

DP Operations Guidance

**Prepared through the Dynamic Positioning Committee
of the**

Marine Technology Society

to aid in the safe and effective management of

DP Operations

October 2010

Part 1

The Dynamic Positioning Guidance was created by Dynamic Positioning Committee of the Marine Technology Society.

These guidelines have been developed from regulations, codes, guidance and industry practice existing at the time of publication, and their purpose is to aid in safe management of DP operations. This publication was designed and intended as a resource for dynamic positioning operations professionals. For any other use beyond personal, research or educational purposes, please contact the Marine Technology Society.

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1. PREAMBLE

This document has been generated by the MTS DP Technical Committee and has been provided to industry as a guidance document for the safe and effective conduct and management of DP operations.

This document is not meant to replace any rules, regulations or owners' operational manuals. It is a compilation of existing guidance and practices gleaned from various sources in industry. It refers to standards and guidance used within the industry and draws attention to them. It also incorporates additional information gleaned from experience and document/ standards not in the public domain

This is not intended to be an all encompassing document covering all aspects of DP operations. It focuses on a number of important DP operational themes, which, if effectively managed, will result in safer DP operations and a reduction in exposure to DP related incidents.

The guidance provided in this document is not directed at any particular category of DP operation or DP vessel. It is intended to apply to any DP operation undertaken by any type and class of DP vessel operating in support of offshore oil and gas activities, Examples include MODUs, ships, construction and logistics vessels where dynamic positioning is used for, or aiding, station keeping.

Layout of the Document

This document consists of two parts. Part 1 contains guidance on the management of DP. Part 2 contains DP operational guidance. Part 2 consists of three Appendices

- Part 2 Appendix 1 – DP MODUs
- Part 2 Appendix 2 – DP Project/ construction vessels
- Part 2 Appendix 3 – DP Logistics vessels

Part 1**1.1 Scope**

Part 1, addresses the themes that, if managed effectively, will contribute to safe and efficient DP operations.

1.2 Definitions**1.2.1 DP System**

The DP system consists of components and systems acting together to achieve reliable position keeping capability. The DP system includes the power system (power generation and power management), thruster system and DP control system.

1.2.2 DP Control System

The DP control system consists of all control components and systems, hardware and software necessary to dynamically position the vessel. The DP control system comprises computer systems, sensors, display systems, position reference systems and associate cabling and routing.

1.2.3 Worst Case Failure

The Worst Case Failure (WCF) is the identified single failure mode in the DP system resulting in maximum effect on DP capability as determined through FMEA study.

1.2.4 Worst Case Failure Design Intent

The Worst Case Failure Design Intent (WCFDI) 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.

1.2.5 Redundancy Concept

The Redundancy Concept is the means by which the Worst Case Failure Design Intent is assured.

1.2.6 Safest Mode

Safest Mode is the configuration that the vessel's DP system should be set up and operated in so as to deliver the intent of the vessel's DP class notation. The objective is that no single failure should result in exceeding the worst case failure. Each DP vessel has only one safest mode which is unique to that vessel.

1.2.7 Safest Mode Of Operation

The Safest Mode of Operation (SMO) is generally a tabulated presentation of how to configure the vessel's DP system, including power generation and distribution, propulsion and position reference systems, so that the DP system, as a whole, delivers the intent of the vessel's DP class notation. The SMO table also sets out the operator actions should a required configuration not be met.

1.2.8 Activity Specific Operating Guidelines

Activity Specific Operating Guidelines (ASOG) are generally presented in tabulated format and set out the operational, environmental and equipment performance limits

considered necessary for safe DP operations while carrying out a specific activity. The table also sets out various levels of operator action as these limits are approached or exceeded. The ASOG will vary depending on the activity and are unique to that activity.

Note Where DP MODUs are carrying out well activities the nomenclature is changed to WSOG (Well Specific Operating Guidelines).

