MSC/Circular.645 - Guidelines for Vessels with Dynamic Positioning Systems - (adopted on 6 June 1994)

The Maritime Safety Committee

1. The Maritime Safety Committee at its sixty-third session (16 to 25 May 1994), approved the Guidelines for Vessels with Dynamic Positioning Systems, set out at annex to the present circular, as prepared by the Sub-Committee on Ship Design and Equipment at its thirty-seventh session.

2. Member Governments are invited to bring the Guidelines to the attention of all bodies concerned, and apply the Guidelines to new vessels with dynamic positioning systems constructed on or after 1 July 1994, in conjunction with implementation of the provisions of paragraph 4.12 of the 1989 MODU Code as amended by resolution MSC.38(63).

3. Member Governments are also invited to use the proposed model form of flag State verification and acceptance document set out in the appendix to the Guidelines.

Annex - Guidelines for Vessels with Dynamic Positioning Systems

Preamble

1. These Guidelines for vessels with dynamic positioning systems have been developed to provide an international standard for dynamic positioning systems on all types of new vessel.

2. Taking into account that dynamically positioned vessels are moved and operated internationally and recognizing that the design and operating criteria require special consideration, the Guidelines have been developed to facilitate international operation without having to document the dynamic positioning system in detail for every new area of operation.

3. The Guidelines are not intended to prohibit the use of any existing vessel because its dynamic positioning system does not comply with these Guidelines. Many existing units have operated successfully and safely for extended periods of time and their operating history should be considered in evaluating their suitability to conduct dynamically positioned operations.

4. Compliance with the Guidelines will be documented by a Flag State Verification and Acceptance Document (FSVAD) for the dynamic positioning system. The purpose of a FSVAD is to ensure that the vessel is operated, surveyed and tested according to vessel specific procedures and that the results are properly recorded.

5. A coastal State may permit any vessel whose dynamic positioning system is designed to a different standard than that of these Guidelines to engage in operations.

1 General

1.1 Purpose and responsibility

1.1.1. The purpose of these Guidelines is to recommend design criteria, necessary equipment, operating requirements, and a test and documentation system for dynamic positioning systems to reduce the risk to personnel, the vessel, other vessels or structures, sub-sea installations and the environment while performing operations under dynamic positioning control.

1.1.2. The responsibility for ensuring that the provisions of the Guidelines are complied with rests with the owner of the DP-vessel.

1.2 Application

. The Guidelines apply to dynamically positioned units or vessels, the keel of which is laid or which is at a similar stage of construction on or after 1 July 1994.

1.3 Definitions

. In addition to the definitions in the MODU Code 1989 the following definitions are necessary for the guidelines:

1.3.1. Dynamically positioned vessel (DP-vessel) means a unit or a vessel which automatically maintains its position (fixed location or predetermined track) exclusively by means of thruster force.

1.3.2. Dynamic positioning system (DP-system) means the complete installation necessary for dynamically positioning a vessel comprising the following sub-systems:

.1. power system,

.2. thruster system, and

.3. DP-control system.

1.3.3. Position keeping means maintaining a desired position with the normal excursions of the control system and the environmental conditions.

1.3.4. 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. generators,

.3. switchboards, and

.4. distributing system (cabling and cable routeing).

1.3.5. Thruster system means all components and systems necessary to supply the DP-system with thrust force and direction. The thruster system includes:

.1. thrusters with drive units and necessary auxiliary systems including piping,

.2. main propellers and rudders if these are under the control of the DP-system,

.3. thruster control electronics,

.4. manual thruster controls, and

.5. associated cabling and cable routeing.

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

.1. computer system/joystick system,

.2. sensor system,

.3. display system (operator panels),

.4. position reference system, and

.5. associated cabling and cable routeing.

1.3.7. Computer system means a system consisting of one or several computer including software and their interfaces.

1.3.8. Redundancy means ability of a component or system to maintain or restore its function, when a single failure has occurred. Redundancy can be achieved for instance by installation of multiple components, systems or alternative means of performing a function.

1.3.9. Flag State Verification and Acceptance Document (FSVAD) means the document issued by the Administration to a DP-vessel complying with these Guidelines. (*See* Appendix for model form.)

