing fitness declaration.

1.2.1 The class of the dynamic positioning system is to include the following sub-systems and their back-up systems:

(1) dynamic system;
(2) controller;
(3) measuring system;
(4) thruster system;
(5) remote thruster system;
(6) control panel.

1.3 Definitions

1.3.1 For the purpose of the Guidelines:

(1) Dynamic positioning vessel means a vessel which automatically maintains its position (fixed location or predetermined track) exclusively by means of thruster force.

(2) Dynamic positioning system means the complete installation necessary for dynamically positioning a vessel, comprising the sub-systems:
① power system;
② thruster system, and;
③ DP-control system and measuring system.

(3) Power system means all components and systems necessary to supply the DP system with power. The power system includes:
① prime movers with necessary auxiliary systems including piping;
② switchboards; and
③ distributing system (cabling and cable routine).

(4) Controller means all concentrated control hardware and software necessary to supply DP of the vessel. The controller is to generally be composed of one or more computers.

(5) Thruster system means all thrusters and control units, and main propellers and rudders concurrently for the use of dynamic position and other propellers.

(6) Position reference system means the system to measure the ship’s position and heading.

(7) Redundancy means ability of a components or system to maintain or restore its function, when a single failure occurs. Redundancy can be achieved for instance by installation of multiple components, systems or alternative means of performing a function.

(8) Environment means environmental status including wind, wave and current. Ice load may not be considered.

(9) Computer system means one or more computers, associated software, peripherals and interfaces, and a computer network with its protocol.

(10) Single failure means a failure appearing in a part or a system that will result in following one or two affections:

① function loss of a part or a system;

② degradation of the function to the degree of lowering safety of vessels, crew and environment.

(11) Reliability means the ability of system or a component to perform its required function without failure during a specified time interval.

1.4 Plans and documents

1.4.1 In addition to the plans and documents submitted for approval as requested by main class, the following plans and documents are to be submitted in triplicate to the Society for examination:

(1) Technique indication of DP system, including the following:

① performance of measuring system and controller, the type of thruster, the controlling method of thruster and thrusting allocation scheme;

② the curves of thrusting output and power input, thrusting force and response time of direction change, anticipated reduction of thrusting force resulting from interaction effects;

③ for class notations of DP-2 and DP-3, the principle indication of on-line “consequence analysis” is to be submitted.

(2) Ultimate status of environment (wind speed, current and wave) (to be indicated either in the form of figure or in writing).

(3) Sensor and referenced system framing figure (position / environmental status).

(4) Functioning figure of the controlling system.

(5) Single line arrangement and indication of cables between each equipment unit (dynamic, control and indication).

(6) Calculations of maximum general power load required for DP.

(7) Failure mode and effect analysis (FMEA) reports (including redundancy test procedure).

(8) Arrangement of control station.

(9) Item list of indication and alarm of the controller.

(10) Mooring and navigation test program (submitted for approval to the site survey location).

1.4.2 The following are to be submitted in triplicate to the Society for reference:

(1) Operation Manual of positioning system, including:
① operation indication;
② maintenance indication;
③ emergency indication.

1.5 Failure mode and effect analysis (FMEA)

1.5.1 The purpose of FMEA is to indicate the different failure mode of the equipment related to DP system functionality. There may be various failure modes in some equipment of the system, which may cause different effects on DP system. Thus, special attention is to be paid to them.

1.5.2 Failure mode and effect analysis are to be carried out to the whole DP system. Failure mode and effect analysis are to be as concrete as possible to include all main components of the system. The following are to generally be included but not be limited:

(1) the indication of all main components of the system and the show of functioning framing figure of the effects between them:

(2) all major failure mode;

(3) the main cause that can be anticipated of each failure mode;

(4) the transient effect that each failure makes to vessel positioning;

(5) the method for detecting failure;

(6) the effect that the failure causes to residual ability of the system;

(7) the analysis to probable common failure mode.

1.5.3 When FMEA is being compiled, each single failure mode affecting other components of the system and to the whole DP system is to be indicated.