1.2.9 Task Appropriate Mode

Task Appropriate Mode (TAM) is a risk based mode. Task Appropriate Mode is the configuration that the vessel's DP system may be set up and operated in, accepting that a single failure could result in exceeding the worst case failure and could result in blackout or loss of position. This is a choice that is consciously made. This mode may be appropriate in situations where it is determined that the risks associated with a loss of position are low and, where the time to terminate is low.

Example 1:- A DP MODU may operate in this mode during times when Time to Terminate is short, and in Safest Mode, when Time to Terminate is long.

Example 2:- A DP pipelay vessel may operate in this mode when more than 500m from a surface or mission critical subsea asset, and in Safest Mode when inside 500m.

1.2.10 Thruster and Generator Operating Strategy (TAGOS)

A document that provides informed guidance, usually derived from a review of the FMEA and if necessary, validation from personnel knowledgeable about vessel specific information, on appropriate configurations of thrusters, generators and power distribution, and associated constraints, so as to enable correct choices to be made to provide optimum level of redundancy.

1.2.11 DP Capability Plots

DP Capability Plots define by theoretical calculation the vessel's capability to maintain position in various environmental conditions, (i.e. wind, seastate and current) and, where appropriate, taking account of certain external forces, such as pipe tension and, in various thruster/ power configurations, including all thrusters running, loss of most effective thruster and following worst case failure.

1.2.12 DP Footprint Plots

DP Footprint Plots are constructed, by observation onboard the vessel in real time conditions. The plots are of the vessel's DP station keeping performance and limitations in various environmental conditions (wind, seastate and current) and in various thruster/ power configurations, including all thrusters running, loss of most effective thruster and after worst case failure.

Note It is acknowledged that DP Footprint Plots for DP MODUs may be less relevant in comparison to DP vessels used for other applications. Owing to their almost continuous work programs DP MODUs will rarely have the opportunity to record DP Footprint Plots for degraded thruster configurations.

1.2.13 Time to Terminate

Time to Terminate (TTT) is calculated as the amount of time required in an emergency to physically free the DP vessel from its operational activity following a DP abort status and allowing it to be manoeuvred clear and to proceed to safety.

For example:- In case of a DP drilling vessel this may be the time needed to release from the wellhead. For a DP diving vessel this may be the time needed for the diver(s) to return to the bell and make a seal so that the vessel can move clear. The Time to Terminate is not fixed for the duration of a DP operation but will vary according to the circumstances.

2. GENERAL

2.1 Philosophy

This document was compiled with the following objectives

- Manage, mitigate and reduce the exposure to, and potential of, DP related incidents.
- Identify themes that need to be managed.
- Provide a list of reference documents that address themes, whilst acknowledging that existing referenced documents do not identify all elements adequately when viewed in isolation.

The themes that have been identified and addressed in this document are:

1. DP Class
2. FMEA/ FMECA
3. DP Capability
4. Position Reference Systems And Sensors
5. Required Modes
6. Trials And Checklists
7. Operation Manuals
8. Activity and Operational Planning
9. Communications
10. DP Planned Maintenance
11. DP Incidents
12. Reporting And Record Keeping
13. Competency
14. Manning

2.2 Lay Out

This document facilitates compilation of existing standards and adds to them as necessary. It is demarcated into two distinct sections.

Main body of the document

Objective: - to provide overarching management guidance on the themes.

Appendices

Objective:- to provide operational guidance on the themes.

Vessels supporting the offshore activities have been categorized as follows

- MODUs
- Project/ construction vessels and barges (e.g.:- pipelay/ heavy lift/ dive support/ ROV/ accommodation support, etc.)
- Logistics vessels (e.g. OSVs/ crew boats)

Note: When logistics vessels are used as platforms to carry out project/ construction activities they should follow the guidelines for project/ construction vessel/ barges.