1.4 Exemptions

. An Administration may exempt any vessel which embodies features of a novel kind from any provisions of the Guidelines the application of which might impede research into the development of such features. Any such vessels should, however, comply with safety requirements which, in the opinion of the Administration, are adequate for the service intended and are such as to ensure the overall safety of the vessel.

. The Administration which allows any such exemptions should list the exemptions on the Flag State Verification and Acceptance Document (FSVAD) and communicate to the Organization the particulars, together with the reason therefore, so that the Organization may circulate the same to other Governments for the information of their officers.

1.5 Equivalents

1.5.1. Where the Guidelines require that a particular fitting, material, appliance, apparatus, item of equipment or type thereof should be fitted or carried out in a vessel, or that any particular provision should be made, or any procedure or arrangement should be complied with, the Administration may allow other fitting, material, appliance, apparatus, item of equipment or type thereof to be fitted or carried, or any other provision, procedure or arrangement to be made in that vessel, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance, apparatus, item of equipment or type thereof or that any particular provision, procedure or arrangement is at least as effective as that required by the Guidelines.

1.5.2. When an Administration so allows any fitting, material, appliance, apparatus, item of equipment or type thereof, or provision, procedure arrangement, novel design or application to be substituted, it should communicate to the Organization the particulars thereof, together with a report on the evidence submitted, so that the Organization may circulate the same to other Governments for information of their officers.

2 Equipment Classes

2.1. A DP-system consists of components and systems acting together to achieve sufficiently reliable position keeping capability. The necessary reliability is determined by the consequence of a loss of position keeping capability. The larger the consequence, the more reliable the DP-system should be.

To achieve this philosophy the requirements have been grouped into three equipment classes. For each equipment class the associated worst case failure should be defined as in 2.2 below.

The equipment class of the vessel required for a particular operation should be agreed between the owner of the vessel and the customer based on a risk analysis of the consequence of a loss of position. Else, the Administration or coastal State may decide the equipment class for the particular operation.

2.2. The equipment classes are defined by their worst case failure modes as follows:

.1. For equipment class 1, loss of position may occur in the event of a single fault.

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

.1. Any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.).

.2. Any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection and reliability.

For equipment class 3, a single failure includes:

.1. Items listed above for class 2, and any normally static component is assumed to fail.

.2. All components in any one watertight compartment, from fire or flooding.

.3. All components in any one fire sub-division, from fire or flooding (for cables, see also 3.5.1).

2.3. For equipment classes 2 and 3, a single inadvertent act should be considered as a single fault is such an act is reasonably probable.

2.4. Based on the single failure definitions in 2.2 the worst case failure should be determined and used as the criterion for the consequence analysis (*see* 3.4.2.4).

2.5. The Administration should assign the relevant equipment class to a DP-vessel based on the criteria in 2.2 and state it in the Flag State Verification and Acceptance Document (FSVAD) (*see* 5.2).

2.6. When a DP-vessel is assigned an equipment class this means that the DP-vessel is suitable for all types of DP-operations within the assigned and lower equipment classes.

2.7. It is a provision of the guidelines that the DP-vessel is operated in such a way that the worst case failure, as determined in 2.2, can occur at any time without causing a significant loss of position.

3 Functional Requirements

3.1 General

3.1.1. In so far as is practicable all components in a DP-system should be designed, constructed and tested in accordance with international standards recognized by the Administration.

3.1.2. In order to meet the single failure criteria given in 2.2, redundancy of components will normally be necessary as follows:

.1. for equipment class 2, redundancy of all active components;

.2. for equipment class 3, redundancy of all components and physical separation of the components.

3.1.3. For equipment class 3, full redundancy may not always be possible (e.g., there may be a need for a single change-over system from the main computer system to the back-up computer system). Non-redundant connections between otherwise redundant and separated systems may be accepted provided that it is documented to give clear safety advantages, and that their reliability can be demonstrated and documented to the satisfaction of the Administration. Such connections should be kept to the absolute minimum and made to fail to the safest condition. Failure in one system should in no case be transferred to the other redundant system.

