Introduction to Dynamic Positioning (DP) Systems

12/2019

Purpose

This Guide provides the reader with a basic introduction to Dynamic Positioning (DP) Systems and operations. It represents a simplified summary of the applicable guidelines and industry standards regarding DP systems and components.

Unless otherwise stated, the information provided in this guide is based from the IMO Circulars; **IMO MSC.1/Circ. 645**, **MSC.1/Circ. 1580** and **MSC.1/Circ. 738 Rev.2.** In particular, the sections **Classes of DP Systems**, **DP Systems Explored**, the **Functionality of Systems**, **Surveys, Tests, and DPVAD**.

Additional guidance and information in the form of Appendices may be published in the future covering specific classes of vessels or topics such as:

- MODUs
- Large OSV (>6000 tons) & Multi-certificated OSV (I & L)
- Investigations
- OSVs < 6000 tons
- Vessels < 100 tons

If you have any recommendations or you would like to provide feedback about this or other publications and materials, please contact the OCS NCOE via one of the following methods

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Objectives

The objectives of this guide are to:
- State examples of DP use on the Outer Continental Shelf.
- Describe the systems and components of a DP system.
- Explain how the system keeps station.
- Describe the Documents normally found on board DP vessels.
- Describe the Surveys and Tests done on DP Systems.
- Outline the applicable guidance and other references applicable to DP systems.

Uses of DP Systems on the OCS

A Dynamic Positioning System is a computer-controlled system used to automatically maintain a vessel's heading and position without the use of mooring lines and/or anchors.

Since it was first introduced in the 1960s, DP Systems have evolved to become the primary means of station keeping for vessels operating on the U.S. Outer Continental Shelf (OCS). DP Systems are often used on Mobile Offshore Drilling Units (MODUs), Floating Production Units (FPUs), Construction Vessels, Accommodation Vessels (Floatels), Dive Support Vessels and Offshore Supply Vessels (OSVs).

The DP system is used to maintain the vessel's position in order to conduct critical activities such as drilling, diving operations, under water construction, and close quarter activities such as bulk cargo transfers, fuel transfers, deck cargo operations, personnel transfers, and ROV work.

DP System Explored

A DP System is comprised of three sub-systems:

- **Power System,**
- **Thruster System, and**
- **DP Control System**

These three sub-systems work in unison to maintain the vessel's heading and position by controlling the horizontal movement of the vessel.

Power System

The power system is comprised of all components and associated systems necessary to supply the DP system with power.

The power system includes but is not limited to:

- prime movers;
- generators;
- switchboards;
- distribution systems (associated cabling and cable routing);
- uninterruptible power supplies (UPS) and batteries; and,
- power management system(s) (as appropriate).

Thruster System

The thruster system is comprised of all components and associated systems necessary to supply the DP system with variable force and direction of thrust.

The thruster system includes:

- thrusters with drive units and necessary auxiliary systems including piping, cooling, hydraulic and lubrication systems, etc;
- main propulsion systems; propellers and rudders, Z-drives, azipods, water jets, etc;
- auxiliary thrusters; tunnel thrusters, drop down thrusters, z-drives, etc;
- thruster control systems;
- manual thruster controls; and,
- associated cabling and cable routing.

DP Control System

The DP control system is comprised of all control components and associated systems, hardware and software necessary to coordinate with the other sub-systems to maintain position.

The DP control system includes:

- computer system;
- joystick system;
- sensor system(s);
- control stations and display system (operator panels);
- position reference system(s);
- associated cabling and cable routing; and,
- networks.

Classes of DP Systems

The IMO has categorized DP Systems into **3 Equipment Classes** based on **redundancy** and **protection**. The necessary redundancy level for the components and systems are determined by the consequence of the loss of vessel position and/or heading. The classes are stated below as defined in IMO MSC.1/Circ. 1580:

Class 1

- A loss of position and/or heading **may occur** in the event of a single fault.