3. DP RELATED DOCUMENTATION

3.1 General

It is recommended that DP vessel owners/ operators should maintain the documentation listed in the table below and should develop and implement associated processes for the purposes of:

- ensuring the safe and effective management of the vessel in DP
- ensuring the technical suitability of the vessel for each DP activity it is required to carry out
- determining the configuration for the safest mode of operation and the task appropriate mode
- understanding the vessel's station keeping capabilities following the worst case failure
- ensuring compliance with appropriate standards and guidelines
- providing training and familiarization material to vessel crews

3.2 Recommended Documentation

Table A Recommended Documentation

Current versions of the documents in the list below should be kept on board and, in addition, where feasible, at the shore based centers of technical management. Documents that have been superseded should be clearly marked and kept separate from current versions. Documents may be in electronic or, hard copy format or, both.

Further guidance relating to the listed documents is given in appropriate sections later in Part 1.

No.	Document	Guidance
1	DP System FMEA or FMECA	To be kept up to date, incorporating all modifications and additions since original study, if not in the document itself, then by other traceable means. All records to be kept on board.
2	DP FMEA Proving Trials	To be conducted to prove initial DP FMEA and at other times to prove modifications and additions to the DP system. DP FMEA Proving Trials should be repeated every five years. Findings and recommendations to be addressed in accordance with their criticality. All records to be kept on board.
3	Annual DP Trials	To be conducted annually. Findings and recommendations to be addressed in accordance with their criticality. Previous trials reports and associated close out documentation to be kept on board.
4	DP Capability Plots	Hard copy DP Capability Plots relevant to the vessel's areas of operations to be readily accessible to DPOs at the DP control location.

No.	Document	Guidance
5	DP Footprint Plots	Hard copy DP Footprint Plots to be taken by DPOs and kept on board. See Note 1 at end of table.
6	Service reports concerning the DP system	Complete history of service reports to be kept on board
7	Details of all DP related modifications and additions	Records of all DP related modifications and additions to be kept on board complete with interface and testing information. See Note 2 at end of table..
8	Vessel audit reports and DP audits and inspection reports.	Complete history of all audit reports, DP audits and inspection reports, inc., findings and close outs to be kept on board
9	DP Operations Manual	Vessel Specific DP Operations Manual ¹ , to be readily accessible at the DP control location and used by the DPOs as a reference for conducting DP operations.
10	DP Incident Reports	Records of all DP station keeping and other DP related incidents to be kept on board, inc., investigation records and close outs.
11	DP Mobilization/ DP Field Arrival/ Trials Procedures (Bridge and Engine Room)	Records of DP Mobilization Trials and DP Field Arrival Checklists to be kept on board for the period set by the owner/ operator and, where relating to a DP incident permanently stored in retrievable archives.
12	DP Location and Watchkeeping checklists (Bridge and Engine Room)	Records of all DP Location and Watchkeeping Checklists to be kept on board for the period set by the owner/ operator and, where relating to a DP incident, permanently stored in retrievable archives.
13	DP related drills and emergency response drills	Records of DP related drills and emergency response drills to be kept on board in retrievable archives.
14	DP fault log	Records of all faults related to the DP system to be kept on board permanently in retrievable archives.
15	DP data logging	Where the vessel has DP data logging facilities electronic records should be kept on board for the period set by the owner/ operator and, where relating to a DP incident, permanently stored in retrievable archives.

¹ The vessel specific DP Operations Manual is additional to the DP control system manufacturer's Operator Manual

No.	Document	Guidance
16	DP alarm printer readouts	Hard copy records of the DP alarm printer readout to be kept on board for the period set by the owner/ operator and, where relating to a DP incident, permanently stored in retrievable archives.
17	DP familiarisation and competency records	All records relating to vessel specific DP familiarisation and competency for DPOs, engineers and electricians to be kept on board permanently in retrievable archives.
18	Résumés and vessel specific work records of all key DP personnel	Resumes of all key DP personnel, copies of certification and qualifications, records of DP watchkeeping hours to be maintained on board. Original DPO certificates and DP Log Books to be held by the DPOs onboard the vessel.

Note 1 It is acknowledged that DP Footprint Plots may be less relevant for DP MODUs than for other DP vessel types.