3.1.4. Redundant components and systems should 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 redundant component or system should be automatic as far as possible, and operator intervention should be kept to a minimum. The transfer should be smooth and within acceptable limitations of the operation.

3.2 Power system

3.2.1. The power system should have an adequate response time to power demand changes.

3.2.2. For equipment class 1 the power system need not be redundant.

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

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

3.2.5. For equipment classes 2 and 3, the power available for position keeping should be sufficient to maintain the vessel in position after worst case failure according to 2.2.

3.2.6. If a power management system is installed, adequate redundancy or reliability to the satisfaction of the Administration should be demonstrated.

3.3 Thruster system

3.3.1. The thruster system should provide adequate thrust in longitudinal and lateral directions, and provide yawing moment for heading control.

3.3.2. For equipment classes 2 and 3, the thruster system should be connected to the power system in such a way that 3.3.1 can be complied with even after failure of one of the constituent power systems and the trusters connected to that system.

3.3.3. The values of thruster force used in the consequence analysis (*see* 3.4.2.4) should be corrected for interference between thrusters and other effects which would reduce the effective force.

3.3.4. Failure of thruster system including pitch, azimuth or speed control, should not make the thruster rotate or go to uncontrolled full pitch and speed.

3.4 DP-control system

3.4.1 General

.1. In general the DP-control system should be arranged in a DP-control station where the operator has a good view of the vessel's exterior limits and the surrounding area.

.2. The DP-control station should display information from the power system, thruster system, and DP-control system to ensure that these systems are functioning correctly. Information necessary to operate the DP-system safely should be visible at all times. Other information should be available upon operator request.

.3. Display systems and the DP-control station in particular, should be based on sound ergonometric principles. The DP-control system should provide for easy selection of control mode, i.e. manual, joystick, or computer control of thrusters, and the active mode should be clearly displayed.

.4. For equipment classes 2 and 3, operator controls should be designed so that no single inadvertent act on the operators panel can lead to a critical condition.

.5. Alarms and warnings for failures in systems interfaced to and/or controlled by the DP-control system are to be audible and visual. A permanent record of their occurrence and of status changes should be provided together with any necessary explanations.

.6. The DP-control system should prevent failures being transferred from one system to another. The redundant components should be so arranged that a failure of one component should be isolated, and the other component activated.

.7. It should be possible control the thrusters manually, by individual joysticks and by a common joystick, in the event of failure of the DP-control system.

.8. The software should be produced in accordance with an appropriate international quality standard recognized by the Administration.

3.4.2 Computers

.1. For equipment class 1, the DP-control system need not be redundant.

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

.3. For equipment class 3, the DP-control system should 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 should not be capable of causing failure at both/all systems. In addition, one back-up DP-control system should be arranged, see 3.4.2.6. An alarm should be initiated if any computer fails or is not ready to take control.

.4. For equipment classes 2 and 3, the DP-control system should include a software function, normally know as `consequence analysis', which continuously verifies that the vessel will remain in position even if the worst case failure occurs. This analysis should verify that the thrusters remaining in operation after the worst case failure can generate the same resultant thruster force and moment as required before the failure. The consequence analysis should provide an alarm if the occurrence of 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 should include a function which simulates the thrust and power remaining after the worse case failure, based on manual input of weather trend.

.5. Redundant computer systems should 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 should be smooth, and within the acceptable limitations of the operation.

.6. For equipment class 3, the back-up DP-control system should be in a room separated by A.60 class division from the main DP-control station. During DP-operation this back-up control system should be continuously updated by input from the sensors, position reference system, thruster feedback, etc., and be ready to take over control. The switch-over of control to the back-up system should be manual, situated on the back-up computer and should not be affected by failure of the main DP-control system.

.7. An uninterruptable power supply (UPS) should be provided for each DP-computer system to ensure that any power failure will not affect more than one computer. UPS battery capacity should provide a minimum of 30 minutes operation following a mains supply failure.

3.4.3 Position reference systems

.1. Position reference systems should be selected with due consideration to operational requirements, both with regard to restrictions caused by the manner of deployment and expected performance in working situation.

.2. For equipment classes 2 and 3, at least three position reference systems should be installed and simultaneously available to the DP-control system during operation.