1.5.4 When redundancy is considered unnecessary or impossible to some components of the system, further consideration of reliability and machinery maintenance is to be given to these components.

1.5.5 The test of system redundancy under each failure mode can substitute FMEA analysis report. The redundancy test procedure is to be based on imitated failure mode. The test is to be carried out under the condition as far as practicable. Detailed redundancy test procedure is to be submitted for examination.

Chapter 2 SURVEYS AND TESTES

2.1 Construction surveys

2.1.1 To check certificates of marine products of relevant equipment.

2.1.2 To assure that the equipment and arrangement of DP system is in compliance with the approved plans and related specifications of the Society.

2.1.3 Where there is redundancy in DP system and independence is required, the concrete consequences for FMEA of different sub-systems are to be verified by means of tests (in accordance with the redundancy test procedure specified in 1.5.5).

2.1.4 All sensors, peripheral equipment and reference system are to be tested before the test of the whole DP system. Alarm system and logical conversion are to be calibrated in accordance with the failure of analogue sensors.

2.1.5 The following tests are to be carried out to thruster:

(1) function test to control of each thruster alarm system;

(2) test of signal exchanges between each thruster and DP system computer;

(3) test of different control methods of the thruster.

2.1.6 Test is to be carried out to the power control apparatus.

2.1.7 The following tests are to be carried out to the whole set of DP system:

(1) Tests to conversion method, back-up system and alarm system with all operation and through different analogue failure status.

(2) Test to manual override function under normal operation and failure status conditions.

(3) Continuous site test for at least 6 to 8 hours to the whole set of automatic system, the failure happened is to be recorded and analyzed.

(4) Under specific environmental conditions, the whole DP system is to be tested for at least 2 hours. Whether condition is to make average load level on thruster reach 50 % or higher. Where the environmental condition can not satisfy the requirements mentioned above, the specific test my be carried out on an appropriate occasion.

2.2 Surveys for maintenance of class

2.2.1 The apparatus such as generator and thruster system related to DP system is to be tested in accordance with the requirements of the main class

2.2.2 When annual surveys are carried out, they are to be ensured that the DP system has normally been maintained in good working order.

2.2.3 The tests are to be carried out in renewal surveys in accordance with the requirements of 2.1.5, 2.1.6 and 2.1.7 (1) to (3).

2.2.4 Where a major alteration is added to hardware or software of the DP system (meaning adding position reference system, installing more or different thruster(s) or adding different control methods), the survey is to be carried out in accordance with concrete conditions to ensure the system in compliance with the requirements of the Guidelines.

2.3 Surveys for marine products

2.3.1 Each DP system (including controller and measuring system) assigned class notation in accordance with 1.2.1 of the Guidelines is to be subjected to survey of marine products in accordance with the Rules for Survey of Marine Products by the Society, and can obtain certificate of marine products.

2.3.2 The relevant components in dynamic system and thruster system are to obtain a certificate of marine products in accordance with the requirements on the main class.

Chapter 3 SYSTEM ARRANGEMENT

3.1 General requirements

3.1.1 The Chapter specifies general type requirements of system arrangement except otherwise specified. These requirements apply to all the vessels with DP additional class notations. Specific requirements for each sub-system are to be specified in sub-system.

3.1.2 In accordance with different additional class notations, the design of DP arrangement is to satisfy the requirements of table 3.1.2.

Arrangement of DP system **Table 3.1.2**

Equipment \ Class notation		DP - 1	DP - 2	DP - 3	
Power system	Generators & prime mover	Non- redundant	Redundant	Redundant, separate compartments	
	Main switchboard	1	1	2, separate compartments	
	Power management	No	Installed	Installed	
Thruster	Thruster arrangement	Non-redundant	Redundant	Redundant, separate compartments	
Control	Automatic control, computer system number	1	2	3 (one of each connected to back-up control system)	
	Manual control, joystick with auto heading	Yes	Yes	Yes	
	Single handle of each thruster	Yes	Yes	Yes	
Sensor	Position reference systems	2	3	3	One of each connected to back-up control system
	Vertical reference systems	1	2	2	
	Gyro	1	2	3	
	Wind speed & direction	1	2	2	
UPS power source		1	1	2, separate compartments	
Back-up control station		No	No	Yes	

3.1.3 Redundant components and systems are to be immediately available and with such capacity that the DP operation can be continued for such a period that the work in progress can be terminated safely. The transfer to the redundant component or system is to be automatic as far as possible, and operator intervention is to be kept to a minimum. The transfer is to be smooth and within acceptable limitations of the operation.