Note 2:- Owners/ operators should keep adequate records and documentation relating to modifications and additions that could have an effect on the DP system, especially interfaces between equipment from different vendors. This is as relevant for equipment whose primary function lies outside the DP system, such as an Emergency Shutdown Systems (ESD), pipe tensioner systems and fire monitor systems as it is for DP equipment, such as propulsion, position references and sensors. All modifications and additions should be subjected to FMEA type analysis and undergo Proving Trials type testing.

4. THEMES

The themes in this Part 1 of the MTS Guidance are addressed from a management perspective. They are covered in greater depth and at an operational level in Part 2.

4.1 DP Class

It is recommended that DP vessels with the following DP equipment class notations be used for the following activities.

Application on DP	Minimum Recommended DP Equipment Class (See Note 1 below)	Remarks
Drilling	2	
Diving	2	
Pipelay	2	
Umbilical Lay	2	
Lifting	2	
Accommodation	2	
Shuttle Offtake	2	
ROV Support (Open Water)	1	
ROV Support (Close Proximity - Surface/ Subsea)	2	
Floating Production	2	
Seismic and Survey vessels (Open water- outside 500 m zone)	**	Class in accordance with contractual requirements
Well Stim	2*	Vessels of lesser Class may be used with the appropriate structured risk identification and mitigation measures in place.
Logistics Operations	2*	Vessels of lesser Class may be used with the appropriate structured risk identification and mitigation measures in place.

Note The vessel's DP system should normally be set up and operated to deliver the intent of the DP class notation. However, on occasion and after a proper assessment of the risks, the vessel may be set up in accordance with the requirements of the Task Appropriate Mode.

4.2 DP FMEA

The DP vessel's DP FMEA is the most important technical document in the list of required documents. The requirement for a DP FMEA has its origins in IMO MSC/Circ 645 (1994) "Guidelines for Vessels with Dynamic Positioning Systems".

These benchmarking guidelines provide the foundation for all subsequent DP rules, regulations and guidance issued by Class and other industry bodies, such as IMCA.

The IMO Guidelines require all DP vessels to be subjected to survey and testing in accordance with IMO's specified guidelines. This includes initial and periodic complete survey and testing of all systems and components required to keep position after single failures associated with the vessel's assigned DP equipment class.

The periodic component in the IMO Guidelines requires the complete survey and testing to be repeated every five years to ensure full compliance with applicable parts of the guidelines.

In addition compliance with IMO Guidelines requires survey and testing after defects are discovered and corrected and, after a DP related accident and, whenever significant repairs or alterations are carried out, so as to demonstrate full compliance with applicable parts of the guidelines.

The IMO Guidelines do not make clear distinction between vessels of different DP equipment class.

This IMO requirement has been interpreted by the DP community such that the survey requirement is met by a DP FMEA (or FMECA²) and the testing requirement by DP FMEA Proving Trials.

Accordingly, all DP vessels of DP Class 2 or 3 are required to have a Class approved and stamped DP FMEA and DP FMEA Proving Trials.

Definitions: An 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. A FMECA is an extension of an FMEA that adds a risk assessment of each failure mode to determine its criticality.

In addition to complying with the IMO Guidelines and the relevant DP rules of the vessel's Classification Society the DP FMEA should achieve the standards of detail and analysis contained in the following industry guidance;

- IMCA M166 "Guidance on Failure Modes and Effects Analysis"
- IMCA M178 "FMEA Management Guide"
- IMCA M04/04 2004 "Methods of Establishing the Safety and Reliability of DP Systems"

Note FMEAs are a requirement to obtain DP Class 2 and 3 notation. Whilst not stipulated as a class requirement for DP 1 vessels owners/ operators are encouraged to subject their DP 1 vessels to the DP FMEA process.

Note Particular attention should be paid in the DP FMEA to the interfaces between the DP system and other systems that have the potential to affect the DP system, such as where the vessel is fitted with an Emergency Shut Down (ESD) system, pipe tensioner system or fire monitor system.