.3. When two or more position reference systems are required, they should not all be of the same type, but based on different principles and suitable for the operating conditions.

.4. The position reference systems should produce data with adequate accuracy for the intended DP-operation.

.5. The performance of position reference systems should be monitored and warnings provided when the signals from the position reference systems are either incorrect or substantially degraded.

.6. For equipment class 3, at least one of the position reference systems should be connected directly to the back-up control system and separated by A.60 class division from the other position reference systems.

3.4.4 Vessel sensors

.1. Vessel sensors should at least measure vessel heading, vessel motions, and wind speed and directions.

.2. When an equipment class 2 or 3 DP-control system is fully dependent on correct signals from vessel sensors, then these signals should be based on three systems serving the same purpose (i.e. this will result in at least three gyro compasses being installed).

.3. Sensors for the same purpose, connected to redundant systems should be arranged independently so that failure of one will not affect the others.

.4. For equipment class 3, one of each type of sensors should be connected directly to the back-up control system and separated by A.60 class division from the other sensors.

3.5 Cables and piping systems

3.5.1. For equipment class 3, cables for redundant equipment or systems should not be routed together through the same compartments. Where this is unavoidable such cables could 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 are not allowed in such ducts.

3.5.2. For equipment class 2, piping systems for fuel, lubrication, hydraulic oil, cooling water and cables should be located with due regard to fire hazards and mechanical damage.

3.5.3. For equipment class 3, redundant piping system (i.e. piping for fuel, cooling water, lubrication oil, hydraulic oil, etc.) should not be routed together through the same compartments. Where this is unavoidable, such pipes could 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.

3.6 Requirements for essential non-DP-systems

. For equipment classes 2 and 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, etc.), should comply with relevant requirements of the Guidelines.

4 Operational Requirements

4.1. Before every DP-operation, the DP-system should be checked according to a vessel specific “location" check list to make sure that the DP-system is functioning correctly and that the system has been set up for the appropriate equipment class.

4.2. During DP-operations, the system should be checked at regular intervals according to a vessel specific watchkeeping checklist.

4.3. DP operations necessitating equipment class 2 or 3 should be terminated when the environmental conditions are such that the DP-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 equipment class 1 and by way of an automatic consequence analysis if operating in equipment class 2 or 3. The necessary operating instructions, etc., should be on board.

4.4. The following checklists, test procedures and instructions should be incorporated into the DP operating manuals for the vessel:

.*1*. Location checklist (*see* 4.1).

.*2*. Watchkeeping checklist (*see* 4.2).

.*3*. DP-operation instructions (*see* 4.3).

.*4*. Annual tests and procedures (*see* 5.1.1.3).

.*5*. Initial and periodical (5-year) tests and procedures (*see* 5.1.1.1 and 5.1.1.2).

.*6*. Example of tests and procedures after modifications and non-conformities (*see* 5.1.1.4).

5 Surveys, Testing and the Flat State Verification and Acceptance Document (FSVAD)

5.1 Surveys and testing

5.1.1. Each DP-vessel which is required to comply with the Guidelines is subject to the surveys and testing specified below:

.*1*. Initial survey which should include a complete survey of the DP-system to ensure full compliance with the applicable parts of the guidelines. Further it includes 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 test carried

out and results should be documented in the Flag State Verification and Acceptance Document (FSVAD). *See* 5.2.

.2. Periodical survey at intervals not exceeding five years to ensure full compliance with the applicable parts of the guidelines. A complete test should be carried out as required in 5.1.1.1. The type of test carried out and the results should be documented in the FSVAD, *see* 5.2.

.3. Annual survey should be carried out within three months before or after each anniversary date of the initial survey. The annual survey should ensure that the DP-system has been maintained in accordance with applicable parts of the guidelines and is in good working order. Further an annual test of all important systems and components should be carried out to document the ability of the DP-vessel to keep position after single failures associated with the assigned equipment class. The type of test carried out and results should be documented in the FSVAD, *see* 5.2.

.4. A survey either general or partial according to circumstances should be made every time a defect is discovered and corrected or an accident occurs which affects the safety of the DP-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 Guidelines. The type of tests carried out and results should be recorded and kept on board.