Class 2

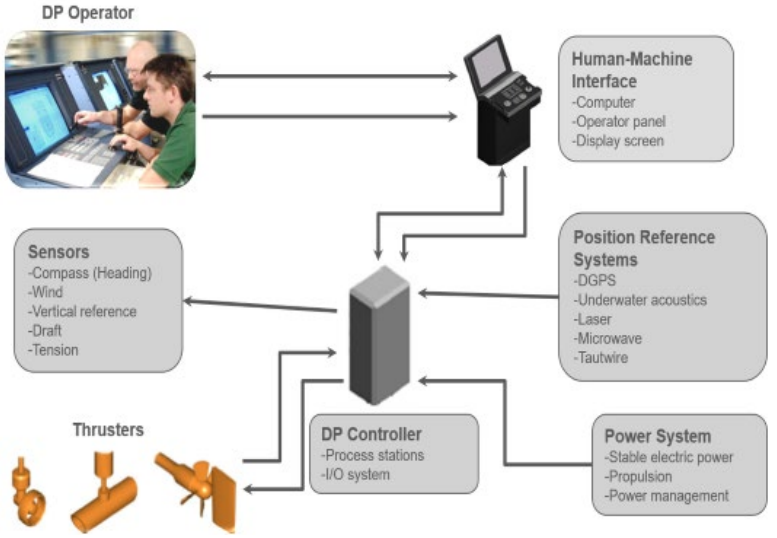
- A loss of position and/or heading **will not occur** in the event of a single fault in any active component or system.
- Single failure criteria include, but are not limited to:
  - Any active component or system (generators, thrusters, switchboards, communication networks, remote-controlled valves, etc.); and,
  - 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.
- 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.

Class 3

- A loss of position and/or heading **will not occur** in the event of a single fault or failure.
- A single failure includes:
  - Items listed above for class 2, and any normally static component assumed to fail;
  - All components in any one watertight compartment, from fire or flooding; and
  - All components in any one fire sub-division, from fire or flooding (for cables, see also paragraph 3.5.1 of IMO MSC.1/Circ. 1580).

Note: for a general overview of equipment and systems related to each Class, see the **Table of Subsystems and Equipment per DP Class** on Page 17.

Functionality of Systems



The DP System maintains a vessel's desired position and/or heading by use of the DP control computer which automates the control of vital power and propulsion systems in order to control 3 of 6 axes of a vessel's movement:

- surge (aft and forward),
- sway (side to side), and
- yaw (heading).

DP Systems are complex and rely on the harmonization of hardware, software, machinery and human interfaces to properly maintain the vessel in a fixed position. The failure of one or more of these systems could result in a potentially catastrophic event. To properly inspect the DP System, it is imperative that marine inspectors have knowledge and understanding of how the system works as a whole.

Power System

The power supply should be reliable and adequate to provide continuous power to the DP control system, thrusters/propulsion systems and all of the vessel's other operational loads or power demands so that the DP system can maintain the vessel's desired position and heading.

DP Class 1

- redundancy of power system is not required

DP Class 2 & 3

- The power system should be divided into at least two or more systems so that in the event of failure of one system, there will be at least one other system in operation to maintain the vessel in position.
- 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.
- There should be enough power available to maintain position after worst-case failure.

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

The approved FMEA will illustrate the configuration of power generation systems.

Control System Computers

The control computers receive input from various sensors and reference systems to determine the vessel's heading, position and the external forces being applied to the vessel. This information is then processed to determine the amount and direction of force that must be applied in order to counteract the external forces. The Power and Thrusts sub-system then execute the commands given from the control system and exerts the desired force needed to maintain the desired heading and position.

DP Class 1

- Redundancy of control system computers is not required.

DP Classes 2 & 3

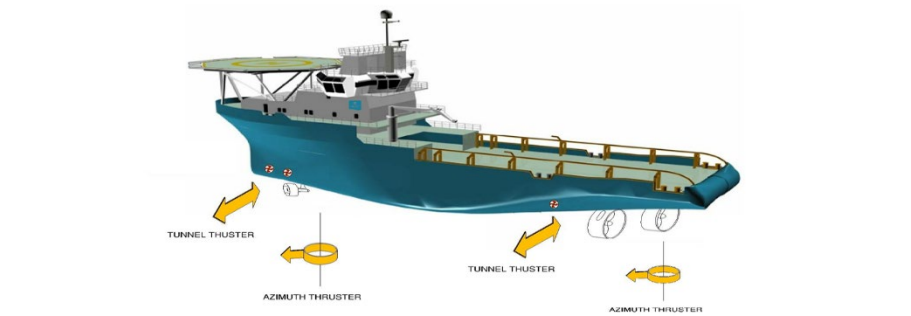
- The DP control system computers should consist of at least two computer systems so that, in case of any single failure, automatic position keeping ability will be maintained.
- There should be automatic transfer of control after a detected failure in one of the computer systems.
- The automatic transfer of control from one computer system to another should be smooth with no loss of position and/or heading.
- The DP control system computers should 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.

DP Class 3,

- An additional backup DP control system computer should be in a room separated by an A-60 class division from the main DP control station.

The approved FMEA will illustrate the configuration of Control System Computers.