3.1.4 Under special environmental condition for operation such as near offshore platform, the DP system is to be so designed that it has remote control of the length and tension of single chain when position mooring equipment is used to help main automatic position. In accordance with the operation conditions, the consequence of chain fracture or thruster failure is to be analyzed.

3.2 Dynamic positioning control station (DP-control station)

3.2.1 DP-control station for DP operating and controlling is to be fitted on DP vessels. The relevant indicators, alarms, control panel and communication system are to be fitted in the control station.

3.2.2 The location of the DP-control station is to be chosen to suit the main activity of the vessel. The DP-control station is to be located with a good view of the surroundings.

3.2.3 For class notation DP-3, back-up DP-control station with back-up computer is to be fitted. The separation between the control station and main control station is to meet the requirement of A-60 Class. In emergency conditions, the operator is to easily move from main DP-control station to back-up DP-control station.

3.2.4 Consideration is to be given to the environmental condition of the DP-control station. If the normal DP operation can be kept upon necessary measures, these measures are to have redundancy for class notations DP-2 and DP-3.

3.3 Arrangement control system

3.3.1 The control system is to include both automatic and manual control modes. Automatic control mode is to include control of position and heading. Set-points for control of position and heading is to be independently selectable. Manual control mode is to include control of thrusters by individual control devices for pitch / speed and azimuth of each thruster, and an integrated remote thruster control by use of joystick.

3.3.2 Class notation DP-1 is to include an automatic control mode and control mode composed of selective integrated joystick and lever controls. Class notations DP-2 and DP-3 are to include at least two independent auto control system and a manual control mode composed of selective integrated joystick and lever controls.

3.3.3 In addition to the requirements of 3.3.2, class notation DP-3 is to include back-up control system fitted in back-up DP control station. The back-up control system is to include auto control mode, and is to be connected to a location reference system. The operation of the location reference system is to not be connected to the main control system.

3.3.4 The back-up control system is to be selected by the switch located at the back-up control station. Where a switch is also fitted at the main control station with the same function as that at the back-up control station, it is allowed when the main control station fails to operate properly the selection of the back-up control system by back-up control station is not hindered.

3.4 Arrangement of control panels

3.4.1 The information sources like displays, indicators, etc. are to provide information in a readily usable form. The operator is to be provided with immediate information of the effect of his actions. Generally, feedback signals or other confirmations of actions carried out are to be displayed, not only the initial command.

3.4.2 Easy switch-over operational modes are to be provided. Active mode is to be positively indicated. Positive indications of the operational status of the different sub-systems are to be given.

3.4.3 Indicators and controls are to be arranged in logical groups, and to be coordinated with the geometry of the vessel when this is relevant.

3.4.4 If control of a sub-system can be carried out from alternate control stations, positive indication of the station in charge is to be provided.

3.4.5 Precautions are to 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 logic requirements to operation.

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

3.4.7 Controls and indicators placed in the wheelhouse are to be sufficiently illuminated. Lights for such purpose are to be provided with dimming facilities.

3.5 Arrangement of cables and piping systems

3.5.1 For class notation DP-2, the critical DP systems for fuel, lubrication, hydraulic oil, cooling water and pneumatic circuit, cables are to be located with due regard to fire hazards and mechanical damage.

3.5.2 For class notation DP-3, redundant piping system (piping for fuel, lubrication, hydraulic oil, cooling water and pneumatic circuit) is not to be routed together through the same compartments. Where this is unavoidable, such pipes could run together in ducts of A-60 class. Cables for redundant equipment or systems are not to be routed together through the same compartments. Where this is unavoidable, such cables could run together in cable ducts of A-60 class. Cable connection boxes are not allowed in such ducts.