5.1.2. 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 fully guarantee the completeness and efficiency of the surveys and testing. The Administration may entrust the owner of the vessel to carry out annual and minor repair surveys according to a test programme accepted by the Administration.

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

5.2 Flag State Verification and Acceptance Document (FSVAD)

5.2.1. A Flag State Verification and Acceptance Document (FSVAD) should be issued, after survey and testing in accordance with these Guidelines, either by officers of the Administration or by an organization duly authorized by it. In every case the Administration assumes full responsibility for the FSVAD.

5.2.2. The FSVAD should be drawn up in the official language of the issuing country and be that of the model given in the appendix to the Guidelines. If the language used is neither English nor French, the text should include a translation into one of these languages.

5.2.3. The FSVAD is issued for an unlimited period, or for a period specified by the Administration.

5.2.4. An FSVAD should cease to be valid if significant alterations have been made in the DP-system equipment, fittings, arrangements, etc., specified in the Guidelines without the sanction of the Administration, except the direct replacement of such equipment of fittings for the purpose of repair and maintenance.

5.2.5. An FSVAD issued to a DP-vessel should cease to be valid upon transfer of such a vessel to the flag of another country.

5.2.6. The privileges of the FSVAD may not be claimed in favour of any DP-vessel unless the FSVAD is valid.

5.2.7. Control of a DP-vessel holding a valid FSVAD should be carried out accordingly the principles of 1.7 in the MODU Code 1989.

5.2.8. Results of the FSVAD tests should be readily available on board for reference.

Appendix - Model Form of Flag State Verification and Acceptance Document

Flag State Verification and Acceptance Document

Table 1 Flag State Verification and Acceptance Document

(Official seal) (State)

Issued under the provisions for guidelines

GUIDELINES FOR VESSELS WITH DYNAMIC POSITIONING SYSTEMS

(MSC/Circ...)

under the authority of the Government of

_____

(full designation of the State)

by

(full official designation of the competant person or organisation authorised by the Administration)

Distinctive identification (Name or number)	Type	Port of registry	Official IMO-number

Date on which keel was laid or vessel was at similar stage of construction or on which major conversation was commenced.....

THIS IS TO CERTIFY that the above mentioned vessel has been duly documented, surveyed, and tested in accordance with the Guidelines for Vessels with Dynamic Positioning Systems (MSC/Circ....) and found to comply with the Guidelines.

The vessel is allowed to operate in DP Equipment Class ..... and in lower equipment classes.

This document remains valid until ..... unless terminated by the Administration, provided that the vessel is operated, unless terminated by the Administration, provided that the Vessel is operated, tested, and surveyed according to the requirements in the guidelines and the results are properly recorded.

Issued at .....

(Place of issue of document)

....

(Date of issue) (Signature of authorised official issuing the certificate)

.....

(Seal or stamp of the issuing authority, as appropriate)

List of Exemptions and Equivalents

Table 2 List of Exemptions and Equivalents

LIST OF EXEMPTIONS AND EQUIVALENTS (ref. items 1.4 and 1.5 of the Guidelines) — — — —

List of Main Systems and Components Covered by FSVAD*

Table 3 List of Main Systems and Components Covered by FSVAD*

LIST OF MAIN SYSTEMS AND COMPONENTS COVERED COVERED BY FSVAD* — — —

* All main systems and components included in the dynamic positioning system are to be listed in a systematic way. As an alternative reference can be made to drawings, etc. It is important that it is possible by this list to identify all systems and components covered by FSVAD. Software versions should also be identified. Equipment installed after date of issuing FSVAD should only be included in the list after control and testing has been completed and modifications and non-conformities report signed.

Record of Annual Survey Reports, and Special (5 years) Survey Reports

Table 4 Record of Annual Survey Reports, and Special (5 years) Survey Reports

Date	Test Type	Remarks	*Report Reference Date/Number	Sign. of appointed surveyor (IR)	Sign. of Master/Platform Manager
* All reports should be filed together with this FSVAD for use during later testing and inspections by nominated surveyors, flag State surveyors, etc.					
IR = if required, ref. item 5.1.2					