Thruster System



The thruster system shall be arranged as to provide the vessel with adequate maneuverability under all operating conditions. Also, the thruster system should be able to provide adequate thrust to control surge, sway and yawing.

Thruster systems should be arranged so that the failure of any part of the system including pitch, azimuth or speed control should not increase the thrust magnitude or direction.

Individual thruster emergency stop systems should be arranged in the DP control station.

DP Class 1 • Redundancy of thrusters system is not required.
DP Classes 2 and 3 • The thruster emergency stop system should have closed loop monitoring to detect any faults.
DP Class 3 • The effects of fire and flooding should be considered.

The approved FMEA will illustrate the configuration of thruster systems.

Position Reference Systems

In order for the DP System to keep a vessel in a desired position, it must utilize a Position Reference System (PRS). The PRS identifies the vessel's current position. This position will either be an **Absolute Position** (geographic position) or a **Relative Position** (relative to a target).

There are several systems, which utilize either absolute or relative positions. Some of these systems and some common brand names are:

Relative PRS	Absolute PRS
Laser (Cyscan®, Fanbeam®)	Satellite (DGPS, DGNSS)
Microwave (Radascan®)	Underwater Acoustics (HPR)*
Tautwire**	

*An acoustic absolute system can be used as a relative system if attached to a non-fixed target.

**A relative system can be used as an absolute system if installed on a point that is a fixed geographical position.

DP Class 1 • At least two position references systems should be available during operations.
DP Classes 2 & 3 • At least three position reference systems should be available during operations.
DP Class 3 • At least one of the position reference systems should be connected directly to the backup control system and separated by an A-60 class division from the other position reference systems.

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

The approved FMEA will illustrate the types PRS on board.

Environmental & Motion Sensors

Vessel should be equipped with sensors to measure **heading, vessel motion** and the **wind speed and direction**. These sensors include;

Gyros:

- The gyrocompass constantly provides the DP computer with the vessel's current heading data in order to maintain and/or control vessel's heading.

Wind:

- Input from wind sensors are needed for the controller to measure the effects of the wind on the sail area of the vessel.

Motion Sensors:

- These sensors measure the 3 of the 6 degree of motions that are not controlled, but must be accounted for to improve accuracy of the position reference systems.
  - Pitch (rock fore and aft),
  - Roll (rock side to side)
  - Heave (lift up and down)

Sensors for the same purpose which are connected to redundant systems should be arranged independently so that failure of one will not affect the others. Example: the 3 gyrocompasses that are providing input data into the 2 DP computers should be arranged that failure of one gyrocompass shall not affect the remaining 2.

DP Class 1

- Redundancy of these systems are not required.

DP Classes 2 & 3

- There should be three sensor available for the same purpose (3 wind sensors, 3 Gyros, 3 motion sensors).

DP Class 3

- One of each type of sensor should be connected directly to the backup DP control system, and separated by an A-60 class division from the other sensors.
- If the data from these sensors are passed to the main DP control system, this system should be arranged so that a failure in the main DP control system cannot affect the integrity of the sensor's data to the backup DP control system

The approved FMEA will illustrate the types of sensors on board .

Operator Control Stations

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

The operator's station should be located where the operator has good visibility of the exterior and surrounding arears.

The operator's station should allow for easy accessibility of the control mode, i.e. manual joystick, or automatic DP control of thrusters, propellers and rudders, if part of the thruster system. The active control mode should be clearly displayed.

The operator's stations should be fitted with visual and audible alarms and warnings for failures in all systems interfaced to and/or controlled by the control system should be audible and visual. There should be a record of their occurrence and of status changes and should be provided together with any necessary explanations.

DP Classes 2 & 3 • Two operator stations should be provided.
DP Class 3 • An additional backup control system should be available in an A-60 class division.
DP Classes 2 and 3 • The operator controls should be designed so that no single inadvertent act on the operator's panel can lead to a loss of position and/or heading.

Human Element (DP Operator)

The DP operator should be:

- A navigational watch officer
- Trained and experienced
- Knowledgeable and familiar with the DP system and vessel's characteristics
- Responsible for the input of the desired position and heading into the DP computer
- Responsible for monitoring all systems to ensure safe, effective and efficient DP Operations, including:
  - weather
  - positioning capability
  - DP control systems
  - power systems
  - thrusters systems
  - any other systems relevant to DP Operations

The required training, familiarization and/or certification of the DP personnel on board will be included in the approved DP Operations Manual.

