BAHRIA CLASSIFICATION SOCIETY

Chapter 22 – Dynamic Positioning Systems

JULY 2022

This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red color.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction is on or after JULY 2022

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Dynamic Positioning Systems

AMENDMENTS

Revised Sections	RCS No.	EIF Date*
Section 02	02/2022	07/2022

* Entry into Force (EIF) Date is provided for general guidance only, EIF dates given in Rule Change Summary (RCS) are considered valid. In addition to the above stated changes, editorial corrections may have been made.

SECTION 1

GENERAL REQUIREMENTS AND INSTRUCTIONS

A. General

1. Scope

These Rules apply to dynamically positioned vessels covered by the IMO "Guidelines for Vessels and Units with Dynamic Positioning Systems" (MSC.1/Circ. 1580).

2. Reference to Other Rules and Regulations

The following BCS Rules shall apply in conjunction with these rules:

Rules for Classification of steel ships.

– Chapter 4, Machinery, –

Chapter 5, Electric.

B. Exemptions

Vessels, which embody features of a novel kind, may be exempted from provisions of the rules the application of which might impede research and development of such features.

C. Class Notations

Ships equipped with dynamic positioning systems , which comply with these rules, will have the following notations affixed to the character of classification:

– DK 1,

– DK 2, or

– DK 3.

Installations for these class notations are grouped into three classes (Section 1.E) and must comply with the requirements laid down in Section 2.

D. Definitions

1. Activity-Specific Operating Guidelines (ASOG)

Guidelines on the operational, environmental and equipment performance limits for the location and specific activity. (For drilling operations, the ASOG may be known as the Well-Specific Operating Guidelines (WSOG)).

2. Bus-tie breaker

A device connecting/disconnecting switchboard sections ("closed bus-tie(s)" means connected).

3. Company

The owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the owner of the ship and who on assuming such responsibility has agreed to take over all duties and responsibilities imposed by the International Safety Management Code.

4. Computer System

A system consisting of one or several computers and associated hardware, software and their interfaces.

5. Consequence analysis

A software function continuously verifying that the vessel will remain in position even if the worst-case failure occurs.

6. Dynamic Positioning control station (DK control station)

A Workstation designated for DK operations, where necessary information sources, such as indicators, displays, alarm panels, control panels and internal communication systems are installed (this includes: DK control and independent joystick control operator stations, required position reference systems' Human Machine Interface (HMI), manual thruster levers, mode change systems, thruster emergency stops, internal communications).

7. Dynamic Positioning operation (DK operation)

Using the DK system to control at least two degrees of freedom in the horizontal plane automatically.

8. Dynamic Positioning Verification Acceptance Document (DPVAD)

The document issued by the Administration or its Recognized Organization to a DK vessel complying with these Rules. (See appendix for model form.)

9. Dynamically Positioned Vessel (DK Vessel)

A unit or a vessel, which automatically maintains its position and/or heading (fixed location, relative location or predetermined track) by means of thruster force.

10. DK Control System

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

– Computer system / joystick system,

– Sensor system,

– Control stations and display system (operator panels),

– Position reference system(s),

– Associated cabling and cable routeing, and

– Networks.

11. Dynamic Positioning System (DK System)

The complete installation necessary for dynamically positioning a vessel, comprising, but not limited to, the following sub-systems:

– Power system,

– Thruster system, and

– DK-control system.

12. Failure

An occurrence in a component or system that causes one or both of the following effects:

- loss of component or system function; and/or

- deterioration of functional capability to such an extent that the safety of the vessel, personnel or environment protection is significantly reduced.

13. Failure Modes and Effects Analysis (FMEA)

A systematic analysis of systems and sub-systems to a level of detail that identifies all potential failure modes down to the appropriate sub-system level and their consequences.

14. FMEA proving trials

The test program for verifying the FMEA.

15. Hidden failure

A failure that is not immediately evident to operations or maintenance personnel and has the potential for failure of equipment to perform an on-demand function, such as protective functions in power plants and switchboards, standby equipment, backup power supplies or lack of capacity or performance.