Key DP personnel, including the vessel Master, DPOs, Engineers and Electricians should have a detailed knowledge of the DP FMEA and should use the information

² Unless expressly stated in this Guidance document a FMECA is interchangeable with an FMEA.

provided to be fully informed about the capabilities and limitations of the vessel's DP system.

The results from a DP FMEA, in particular issues related to the vessel's worst case failure and significant single point failures, should be used in the formulation of operational, emergency response and planning decisions.

4.3 DP Capability Plots

DP Capability Plots should be calculated for the vessel. Guidance is provided on DP Capability Plots in IMCA M140 Rev 1, "Specification for DP Capability Plots".

These theoretical plots are calculated from detailed information of the vessel's hull and superstructure form and available thruster power. The calculations should use environmental data (seastate, wind and current) appropriate to the area in which the DP vessel is to operate.

These plots should show the limiting wind speed 360 degree envelopes for the scenarios below, where each point on the envelope represents the wind speed at which it is calculated that the vessel will be unable to maintain position in DP.

DP Capability Plots should include the following scenarios at current speeds of 0kts, 1kt and 2kts, or at other current speeds that are representative of the location in which the DP vessel is to operate:

- Fully intact power generation and thrusters.
- Loss of most effective thruster(s).
- Following the worst case failure.

Note The DP Capability Plots should be provided in a format that is intuitive to the user on board (e.g. Polar Plot).

DP Footprint Plots

DP Footprint Plots should also be produced on board. DP Footprint Plots are not theoretical. They are actual measurements of the vessel's DP station keeping performance in the actual environmental conditions and thruster configuration at the time the plot was taken. DP Footprint Plots should be taken whenever opportunities arise, such as during standby periods, weather downtime or on arrival at the field. Plots should be taken for the thruster configurations used in the DP Capability Plots, i.e. fully intact, loss of most effective thruster(s) and after worst case failure.

Some DP systems have a software application that produces DP Footprint Plots electronically. DPOs can also produce DP Footprint Plots by manual methods using a plotting sheet.

DP Footprint Plots serve two main purposes.

- They provide a scatter plot of vessel positions at regular intervals around the required set position (this shows accuracy of station keeping)
- They also provide comparison points on the limiting wind speed envelope given in the theoretical DP Capability Plots (this shows wind speeds at which it was seen that the vessel was unable to maintain position, thus validating or contradicting the theoretical DP Capability Plots for the various thruster configurations.)

DP Footprint Plots serve other purposes, including learning and familiarisation opportunities for DPOs and in providing snapshots of vessel station keeping behaviour for specific locations and activities.

Theoretical DP Capability Plots and DP Footprint Plots combine together to enhance knowledge and understanding of the vessel's DP station keeping ability.

Note DP Footprint Plots originated in harsh weather regions, such as in the North Sea. The plots are used to gain a better understanding of the vessel's actual station keeping performance and limitations in intact and, in various degraded thruster configurations, including worst case failure, whilst the vessel is being subjected to real environmental forces.

It is acknowledged that DP Footprint plots may be of less relevance to DP MODUs.

4.4 Position Reference Systems and Sensors

The DP vessel should be equipped with suitable position reference and sensors in accordance with the vessel's DP class notation and operational requirements. 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 situations.

Position reference systems comprise absolute and relative systems. An absolute system gives vessel geographical position. A relative system gives vessel position in relation to a non-fixed reference. A relative system can be used as an absolute system if installed on a point that is a fixed geographical position. And, an acoustic absolute system can be used as a relative system if attached to a non-fixed asset.

The following are the most common position reference systems in use.

- | | |
|----------|--|
| Absolute | DGNSS (DGPS and GLONASS)
Acoustic (USBL, SBL, LBL)
Taut wire
See Note |
| Relative | Artemis
Laser (Fanbeam, Cyscan)
Radar (RADius, RadaScan)
DARPS |

Note Class rules give minimum requirements for the number of position references. Where operational uptime is one of the key success factors the benefit gained by consciously exceeding the minimum requirements are to be evaluated. Other benefits of exceeding minimum requirements include greater redundancy and improved station keeping performance.