For additional information on these components and their integration into a DP system, see the OCS NCOE's *Drill Down* on Dynamic Positioning Systems, Issue: 10-TS, 15 Feb 2018. (https://www.dco.uscg.mil/OCSNCOE/The-Drill-Down/). Also, visit our website and select Dynamic Positioning from the menu for more resources and information regarding DP systems.

IMO Equipment Class and Classification Society Notations

The DP Class that the vessel has been assessed and endorsed for will be indicated on the Classification Certificate.

The table below illustrates the correlation between the IMO equipment classes 1, 2, & 3, to the most common Classification Societies' Notations found on Class Certificates.

IMO Class	ABS	DNV-GL	LR
1	DPS-1	DYNPOS-AUT Or DPS 1	DP (AM)
2	DPS-2	DYNPOS-AUTR Or DPS 2	DP (AA)
3	DPS-3	DYNPOS-AUTRO Or DPS 3	DP (AAA)

IMO Guidelines for Vessel Operations with DP Systems

IMO has developed guidance for vessels operating with DP Systems; IMO MSC.1/Circ. 645, MSC.1/Circ. 1580 and MSC.1/Circ. 738 Rev.2.

Although the USCG has not developed regulations requiring compliance with these IMO DP Circulars, these circulars have been used as the standard guidance for plan review and approval, and are used by industry, ACS/RO's and even the Marine Safety Center (see MTN 02-11) for DP systems.

IMO MSC.1/Circ.645: (6 June 1994)

- Approved by the IMO's MSC 63 in May 1994 to provide an international standard for dynamic positioning systems on all types of vessels.
- Applies 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.**
- Recommend design criteria, necessary equipment, operating requirements and a test and recommended documentation system for dynamic positioning systems to reduce the risk to personnel, equipment and the environment, while performing operations under dynamic positioning control.

IMO MSC.1/Circ. 1580: (16 June 2017)

- This circular recommends the design criteria, equipment, operating provisions and testing as well as a documentation regime for DP systems in order to reduce the risk to personnel, equipment and the environment, while performing operations under dynamic positioning control.
- IMO recommends that the current guidelines in this circular be applied to vessels and units constructed on or **after 9 June 2017.**
- It was developed for new vessels and units constructed **after 9 June 2017)** with dynamic positioning systems to provide an amended standard reflecting the current industry practice and DP technology advancements since 1994.
- For vessels and units constructed on or after 1 July 1994 but before 9 June 2017, the previous version of the Guidelines (IMO MSC.1/Circ.645) may continue to be applied, however it is recommended that section 4 (Operational Requirements) of the present Guidelines be applied to all new and existing vessels and units, as appropriate.

IMO MSC.1/Circ. 738, Rev. 2: (16 June 2017)

- The IMO's Maritime Safety Committee noted that the IMCA M 117 Rev. 1 Training and Experience of Key DP Personnel was updated to IMCA M 117 Rev. 2.
- The IMO's Maritime Safety Committee also approved revised circular and requested Member States to bring it to the attention of all parties concerned.
- Other than those changes, everything in **MSC.1/Circ.738, Rev.1** remains the same.
- **IMO MSC.1/Circ. 738 Rev. 2 Revokes MSC.1/Circ.738, Rev. 1.**

DP System Plan Review and Approval

For U.S. Flagged vessels, the DP System's Plans and Documents should be approved by the U.S. Coast Guard's Marine Safety Center or an ACS/RO on behalf of the Coast Guard. Evidence of approval will be a copy of stamped Plans/Documents, and Reviewed/Approved Letter from the approving authority. There should also be records of the completed Proving Trials on board that should be stamped reviewed/approved.

The Marine Safety Center oversees plan review and other technical work performed by ACS/ROs for U.S. Flagged vessels and has published several guidance documents regarding the review and approval of plans for DP systems. Two of them that are discussed in this DP Guide are; MTN 02-11 and PRG E2-24.

DP Documents that should be reviewed and approved which are common to both MSC's MTN 02-11 and IMO Guidelines are:

- DP FMEA
- DP Proving Trials
- Special Trials (when applicable)
- Operations Manual

Marine Safety Center MTN 02-11

The Marine Safety Center has published a Technical Note for DP Plan Submittal and Approval (MSC's MTN 02-11) which provides guidance for submitting plans to the MSC, or to an Authorized Classification Society (ACS) conducting review of these systems on behalf of the Coast Guard. Enclosure (2) of the MTN allows the submitters to submit plans using the IMO MSC/Circular 645 Guidelines for vessels with DP Systems as the baseline for the design, or cite the relevant Classification Society Rules for the design.