16. Joystick system

A system with centralized manual position control and manual or automatic heading control.

17. Loss of position and/or heading

That the vessel's position and/or heading is outside the limits set for carrying out the DK activity in progress.

18. Position Keeping

Maintaining a desired position and/or heading or track within the normal excursions of the control system and the defined environmental conditions (e.g. wind, waves, current, etc.)

19. Power management system

A system that ensures continuity of electrical supply under all operating conditions

20. Power System

All components and system necessary to supply the DK system with power. The power system includes but is not limited to:

– Prime movers with necessary auxiliary systems including piping, fuel, cooling, pre-lubrication and lubrication, hydraulic, pre-heating and pneumatic systems,

– Generators,

– Switchboards,

– Distributing system (cabling and cable routeing).

– Power supplies, including uninterruptible power supplies (UPS) and

– Power management system(s) (as appropriate).

21. Redundancy

Ability of a component or system to maintain or restore its function , when a single failure has occurred . Independent of the requirements of BCS "Regulations for the Use of Computers and Computers Systems " redundancy can be achieved for instance by installation of multiple components , systems or alternative means of performing a function.

22. Time to safely terminate (operations)

The amount of time required in an emergency to safely cease operations of the DK vessel.

23. Thruster System

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

– Thrusters with drive units and necessary auxiliary systems including piping, cooling, hydraulic and lubrication systems, etc.,

– Main propellers and rudders if these are under the control of the DK-system,

– Thruster control systems(s),

– Manual thruster controls, and

– Associated cabling and cable routeing.

24. Worst-Case Failure Design Intent (WCFDI)

The specified minimum DK system capabilities to be maintained following the worst-case failure. The worst-case failure designintent is used as the basis of the design. This usually relates to the number of thrusters and generators that can simultaneously fail.

25. Worst-Case Failure (WCF)

The identified single fault in the DK system resulting in maximum detrimental effect on DK capability as determined through the FMEA.

E. Requirements for Class Notations

1. Reliability

A DK system consists of components and systems acting together to achieve sufficient reliable position keeping capability. The necessary redundancy level for component and systems is determined by the consequence of a loss of position and/or heading keeping capability. The larger the consequence, the more reliable the DK system shall be.

Consequently the requirements have been grouped into three class notations. For each class notation the associated single failure criteria shall be defined as in 2. below.

The class notation of the vessel required for a particular operation based on a risk analysis of the consequence of a loss of position.

2. Class Notations

2.1 For class notation DK 1, loss of position and/or heading may occur in the event of a single fault.

2.2 For class notation DK 2, a loss of position and/or heading will not occur in the event of a single fault in any active component or system. Common static components may be accepted in systems which will not immediately affect position keeping capabilities upon failure (e.g. ventilation and seawater systems not directly cooling running machinery). Normally such static components will not be considered to fail where adequate protection from damage is demonstrated to the satisfaction of the Administration. Single failure criteria include, but are not limited to:

– Any active component or systems (generators, thrusters, switchboards, communication networks, remote controlled valves, etc.),

– Any normally static component (cables, pipes, manual valves, etc.), that may immediately affect position keeping capabilities upon failure or is not properly documented with respect to protection.

2.3 For class notation DK 3, a loss of position and/or heading will not occur in the event of a single fault or failure. A single failure applies to:

– Items listed above for class notation DK 2, and any normally static component is assumed to fail,

– All components in any one watertight compartment, caused by fire or flooding,and

– All components in any one fire sub-division, caused by fire or flooding (for cables, see also Section 2, B.5.1).

2.4 For class notations DK 2 and DK 3, a single inadvertent action should be considered as a single fault, if such an action is reasonably probable.

3. Worst Case Failure

3.1 Based on the single failure definitions as given in 2. the worst case failure should be determined and used as criterion for the consequence analysis (see Section 2, B.4.2.4).