Chapter 4 THRUSTER SYSTEM

4.1 General requirements

4.1.1 The thrusters mentioned in the Guidelines are pipe tunnel thrusters, azimuth thrusters, with fixed or variable pitch blades, with electric, direct diesel, or hydraulic drive. Other types of thrusters will be considered specially in each case.

4.1.2 Except otherwise specified in the Guidelines, the design and manufacture of the thrusters including prime mover, gear box shafting and propeller are to comply with the applicable requirements of PART THREE of the Rules and Regulations for the Construction and Classification of Sea-Going Steel Ships by the Society.

4.1.3 Control and monitoring of the thrusters are to meet the requirements of Chapter 6.

4.2 Thruster arrangement

4.2.1 The thruster location is to minimize interference between thrusters, thruster and hull.

4.2.2 Thruster intake depth is to be sufficient to reduce the probability of ingesting floating debris and of vortex formation.

4.2.3 The number and capacity of the thrusters are to meet the following requirements:

(1) In the specified environmental conditions, the thruster system is to provide adequate thrust in longitudinal and lateral directions and provide yawning moment for heading control.

(2) For class notation DP-2 and DP-3, in the arrangement of redundant thrusters, any one of the thrusters fails, the thruster system is to still provide adequate thrust in longitudinal and lateral directions and provide yawning moment for heading control.

4.2.4 The values of the thruster forces used in the consequence analysis are to be corrected for interference between thrusters and other effects which will reduce the effective force.

Chapter 5 POWER SYSTEM

5.1 General requirements

5.1.1 Except otherwise provided in the Guidelines, power system is to comply with the applicable requirements of PART FOUR of the Rules and Regulations for the Construction and Classification of Sea-Going Steel Ships by the Society.

5.2 Number and capacity of generators

5.2.1 When starting thrusters on dedicated generators, especially when one generator fails to work, transient voltage drop caused in bus-bar system is not to be in excess of 15 % of the rated voltage.

5.2.2 If the total installed thruster capacity exceeds the total installed power, interlocks or thrust limitations are to be arranged to prevent overloading the power plant.

5.2.3 The high reactive load demands which may occur in DP thruster operation are to be considered when selecting number and type of generators.

5.3 Power management system

5.3.1 For vessels with class notations DP-2 and DP-3, an automatic power management system is to be arranged. This system is to perform load dependent starting of additional generators, and may also include load dependent stop of running generators. The system is to block starting of large consumers when there is not adequate running generator capacity, and to start up back-up generators as required, and hence to permit requested consumer start to proceed.

5.3.2 The alarm is to be given when total power load exceeds the preset percentage of the total capacity of the working generators. The set value of the alarm can be adjusted between 50% and 100% of the working capacity, is to be determined in accordance with number of the working generators and influence of failure of one generator.

5.3.3 The measures are to be taken for the power supplied thruster system before the load reaches the alarm value specified in 5.3.2, so that the other generators can automatically start, coordinate and distribute load.

5.3.4 Sudden overload caused by stop of one or more generators is not to create black-out. Reduction in thruster load, i.e. pitch or speed reductions, must be introduced in the period it takes to start and bring a new generator on the line. If this function is taken care of by the DP-computer system, the effect is to be coordinated with the power management system.

5.4 Main switchboard arrangement

5.4.1 For class notation DP-2 and DP-3, the main switchboard is to be so arranged that it will not accept total black-out as the consequence of any single failure. Single failure is defined as any system or component break-down of technical nature. For vessel with class notation DP-3, single failure is to also include the failures caused by flood and fire incidents. The immediate consequence of this is that physical separation of redundant components / systems must be used to limit the failure effects of flood and fire.

5.4.2 When considering single failures of switchboards, the possibility of direct short circuit of the main bus-bar has to be considered.

5.4.3 A bus-bar system consisting of at least two sections will be accepted. It is accepted that the sections are connected with bus-tie breakers, provided that these are circuit breakers capable of breaking the maximum short circuit currents in the system.