Marine Safety Center PRG E2-24

In addition to MTN 02-11, The Plan Review Guideline (PRG) titled "E2-24 Dynamic Positioning Systems" will assist the plan submitters with preparing and submitting a DP system plan to the Marine Safety Center.

DP and Vital System Terms Correlation

Common terms when discussing DP systems with the Marine Industry and Class Societies are; DP Proving Trials, Annual Trials and DP Failure Modes and Effects Analysis (FMEA). These terms can be correlated to the Coast Guard Regulatory terms of; Qualitative Failure Analysis (QFA), Design Verification Test Procedures (DVTPs) and Periodic Safety Test Procedures (PSTPs).

The table below shows the correlation between the terms used in 46 CFR 62 Vital System Automation and equivalent DP terms.

Vital System Automation	DP Systems
QFA	FMEA
DVTP	Proving Trials
PSTP	Annual/Periodic/Special Trials

Surveys, Tests & DPVAD

DP FMEA

A FMEA is 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.

- Required for DP **Classes 2 & 3**.
- Should be carried out to demonstrate that no single failure will cause a loss of position or heading and should also verify worst-case failure design intent.
- The DP components and systems on board the vessel should match the components and systems that are listed in the approved FMEA.
- Should be kept on board and should be kept updated so that it remains current.
- Should be approved by flag state or their recognized ACS/RO.
    - For U.S. Flagged vessels, the FMEA will be approved by the Marine Safety Center or an ACS/RO.

DP Proving Trials

A survey and proving trials should be conducted to confirm the expected effects of the failure modes found in the FMEA desktop analysis.

- Required for DP **Classes 2 &3**.
- Should test the interface of the different systems and equipment of the different vendors.
- Proving Trials test to confirm that no single fault will cause a loss of position or heading and will also verify worst-case failure analysis.
- The test procedures and the results of the DP proving trials should be kept on board.
- Should be approved by the flag state or their recognized ACS/RO. For U.S. Flagged vessels, the Proving Trials will be approved by the Marine Safety Center or an ACS/RO.
- These tests are comparable to the U.S. Regulatory requirements for Design Verification Test Procedures.

DP Periodic Trials

A survey and periodic trials should be completed every 5 years using similar test procedures as the DP Proving Trials.

- Required for DP **Classes 2 &3**.
- Tests should confirm that system continues to operate as designed and no single fault will cause a loss of position or heading and will also verify worst-case failure analysis.
- The test procedures and the results of the periodic trials should be kept on board.

DP Annual Trials

The annual survey and tests of the DP system and components should be completed within 3 months before or after the anniversary date of the DPVAD or initial survey.

- Required for **DP Classes 2 &3**.
- Verifies that the DP system is able to function as designed and also validates the FMEA and operations manual.
- Annual Trials are usually more limited in scope and are comparative to that of the Regulatory requirements of the Periodic Safety Test Procedures.
- The test procedures and the results of the annual trials should be kept on board.

Special Trials

Either a general or partial survey and test, depending on the circumstances, should be carried out each time a defect is discovered and corrected or after an accident occurs which affects the safety of the DP vessel, or whenever any significant repairs or alterations are made.

- Any changes, upgrades, or modifications (excluding in-kind changes) to components or systems listed in the FMEA, including software changes, must be resubmitted to the Marine Safety Center and/or an ACS/RO for approval and be tested.
- The tests procedures and the results of the special trials should be kept on board.
- Should be approved by flag state or their recognized ACS/RO.
- For U.S. Flagged vessels, these tests will be approved by the Marine Safety Center or an ACS/RO.

DP Verification Acceptance Document (DPVAD)

This document should be issued by the Flag State or RO to vessels that comply with the IMO DP guidance (IMO 645 or IMO 1580), as applicable.

- Should be issued for a period not to exceed 5 years
- Should cease to be valid if significant alterations have been made to the DP system or components without Administration or RO approval.

Note: Because the U.S. Coast Guard does not have any regulations regarding DP systems, DPVADs are not normally found on U.S. Flagged vessels. Verification of DP systems would be found on the appropriate Classification Certificate.

Operations

DP Operations Manual

A DP Operations Manual is required as part of the plan review and approval. The DP Operations Manual should be vessel specific and located near the DP Operator's Station, readily available to the DPO for quick reference during DP Operations. DP operations should be conducted in accordance with the approved DP Operations Manual.

DP Operations may be considered "Key Shipboard Operations" as stated in Regulation 7 of ISM. Therefore, the DP Operations Manual may also be part of the vessel's SMS.