3.2 When a DK vessel is assigned to a class notation this means that the DK vessel is suitable for all types of DK operations within the assigned and lower grade of class notations.

Note:
It is a provision of the rules that the DK vessel is operated in such a way that a single failure, as determined in 2. can occur at any time without causing a breach of acceptable excursion criteria set for loss of position and/or heading for class notations DK 2 and DK 3.

F. Documents for Approval

The documents and drawings specified in 1. to 5. are to be submitted for approval at least in triplicate. Operation and maintenance manuals specified in 1. may be submitted in a single set.

1. General Documention

– Description of the DK system characteristics,

– Description of thruster characteristics,

– Description of position holding performance of the vessel due to wind and sea conditions,

– Operation description, instruction manual, maintenance manual,

– Reports or certificates due to type approval tests, if applicable.

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),

– Wiring diagram,

– 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 arrangement drawings, e.g. control panels, control consoles, location of control station,

– List of equipment identifying manufacturer, type, type approval number and/or authority,

– Description of the principle of the ability of maintaining position after specific single failures, (see Section 2, B.4.4)

– Factory Acceptance Test (FAT) program,

– Programs for tests and trials (see Section 3).

3. Thruster Documentation

– Documentation according to the relevant rules for classification and construction.

4. Electric Power System Documentation

- Documentation according to the relevant rules for classification and construction.

5. Failure Mode and Effect Analysis (HDEA) / Redundancy Test

Documentation concerning reliability and availability of the DK system shall be provided for the class notations DK 2 and DK 3 by means of a Failure Mode and Effect Analysis (HDEA). As an alternative to a HDEA the redundancy may be documented in a redundancy test procedure, which is to be verified during sea trials.

SECTION 2

DK FUNCTIONAL and OPERATIONAL REQUIREMENTS

A. Functional Requirements

1. All components in a DK system shall be designed, constructed and tested in accordance with BCS accepted rules and standards.

2. If external forces from mission-related systems (cable lay, pipe lay, mooring, etc.) have a direct impact on DK performance, the influence of these systems should be considered and factored into the DK system design. Where available from the DK system or equipment manufacturer, such data inputs should be provided automatically to the DK control system. Additionally, provisions should be made to provide such data inputs into the DK control system manually. These systems and the associated automatic inputs should be subject to surveys, testing and analysis specified in Section 3, B.

3. In order to meet the single failure criteria given in Section 1. E.2, redundancy of components will normally be necessary as follows:

– For class notation DK 2, redundancy of all active components,

– For class notation DK 3, redundancy of all components and A-60 physical separation of the components.

4. For class notation DK 3, full redundancy of the control systems may not be possible. (i.e. there may be a need for a single changeover system from the main computer system to the backup computer system). Such connections between otherwise redundant and separated systems may be accepted when these are operated so that they do not represent a possible failure propagation path during DK operations. Failure in one system should in no case be transferred to the other redundant system.

5. For class notations DK 2 and DK 3, connections between otherwise redundant and separated systems should be kept to a minimum and made to fail to the safest condition. Failure in one system should in no case be transferred to the other redundant system.

6. Redundant components and systems shall be immediately available without needing manual intervention from the operators and with such capacity that the DK operation can be continued for such a period that the work in progress can be terminated safely. The transfer of control shall be smooth and within acceptable limitations of the DK operation(s) for which the vessel is designed.

7. For class notations DK 2 and DK 3, hidden failure monitoring should be provided on all devices where the FMEA shows that a hidden failure will result in a loss of redundancy.

8. The DK control station should be arranged where the operator has a good view of the vessel's exterior limits and the surrounding area. Equipment that should be located at the DK control station includes, but is not limited to:

- DK control and independent joystick control operator stations;
- Manual thruster levers;
- Mode change systems;
- Thruster emergency stops;
- Internal communications; and
- Position reference systems' HMI, when considered necessary

B. System Arrangement

1. General

1.1 The requirements for the DK-system arrangement 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 items. 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 changes in power demand.