5.4.4 For class notation DP-2, it is accepted that the bus-bar sections are arranged in one switchboard. For vessel with class notation Dp-3, it is required that each bus-bar section is isolated from the other(s) by A-60 partitions. There is to be a bus-tie breaker on each side of the A-60 partitions.

5.4.5 For vessel with class notations DP-2 and DP-3, it is to be possible to operate with separated bus-bar sections. Protection against black-out due to overload caused by thruster is to be effective in isolated bus-bar sections.

5.4.6 Bus-bar sections may be connected together during starting of large motors in order to meet requirements for voltage deviations.

5.4.7 The on-line power reserve, i.e. the difference between on-line generator capacity and generated power at any time is to be displayed on panel meters or other type of continuous indicators in the DP control center. For split-bus power arrangements, indications are to be provided for individual bus-bar sections. The reserve power indicators may be omitted in systems where it is impossible to overload the power plant by thruster operation.

Chapter 6 CONTROLLER AND MEASURING SYSTEM

6.1 General requirements

6.1.1 Except otherwise specified in this Chapter, controller and measuring system is to comply with applicable requirements of Automatic Control and Remote Control in PART SEVEN of the Rules and Regulations for the Construction and Classification of Sea-Going Steel Ships by the Society.

6.2 Composition of the controller and measuring system

6.2.1 The controller and measuring system comprise the following equipment:

(1) computer system;

(2) manual thruster controls;

(3) joystick thruster controls;

(4) automatic thruster controls;

(5) position reference systems;

(6) sensor systems;

(7) display and alarm;

(8) communication.

6.3 Computer system

6.3.1 For class notation DP-1, the computer of the DP control system need not be redundant.

6.3.2 For class notation DP-2, the DP control system is to consist of at least two independent computer systems. Common facilities such as self-checking routines, data transfer arrangements and plant interfaces are not to be capable of causing the failure of both / all systems.

6.3.3 For class notation DP-3, the DP control system is to 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 plant interfaces are not to be capable of causing the failure of both / all systems. In addition, one back-up DP control system is to be arranged. An alarm is to be initiated if any computer fails or is not ready to take control.

6.3.4 For class notations DP-2 and DP-3, the DP control is to include a software function, normally known as “consequent analysis”, which continuously verifies that the vessel will remain in position even if the worst case failure occurs. This analysis is to 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 consequence analysis is to provide 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 is to include a function which simulates the thrust and power remaining after the worst case failure, based on manual input of weather trend.

6.3.5 For class notations DP-2 and DP-3, redundant computer systems are to 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 is to be smooth and within the acceptable limitations of the operation.

6.3.6 For class notation DP-3, the back-up DP control system is to be in a room, separated by an A-60 class division from the main DP control station. During DP operation, this back-up control system is to be continuously updated by input from the sensors, position reference system, thruster feedback, etc., and to be ready to take over control.

6.4 Manual thruster control

6.4.1 Manual operation of each thruster: start, stop, azimuth and pitch / speed control is to be arranged in the DP center (start / stop of high voltage motors may be excluded in the DP center).

6.4.2 Running / stop, pitch / speed, and azimuth for each thruster is to be displayed at the DP manual control stand.

6.4.3 Manual thruster control is to be accessible at all times, also during all failure conditions in automatic and joystick control systems.

6.4.4 Each thruster is to be fitted with an independent stop gear in the DP center.

6.5 Joystick thruster control

6.5.1 Joystick thruster control system is an integrated control system of thrusters, propellers, and rudders. The joystick is to enable the command of longitudinal thrust, transverse thrust, a turning moment, and all combinations of these thrust components.

6.5.2 The joystick system may exclude certain thrusters or rudders which are not necessary to obtain an adequate thrust level in all directions.

6.5.3 The joystick controller is to include selectable automatic heading control.

6.6 Automatic thruster control

6.6.1 The automatic thruster control is to consist of a computer system, comprising one and more computers with processing units, input / output devices, and memory.

6.6.2 Class notation DP-1 is to comply with the following requirements:

(1) The computer system executing automatic thrust control is to produce commands for pitch / speed and azimuth for all thrusters. The commanders are to be transmitted to the individual thrusters control units via the circuits for selection of command source.