The requirement for the vessel specific DP Operations Manual is in addition to the manufacturer's Owner's or Operator's Manual.

The requirements for the contents of the DP Operations Manual differ depending on the approving authority. However, most DP Operations Manual will normally include the items listed below:

- **Vessel Specific DP Operation Instructions:** The manual should be representative of the way the vessel is operated in DP. It may also include Company Specific Policies and Procedures regarding Operations and Reporting.
- **On-site Location and Watch-keeping Checklists:** Checklists specific to the on-site location as well as watch-keeping should be included in the DP Operation's Manual. These checklist usually include both bridge and engine room checklists.
- **DP Personnel Training and Competence Requirements:** The Operations Manual should provide requirements for training and competence of all DP personnel. This may include: on board familiarization, training certifications, checklists and assessments.
- **Weather and Operation Limitations:** The DP Operations Manual should include information related to the limitation of DP Operations with regards to; weather, power systems, thrusters, proximity to other vessels/MODUs/structures, draft, Simultaneous operations, PMS, etc.
- **Capability Plots:** The DP Operations Manual may also include Capability Plots which are calculated 360 degree envelopes of current and wind speeds that the vessel can theoretically be able to maintain position in certain scenarios. These scenarios would include; intact power and thrusters, loss of most effective thrusters, and following a worst case failure (WCF).

  Although, capability plots may be included in the approved DP Operations Manual, they may also be in a separate folder for quicker access during DP Operations.

- **Foot Print Plots:** Foot Print Plots are actually taken onboard, to measure the vessel's performance while on DP within an established time period. The DP Operations Manual should include instructions on when these plots should be taken and include a sample form. These plots are normally completed manually, but may be done electronically if the DP Operator Station has the capability.
- **Incident/Accident Reporting:** Incident/Accident reporting requirements should be included in the DP Operations Manual. There may also be instructions for reporting requirements for change of status when using an ASOG/WSOG or CAMO.
- **Record Keeping:** The DP Operations Manual should also contain instructions for record keeping. DP related records should be maintained onboard and, where appropriate, at the company's office.
- **Operational Planning**: The DP Operations Manual should include specific guidance in the form of an ASOG/WSOG and CAMOs for specific DP activities and missions, as appropriate. The DP Operations Manual should also give the configuration arrangement of the vessel's DP system for TAMs, and CAMs.
- **List of Critical Components**: A list of critical components should be identified and listed in the DP Operations Manual.
- **Blackout Recovery:** There should be blackout recovery procedures in the DP Operations Manual to provide guidance for recovery in the event of a blackout.

Maintenance Records

Each DP vessel should have a structured planned maintenance system that specifically addresses maintenance of the vessel's DP System and Components.

Includes all components of the DP system to include the power, thruster and control systems.
Should address all systems and components that may affect the safety of the DP operations and station keeping capabilities.

Note: Service Reports for DP system should also be kept on board.

Records of Warnings and Alarms

Records of system warnings and alarms should be kept by means of an electronic DP data log, or a dedicated printer readout. Records relating to a DP incident should be permanently stored in retrievable archives.

Table of Subsystems & Equipment per DP Class

DP Class Equipment Requirements					
Subsystem or Component			**Minimum Requirements for each DP Class**		
			Class 1	**Class 2**	**Class 3**
Power	Generators & Prime Movers		Non-Redundant	Redundant	Redundant, with separate A-60 compartments
	Main Switch Board		1	1 w/Bus Tie	2, with 1 in separate A-60 compartment
	Bus Tie Breaker		0	1	2
	Distribution System		Non-Redundant	Redundant	Redundant, with 1 in separate A-60 compartment
	Power Management System		Optional	Yes	Yes
Thrusters /Propulsion	Arrangement		Non-Redundant	Redundant	**Redundant**
Controls	DP Computer Systems		1	2	2 + 1 in A-60 backup control station
	Manual Control – Joystick		Yes	Yes	Yes
	Single Levers for each thruster		Yes	Yes	Yes
	Operator Control Station		1	2	2 + 1 in A-60 backup control station
	Consequence Analysis		No	Yes	Yes
	Position Reference Systems		2	3	2 + 1 in A-60 backup control station
	Sensors	Wind	1	3	2 + 1 in A-60 backup control station
		Motion	1	3	2 + 1 in A-60 backup control station

Controls	Sensors	Gyro	1	3	2 + 1 in A-60 backup control station
	UPS		1	2	2 + 1 in A-60 backup control station
FMEA/Proving Trials			No	Yes	Yes