2.2 For class notation DK 1 the power system need not be redundant.

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

2.4 For class notation DK 3, the power system shall be divisible into two or more system such that in the event of failure of one system, at least one other system will remain in operation and provide sufficient power for station keeping. The divided power system shall be located in different spaces separated by A-60 class divisions. Where the power systems are located below the operational waterline, the separation shall also be watertight. Bus-tie breakers shall be open during operations unless equivalent integrity of power operation can be accepted according to A.1.

2.5 For class notations DK 2 and DK 3, the power available for position keeping shall be sufficient to maintain the vessel in position after a single fault according to Section 1.E.2.

2.6 For class notations DK 2 and DK 3, at least one automatic power management system (PMS) should be provided and should have redundancy according to the equipment class and a blackout prevention function.

2.7 Alternative energy storage (e.g. batteries and fly-wheels) may be used as sources of power to thrusters as long as all relevant redundancy, independency and separation requirements for the relevant notation are complied with. For class notations DK 2 and DK 3, the available energy from such sources may be included in the consequence analysis function required in item 4.2.4 when reliable energy measurements can be provided for the calculations.

2.8 Sudden load changes resulting from single faults or equipment failures should not create a blackout.

3. Thruster System

3.1 Each thruster on a DK system should be capable of being remote-controlled individually, independently of the DK control system.

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

3.3 For class notations DK 2 and DK 3, the thruster system shall be connected to the power system in such a way that the requirements of 3.2 can be complied with even after failure of one of the constituent power systems and the thrusters connected to that system.

3.4 The values of thruster force used in the consequence analysis (see 4.2.4) shall be corrected for interference between thrusters and other effects, which would reduce the effective force.

3.5 A failure of the thruster system, including pitch, azimuth and/or speed control, shall not cause an increase in thrust magnitude or change in thrust direction.

3.6 Individual thruster emergency stop systems should be arranged in the DK control station. For class notations DK 2 and dk 3, the thruster emergency stop system should have loop monitoring. For class notation DK 3, the effects of fire and flooding should be considered.

4. DK Control System

4.1 General

4.1.1 In general, the DK control system shall be arranged in a DK control station from where the operator has a good view of the vessel's exterior limits and the surrounding areas.

4.1.2 The DK control station shall display information from the power system, thruster system, and DK control system to ensure that these systems are functioning correctly. Information necessary to safely operate the DK system safely shall be always visible. Other information shall be available upon operator request.

Table 2.1 DK system arrangement

Subsystem or component			Minimum requirements for class notation			
			DK 1	DK 2	DK 3	
Power system	Generators and prime mover		Non-redundant	Redundant	Redundant, separate compartments	
	Main switchboard		1	1	2 in separate compartments	
	Bus-tie breaker		0	1	2	
	Distribution system		Non-redundant	Redundant	Redundant, through separate compartments	
	Power management		No	Redundant	Redundant, separate compartments	
Thruster system	Arrangement of thrusters		Non-redundant	Redundant	Redundant, separate compartments	
DK-relevant auxiliary systems			-	Redundant **(3)**	Redundant, separate compartments, provided WCF is not exceeded	
DK Control system	Auto control; no. of computer systems		1	2	2+1 in backup control station	
	Manual control; Joystick with auto heading		Yes	Yes	Yes	
UPS for DK control system			1	2	2+1 In separate compartments	
Sensors	Position reference systems		2	3	3 Whereof 1 connected to back-up control system	
	Vessel's sensors	Wind	1	3	3	One of each connected to back-up control system
		Vertical reference sensor (VRS)	1	3	3	
		Heading reference system	1	3 **(1)**	3	
Essential non-DK systems **(2)**			Non-redundant	Redundant	Redundant, separate compartments	
Printer			Yes	Yes	Yes	

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

(2) *See Section 2.B.6*

(3) *When active components are used*

4.1.3 Display systems and the DK control station in particular, shall be based on sound ergonomic principles which promote proper operation of the system. The DK control system shall provide for easy accessibility of the control mode, i.e. manual, joystick, or automatic DK control of thrusters, propellers and rudders, if part of the thruster system. The active mode shall be clearly displayed.