(2) The computer system is to perform self-check routines that are to bring the computer system to a stop when critical failure conditions are detected.

(3) When stopped, either by automatic or manual means the computer system is to set speed / pitch commands to zero.

6.6.3 Class notation DP-2 is to comply with the following requirements:

(1) The computer systems executing automatic thrust control are to produce command output to the thrusters after the occurrence of any single failure within the computer system or its associated equipment. The requirement may be realized by at least two parallel computing systems, one of which is to be selected as the on-line system and the other system or systems are to be in stand-by condition. This selection is to be possible by manual means.

(2) The computer systems are to perform self-check routines for detection of failure.

(3) If the on-line system detects a failure, an automatic transfer of on-line function to a stand-by system is to take place.

(4) If a failure of a stand-by system, or any of the sensors or position references selected for this system, is detected, an alarm is to be given.

(5) There is to be an identification of the on-line system at the operator panel.

6.6.4 Class notation DP-3:

(1) Computer systems are to satisfy the requirements of class notation DP-2.

(2) There is to be an automatic back-up system located separated from the main system by an A-60 partition.

(3) If a triple-computer system is chosen for the main system, one of these computers may serve as the

back-up, provided that the necessary independence as required for the back-up is achieved.

(4) There is to be at least one position reference system and one compass connected to the back-up system, independent of the condition of the main system.

(5) The back-up system is to be activated by the operator, either at the main DP center or at the back-up station. The nature of the switching is to be such that no single failure will render the back-up inoperable together with the main system.

6.7 Thruster control mode selection

6.7.1 The thruster control mode is to be selectable by a simple device located in the DP control center. The control mode selector may consist of a single selector switch, or individual selectors for each thruster.

6.7.2 The control mode selector is to be so arranged that it is always possible to select manual controls after any single failure in the DP control mode.

6.7.3 For class notations DP-2 and DP-3, the mode selector is to be such that no single failure will deselect all thrusters from the automatic control mode.

6.7.4 The mode selector may consist of a single switch also for class notation DP-3 even if this may be damaged by a fire, or other hazards, provided that the back-up computer system is still selectable.

6.8 Position reference systems

6.8.1 As a general rule, a DP system is to include at least two independent reference systems. For class notations DP-2 and DP-3, at least three position reference systems are to be installed and simultaneously available to the DP system during operation. When two or more position reference systems are required, they are not both / all to be of the same type, but based on different principles and suitable for the operating conditions.

6.8.2 The system is to allow for smoothing and mutual adjustment of the inputs originating from various position reference systems and transfer between reference systems is to be bumpless.

6.8.3 Position reference systems are to provide position data with adequate accuracy with respect to the intended DP operations. When a vessel deviates from the predetermined course or from the operating area decided by the operator, audible and visual alarms are to be given. Position reference systems are to be monitored. When the signals provided are incorrect or declined obviously, the alarm is to be given.

6.8.4 For class notation DP-3, a position reference system is to be connected to the back-up control center, and to be separated from other position reference systems with A-60 class.

6.8.5 When acoustic position system is used, the machine and water acoustic interference on transmission channel of the water acoustic monitor is to be reduced to the least.

6.8.6 When tensioning system is used, the wire and tensioning device is to apply to the environment at sea.

6.8.7 When the signals from the position reference system are changed by vessel motion (rolling and pitching), the location is to automatically be revised.

6.9 Sensor systems

6.9.1 Vessel sensors are to measure at least vessel heading, vessel motion, wind speed and direction.

6.9.2 Sensors are to be as far as possible provided with failure monitors (overheating, power loss).

6.9.3 Input from sensors is to be monitored in order to detect possible faults, notably relative to temporal evolution of the signal. As regards the analogue sensors, an alarm is to be triggered in the event of connecting line wire break, short circuit and low insulation.

6.9.4 Any failure of automatic change-over between sensors is to activate visual and audible alarms at the control room.

6.9.5 Sensors used for the same purpose connected to redundant systems are to be arranged independently so that failure of one does not affect the others.

6.9.6 For class notation DP-3, one of each type of sensor is to be connected directly to the back-up control system and separated by an A-60 class division from the other sensors.