Regulatory, Policy and Guidance References

2009 MODU Code	Regulation 4.13 Dynamic Positioning
46 CFR Part 15	Vessel Manning
46 CFR Subchapter F	Marine Engineering
46 CFR Subchapter I	Cargo & Miscellaneous Vessel
46 CFR Subchapter J	Electrical
46 CFR Subchapter L	Offshore Supply Vessel
77 FR 26562 (2012)	Mobile Offshore Drilling Units Dynamic Positioning Guidance
77 FR 62247 (2012)	Dynamic Positioning Operations Guidance for Vessels Other Than Mobile Offshore Drilling Units Operating on the U.S. Outer Continental Shelf
ABS Rules Part 4	Vessel Systems and Machinery
ACP Supplement	ABS Supplement for Steel Vessels
ACP Supplement	ABS Supplement for Steel Vessels < 90 meters
ACP Supplement	ABS Supplement for Offshore Supply Vessels
ACP Supplement	DNV Supplement, Revision 11
ACP Supplement	DNV MODU Supplement
ACP Supplement	LR Supplement, Revision 2.0
ACP Supplement	GL Supplement, Revision 15
ACP Supplement	RINA Supplement
ACP Supplement	DNV GL Supplement
ACP TTP	Alternate Compliance Program Tactics, Techniques and Procedures
CG-5PC Policy Ltr. (2013)	Voluntary Reporting of Dynamic Positioning (DP) Incidents on Mobile Offshore Drilling Units (MODUs)
Class Society Rules	Various for those Vessels that are Alternate Compliance Vessels
D08 DP Policy Letter	D8(m) Policy Ltr. 01-2003, 22 January 2003, “Use of DP by OSVs for Oil and Hazardous Transfers”.
IMO MSC.1/Circ. 1580	Guidelines for vessels and units with Dynamic Positing (DP) Systems (17 June 2017)
IMO MSC.1/Circ. 645	Guidelines for Vessels with Dynamic Positing Systems (6 June 1994)

IMO MSC.1/Circ. 738/Rev. 2	Guidelines For Dynamic Positioning System (DP) Operator Training (16 June 2017)
MODU DP Checklist	Mobile Offshore Drilling Unit (MODU) Dynamic Positioning Guide (FR 26562 related)
MSC Guidelines	E2-01 Vital System Automation
MSC Guidelines	E2-05 Design Verification Test Procedures (DVTP)
MSC Guidelines	E2-17 Periodic Safety Test Procedures (PSTP)
MSC Guidelines	E2-18 Qualitative Failure Analysis (QFA)
MSC Guidelines	E2-24 Review of DP Systems
MSC Technical Note	02-11 Vital System Automation & DP System Plans
MTS DP Ops Guide Part 1	Marine Technical Society's DP Operational Guidance, 2012, Part 1
MTS DP Ops Guide Part 2 App. 1.	Marine Technical Society's DP Operational Guidance, 2012, Part 2, Appendix 1, (DP MODUs)
MTS DP Ops Guide Part 2 App. 2.	Marine Technical Society's DP Operational Guidance, 2012, Part 2, Appendix 2, (DP Project/Construction Vessels)
MTS DP Ops Guide Part 2 App. 3.	Marine Technical Society's DP Operational Guidance, 2012, Part 2, Appendix 3, (DP Logistics Vessels)
NVIC 01-78 CH-1	Automation of Offshore Supply Vessels of 100 or more GT
NVIC 02-95 CH-3	USCG's Alternate Compliance Program (ACP)

Glossary

ABS – American Bureau of Shipping
ACP – Alternate Compliance Program
ACP TTP – Alternate Compliance Program Tactics, Techniques and Procedures
ACS/RO – Authorized Classification Society/Recognized Organization
ASOG – Activity Specific Operating Guidelines
CAM – Critical Activity Mode (configuration)
CAMO – Critical Activity Mode of Operation
CG – Coast Guard
CG MI – Coast Guard Marine Inspector
MSC – Coast Guard Marine Safety Center
DNV-GL – Det Norske Veritas-Germanischer Lloyd
DOC – Document of Compliance
DP – Dynamic Positioning
DPO – Dynamic Positioning Operator
DPVAD – Dynamic Positioning Verification Acceptance Document
DVTP – Design Verification Test Procedures
FLOATELS – Floating Hotels
FMEA – Failure Mode Effects and Analysis
FPSO – Floating Production Storage and Offloading Units