4.1.4 For class notations DK 2 and DK 3, operator controls shall be designed so that no single inadvertent action on the operators' panel may lead to a loss of position and/or heading.

4.1.5 Alarms and warnings for failures in all systems interfaced to and/or controlled by the DK control system shall be audible and visual. A record of their occurrence and status changes shall be provided together with any necessary explanations.

4.1.6 The DK control system shall prevent failures being transferred from one system to another. The redundant components shall be so arranged that a failed component or components may be easily isolated so that the other component(s) can take over smoothly with no loss of position and/or heading.

4.1.7 It shall be possible to control the thrusters manually, by individual levers and by an independent joysticks in the event of failure of the DK-control system. If an independent joystick is provided with sensor inputs, failure of the main DK control system should not affect the integrity of the inputs to the independent joystick.

4.1.8 A dedicated UPS should be provided for each DK control system (i.e. minimum one UPS for class notation DK 1, two UPSs for class notation DK 2 and three UPSs for class notation DK 3) to ensure that any power failure will not affect more than one computer system and its associated components. The reference systems and sensors should be distributed on the UPSs in the same manner as the control systems they serve, so that any power failure will not cause loss of position keeping ability. An alarm should be initiated in case of loss of charge power. UPS battery capacity should provide a minimum of 30 minutes operation following a main supply failure. For class notations DK 2 and DK 3, the charge power for the UPSs supplying the main control system should originate from different power systems.

4.1.9 The software shall be produced in accordance with the BCS "Regulations for the Use of Computers and Computer Systems " or with an appropriate international quality standard recognized by BCS.

4.2 Computer systems

4.2.1 For class notation DK 1, the DK control system need not be redundant.

4.2.2 For class notation DK 2, the DK control system shall consist of at least two computer systems so that, in case of any single failure, automatic position keeping ability will be maintained. Common facilities, such as self- checking routines, alignment facilities, data transfer arrangements and plant interfaces, shall not be capable of causing failure of more than one computer system. An alarm should be initiated if any computer fails or is not ready to take control.

4.2.3 For class notation DK 3, the DK control system shall consist of at least two computer systems arranged so that, in case of any single failure, automatic position keeping ability will be maintained. Common facilities, such as self-checking routines, alignment facilities, data transfer arrangements and plant interfaces , shall not be capable of causing failure of more than one computer system . The two or more computer systems mentioned above do not include the backup computer system ; thus , in addition , one separate backup DK control system should be arranged, see 4.2.6. An alarm shall be initiated if any computer fails or is not ready for operation.

4.2.4 For class notations DK 2 and DK 3, the DK 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 , propellers and rudders (if included under DK control) that remain in operation after the worst case failure can generate the same resultant thruster force and moment as required before the failure. The consequence analysis shall provide an alarm if the occurrence of a worst case failure would lead to a loss of position and /or heading due to insufficient thrust for the prevailing environmental conditions (e.g. wind, waves, current, etc.). 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 the environmental conditions.

4.2.5 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 with no loss of position and/or heading.

4.2.6 For class notation DK 3, the back-up DK control system shall be located in a room separated by A-60 class divisions from the main DK control station. During DK operation this back-up control system shall be continuously updated by input from at least one of the required sets of 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 DK control system. Main and backup DK control systems shall be so arranged that at least one system will be able to perform automatic position keeping after any single failure.

4.2.7 Each DK computer system shall be isolated from other on-board computer systems and communications systems to ensure the integrity of the DK system and command interfaces. This isolation may be effected via hardware and/or software systems and physical separation of cabling and communication lines. Robustness of the isolation shall be verified by analysis and proven by testing. Specific safeguards shall be implemented to ensure the integrity of the DK computer system and prevent the connection of unauthorized or unapproved devices or systems.

4.3 Position reference systems

4.3.1 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 working situation.

4.3.2 For class notation DK 1, at least two independent position reference systems should be installed and simultaneously available to the DK control system during operation.