6.10 Display and alarm

6.10.1 DP control center is to display the information from power system, thruster system and DP control system, so as to ensure these systems in normal operation. The information needed for safe operation of DP system may be obtained at any time.

6.10.2 The display system, especially that located at the DP control center, is to comply with the principle of human engineering. The DP control system is to be easy to select control methods such as manual control, stick control, or computer control of thrusters. The control method of the operation is to also be displayed clearly. The display system is to comply with the following principles:

(1) isolating redundant devices so as to reduce the possibility of failure;

(2) easy to maintain;

(3) preventing negative influence from environment and electromagnetic interference.

6.10.3 For the vessels with class notations DP-2 and DP-3, operator control devices are to be so designed that no

misoperation will lead to ultimate limit state.

6.10.4 When the failures occur to the DP system and the equipment it controls, audible and visual alarms are to be given. The happening and status of these failures are to be permanently recorded.

6.10.5 The DP system is to prevent failures from one system to another. Redundant units are to be so arranged that they can separate one unit while starting another unit.

6.10.6 Under practicable conditions, each DP control center is to be fitted with alarm and display / status display as specified in table 6.10.6.

Alarm and display of control center **Table 6.10.6**

System	Monitored parameters	Alarm	Display
Thruster power system	Engine lubricating oil pressure - low	X	
	Engine coolant temperature – high	X	
	CPP hydraulic oil pressure – low and high	X	
	CPP hydraulic oil temperature - high	X	
	CPP pitch		X
	Thruster RPM		X
	Thruster direction		X
	Thruster motor / SCR coolant leakage	X	
	Thruster motor SCR temperature		X
	Thruster motor short circuit		X
	Thruster motor exciter power available		X
	Thruster motor supply power available		X
	Thruster motor overload	X	
	Thruster motor high temperature	X	
Power distribution system	Status of automatically controlled circuit breakers		X
	Bus bar voltage		X
	Bus bar frequency		X
	Power factors		X
	Bus bar current and power levels		X
	High power consumers – current levels		X
	Back-up power availability		X
System performance	Excursion outside operating envelope	X	
	Control system failure	X	
	Position sensor failure	X	
	Vessels target and present position and heading		X
	Wind speed and direction		X
	Selected reference system		X
Specific requirements for DP-2 & DP-3	Thruster location (pictorial)		X
	Percentage thrust		X
	Available thrusters on stand-by DP alert through consequence analyzer	X	X
	Position information of individual position reference systems concerned		X

6.10.7 Where alarm and display items arranged in accordance with the requirements in 6.10.6 are not practicable and necessary, the alarm and display items may be reduced in accordance with the actual condition, but it is to be subjected to the consent of the Society.

6.11 Communication system

6.11.1 A two way communication device is to be fitted between DP control center and following locations:

(1) wheelhouse;

(2) main engine control room;

(3) related operating control rooms.

6.11.2 The power supply of communication system is to be independently separated from the main power of the vessel.

6.12 Unbroken power source

6.12.1 For class notations DP-1 and DP-2, the controller and measuring system are to be supplied by unbroken power source. For class notation DP-3, two independent unbroken power sources are to be arranged. The battery capacity of each unbroken power source is required to maintain the operation of at least 30 min.

Chapter 7 ENVIRONMENTAL CONDITIONS

7.1 General requirements

7.1.1 For unlimited service, a set of standard North Sea Environmental Conditions is to be used.

7.1.2 For restricted service, a long-term distribution of environmental conditions prevailing where the vessel is in operation is to be considered.

7.1.3 When ensuring achieving ability of DP system, the ability under the following three conditions is to be calculated:

(1) with all thrusters operating;

(2) with one single failure;

(3) with most critical single failure.

7.1.4 Environmental forces (wind, wave drift and current loads) and thrust are to be evaluated through tunnel and tank model tests or other recognized methods.

Chapter 8 SPARE PARTS

8.1 General requirements

8.1.1 Spare parts necessary for the continued DP operation of the vessel are to be considered in connection with the redundancy requirements applicable to the specific class notation.