FR – Federal Register
IMCA – International Marine Contractors Association
IMO's MSC – International Maritime Organization's Maritime Safety Committee
ISM – International Safety Management System
LR – Lloyds Register
MODU – Mobile Offshore Drilling Unit
MRS – Motion Reference System
MRU – Motion Reference Unit
MSC – Marine Safety Center (U.S.)
MTS – Marine Technical Society
OCS – Outer Continental Shelf
OCS NCOE – Outer Continental Shelf National Center of Expertise
OSV – Offshore Supply Vessel
PRS – Position Reference System
PSTP – Periodic Safety Test Procedures
QFA – Qualitative Failure Analysis
SIMOPS – Simultaneous Operations
SMC – Safety Management Certificate
TAM – Task Appropriate Mode (configuration)
UPS – Uninterrupted (or uninterruptible) Power Supply
USCG MSC's MTN – Marine Safety Center's Marine Technical Note
USCG MSC's PRG – Marine Safety Center's Plan Review Guide
USCG's MSC – United States Coast Guard's Marine Safety Center
VRS – Vertical Reference System
VRU – Vertical Reference Unit
WCF – Worst Case Failure
WCFDI – Worst Case Failure Design Intent

Definitions

The following are definitions for the purpose of this guide.

Absolute Reference System: A position reference system that provides geographical position information.

Activity Specific Operating Guidelines: Tabulated guidelines for the operational, environmental and equipment performance limits for a specific activity and location. The table also sets out various levels of DPO's actions should any situation changes.

Bus-Tie: A device for connecting/disconnecting multiple switchboards.

Company: The person, organization or charterer who has assumed the responsibility of operation of the vessel. This would normally be the same as the Company as stated on the vessel's SMC.

Consequence Analysis: A software function built-in for DP 2 & 3 class systems, which continuously monitors the system and environmental impacts, verifying that the vessel will remain in position even if a worst-case failure occurs.

Critical Activity Mode of Operations: A tabulated table presentation of the CAM which also sets out the DPO's action should the required configuration not be met.

Critical Activity Mode: The configuration of the DP system should be setup and operated in so as to deliver the intent of the vessel's DP class notation.

DP Capability: A vessel's ability to maintain position or station keeping while using the DP system (on DP).

DP Control Station: DPO workstation where the DPO can monitor and control all systems and components of the DP System.

DP Control Systems: All control components and systems, hardware and software including; computer systems, sensors, display systems, PRS, and associated cable and routing, necessary to dynamically position the vessel.

DP Incident: A major system failure, environmental or human factor which has resulted in loss of DP capability and/or station keeping.

DP Operation: When the DP system controls at least 2 degrees of freedom in the horizontal plane.

DP Operations Manual: A vessel specific operations manual to provide the DPO with guidance and procedures for carrying out DP operations.

DP Personnel: All personnel involved with DP operations, including the DPO.

DP Undesired Event: A system failure, environmental or human factor which has caused a loss of redundancy and/or compromised DP capability and/or station keeping.

DPO: A member of the navigation watch team that has been delegated to operating of the DP system.

Drift Off: a loss of position caused by a partial or total loss of thrust leading the DP vessel/installation to drift.

Drive Off: a loss of position caused by an improper and undesired force applied by the DP system or a DP control system instability leading the DP vessel/installation to move in an undesired direction (yaw, surge and/or sway).

Dynamic Positioning Vessel: A vessel maintaining position and heading or following a target automatically by means of the DP System.

Fail Safe Condition: The system is returned to a safe state in the case of a failure or malfunction.

Loss of Position: The vessel's position is outside the limits set for conducting a desired task or activity.

Position Keeping: The act of maintaining a desired position within the limits set for conducting a desired task or activity under defined environmental conditions.

Redundancy: The ability of a system or component to maintain or restore its function when a single fault has occurred.

Redundant Groups (Subsystems): Two or more component groups each of which is capable of individually and independently performing a specific function.

Relative Reference Systems: A position reference system that gives the vessel's position relative to a non-fixed reference.

Station or Position Keeping: Maintaining a desired position within the normal excursions of the control system and under the defined environmental conditions.

Task Appropriate Mode: the appropriate configuration of the DP system and operational procedures when CAM is not required. For example, TAM configuration can be used where determined that the risks from loss position are not critical.

Well Specific Operational Guide: The MODU version of the ASOG.

Worst Case Failure Design Intent: Is the single failure with the maximum consequences that has been the basis of the design and operational conditions. This usually relates to a number of thrusters and generators that can simultaneously fail.

Worst Case Failure: The identified single fault in the DP system resulting in maximum DP capability as determined through the FMEA study. The WCF is used in consequence analysis.