4.3.3 For class notations DK 2 and DK 3, at least three position reference systems shall be installed and simultaneously available to the DK control system during operation.

4.3.4 When 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.

4.3.5 The position reference systems shall provide data with adequate accuracy and repeatability for the intended DK operation.

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

4.3.7 For class notation DK 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.

4.4 Sensor systems

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

4.4.2 When, for a class notation DK 2 or DK 3, the DK 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 three heading reference sensors being installed).

4.4.3 Sensors for the same purpose which are connected to redundant systems, shall be arranged independently so that failure of one will not affect the others.

4.4.4 For class notation DK 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. If the data from these sensors is passed to the main DK control system for their use, this system should be arranged so that a failure in the main DK control system cannot affect the integrity of the signals to the backup DK control system.

5. Cables and Piping Systems

5.1 For class notation DK 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, the termination of the ducts included, which are effectively protected from all fire hazards, except that represented by the cables themselves. Cable connection boxes may not be provided within such ducts.

5.2 For class notation DK 2, piping systems for fuel, lubrication, hydraulic oil, cooling water and cables shall be with due regard to fire hazards and mechanical damage.

5.3 For class notation DK 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, the termination of the ducts included, which are effectively protected from all fire hazards, except that represented by the pipes themselves.

6. Requirements For Essential Non-DK Systems

For class notations DK 2 and DK 3, systems not directly part of the DK system but which in the event of failure could cause failure of the DK system (e.g., common fire suppression systems, engine ventilation, heating, ventilation and air conditioning (HVAC) systems, shut-down systems, etc), shall also comply with the relevant requirements of these Rules.

7. Independent Joystick System

7.1 A joystick system independent of the automatic DK control system should be arranged. The power supply for the independent joystick system (IJS) is to be independent of the DK control system UPSs. An alarm should be initiated upon failure of the IJS.

7.2 The IJS should have automatic heading control.

C. Operational Requirements

1. Before every DK operation, the DK system should be checked according to applicable vessel specific location checklist(s) and other decision support tools such as ASOG in order to make sure that the DK system is functioning correctly and that the system has been set up for the appropriate mode of operation.

2. During DK operations, the system should be checked at regular intervals according to the applicable vessel-specific watchkeeping checklist.

3. DK operations necessitating class notation DK 2 or DK 3 should be terminated when the environmental conditions (e.g. wind, waves, current, etc.) are such that the DK vessel will no longer be able to keep position if the single failure criterion applicable to the equipment class should occur. In this context, deterioration of environmental conditions and the necessary time to safely terminate the operation should also be taken into consideration. This should be checked by way of environmental envelopes if operating in class notation DK 1 and by way of an automatic means (e.g. consequence analysis) if operating in class notation DK 2 or DK 3.

4. The necessary operating instructions should be kept on board.

5. DK capability polar plots should be produced to demonstrate position keeping capacity for fully operational and post worst-case single failure conditions. The capability plots should represent the environmental conditions in the area of operation and the mission-specific operational condition of the vessel.

6. The following checklists, test procedures, trials and instructions should be incorporated into the vessel-specific DK operations manuals:

- Location checklist (see item 1);
- Watchkeeping checklist (see item 2);
- DK operating instructions (see item 4);
- Annual tests and procedures (see Section 3, B.1.3)
- Initial and periodical (5-year) tests and procedures (see Section 3,B.1.1 and 1.2);
- Examples of tests and procedures after modifications and non-conformities (see Section 3,B.1.4);

- Blackout recovery procedure;
- List of critical components;
- Examples of operating modes;
- Decision support tools such as ASOG; and
- Capability plots (see item 5).

SECTION 3

SURVEYS, TESTING and DYNAMIC POSITIONING VERIFICATION ACCEPTANCE DOCUMENT (DPVAD)

A. Factory Acceptance Tests (FAT)

Before a new installation is surveyed and tested as specified in B. factory acceptance tests shall be carried out at the manufacturer's work. These tests are to be based on the approved program as required Section 1, F.3.

B. Surveys and Testing

1. Each DK vessel, which is required to comply with the rules, is subject to surveys and testing specified below:

1.1 An initial survey which should include a complete survey of the DK system and FMEA proving trials for DK classes DK 2 and DK 3 to ensure full compliance with the applicable parts of the Rules. Furthermore it should include a complete test of all systems and components and the ability to keep position after single failures associated with the assigned equipment class. The type of tests carried out and results should be recorded and kept on board;

1.2 A periodical testing at intervals not exceeding five years to ensure full compliance with the applicable parts of the Rules. A complete test should be carried out as required in item B.1.1. The type of tests carried out and results should be recorded and kept on board;

1.3 An annual survey should be carried out within three months before or after each anniversary date of the Dynamic Positioning Verification Acceptance Document **(1).** The annual survey should ensure that the DK system has been maintained in accordance with applicable parts of the Rules and is in good working order. The annual test of all important systems and components should be carried out to document the ability of the DK vessel to keep position after single failures associated with the assigned equipment class and validate the FMEA and operations manual. The type of tests carried out and results should be recorded and kept on board; and

1.4 A survey, either general or partial according to circumstances, should be carried out every time a defect is discovered and corrected or an accident occurs which affects the safety of the DK vessel, or whenever any significant repairs or alterations are made. After such a survey, necessary tests should be carried out to demonstrate full compliance with the applicable provisions of the Rules. The type of tests carried out and results should be recorded and kept on board.

2. For class notations DK 2 and DK 3, an FMEA should be carried out. This is a systematic analysis of the systems to the level of detail required to demonstrate that no single failure will cause a loss of position or heading and should verify worst-case failure design intent. This analysis should then be confirmed by FMEA proving trials. The FMEA and FMEA proving trials result should be kept on board and the FMEA should be kept updated so that it remains current.

3. These surveys and tests should be witnessed by officers of the Administration. The Administration may, however, entrust the surveys and testing either to surveyors nominated for the purpose or to organizations recognized by it. In every case, the Administration concerned should guarantee the completeness and efficiency of the surveys and testing. The Administration may entrust the company of the vessel to carry out annual and minor repair surveys according to a test programme accepted by the Administration.

4. After any survey and testing has been completed, no significant change should be made to the DK system without the sanction of the Administration, except the direct replacement of equipment and fittings for the purpose of repair or maintenance

C. Dynamic Positioning Verification Acceptance Document (DPVAD)

1. Compliance with these Rules should be verified by a DPVAD issued by or on behalf of the Administration.

2. A DPVAD should be issued, after survey and testing in accordance with these Rules, by the Administration or an organization recognized by it.

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(1) *If a Dynamic Positioning Verification Acceptance Document is not available, the anniversary date of the initial survey should be used to determine the date of the annual survey.*

3. The DPVAD should be drawn up in the official language of the issuing country and in the form given in the appendix to MSC.1/Circ.1580 "Guidelines For Vessels and Units With Dynamic Positioning Systems". If the language used is neither English nor French, the text should include a translation into one of these languages.

4. The DPVAD is issued for a period not exceeding five years, or for a period specified by the Administration.

5. The DPVAD should cease to be valid if significant alterations have been made in the DK system equipment, fittings, arrangements, etc. specified in the Guidelines without the sanction of the Administration, except the direct replacement of such equipment or fittings for the purpose of repair or maintenance.

6. The DPVAD issued to a DK vessel should cease to be valid upon transfer of such a vessel to the flag of another country.

7. The privileges of the DPVAD may not be claimed in favour of any DK vessel unless the DPVAD is valid.

8. Results of the DPVAD tests should be readily available on board for reference.

D. Training

Personnel engaged in operating a DK system should have received relevant training and practical experience in accordance with the provisions of the 1978 STCW Convention, as amended, the STCW Code, as amended, and the *Guidelines for Dynamic Positioning System (DP) Operator Training* (MSC/Circ.738, as amended).