Caution Additional position reference systems should be based on different principles. It is generally not recommended to use multiple (>2) satellite based systems in conjunction with other positions reference systems as this may result in skewed weighting in favor of multiple satellite systems.

Note It could be debated that Taut Wire and Acoustic position reference systems are relative position reference systems. For purposes of this document, absolute indicates that this position reference sensor is independent of another fixed or floating offshore structure.

4.5 Recommended DP Control Modes for DP Activities

The DP vessel should be equipped with suitable DP modes and features with due consideration to operational requirements, both with regard to restrictions caused by the activity and performance criteria required to execute the activity safely and successfully.

The following selected DP control modes are relevant to specific DP activities.

Target Follow Enables the DP vessel to follow a moving target and is used, for example, to follow an ROV along a pipeline.

Heavy Lift Takes account of the effects of the load transfer on the mass of the vessel and the additional lateral force, normally by reducing gain and relaxing the DP controller.

External Force Compensation

Where the measured external force acting on the vessel, which is separate from the environment, is included in the DP calculation and treated as a force feed forward. This mode is used to account for pipe tensions in a pipe layer and hawser tension in a shuttle tanker.

Fire Monitor Compensation

Used to compensate for the varying forces exerted on vessel from the fire monitors.

Weathervane Enables the DP vessel to rotate with the wind, current and waves around a fixed or moving point called the terminal point. Neither the heading nor the position of the DP vessel is fixed. The heading of the vessel is controlled to point towards the terminal point. The position of the vessel is controlled to follow a circle, called the setpoint circle, around the terminal point. This mode is appropriate for connected shuttle tanker/ FPSO operations.

Caution It is not uncommon for the term “weathervane” to be used to denote “minimum thrust”, i.e. where the DP control system allows the vessel’s heading to rotate to minimize external forces acting on the vessel and thruster requirements. These terms should not be confused.

4.6 Trials and Checklists

A range of trials and checklists is to be provided for each DP vessel and implemented as a verification that the vessel’s DP system complies with and, is operated in accordance with, applicable standards and guidelines. This verification process should confirm the failure modes and their effects on the systems and equipment analysed in the DP FMEA document (to include the Worst Case Failure) and the vessel’s station keeping ability following its Worst Case Failure. Owners/operators should refer to the following list of trials and checklists when developing an

appropriate regime for their own DP vessels. The list below is a typical list for a DP dive support vessel.

DP FMEA Proving Trials: A series of tests used to prove expected effects of failure modes found in the FMEA desktop analysis. These tests should also include the testing of interfaces between different vendor systems and equipment. These tests should be conducted immediately following launching of a new build vessel and following modifications, additions, upgrades repairs.

Endurance Trials:- (new build/ system modifications class requirement): To prove the operation of the DP system under load conditions for at least 4 hours without significant alarms of the DP system.

Annual DP Trials:- A series of tests of fault and failure conditions relevant to the DP System. The tests should be designed to prove system redundancy, as defined in the DP FMEA, system and equipment functionality, to validate repairs and preventive maintenance, and test the operation of protection and detection devices and responses so as to demonstrate that the vessel's DP system remains fit for purpose. Annual DP Trials should be performed at a specific once a year within 3 months of the anniversary of the previous year's trials. Annual DP Trials also provide the opportunities for training of the vessel's crew and enhancement of their knowledge of failure modes and their effects.

Note Experience has shown that, owing to heavy operational demands, DP drilling units are not usually able to meet the above criteria for conducting Annual DP Trials at a specific time once a year. This has been recognized by the industry with publication of specific guidance relating to the conduct of Annual DP Trials for DP MODUs. This is given in IMCA M191, "Guidelines for Annual DP Trials for DP Mobile Offshore Drilling Units". The guidance sets out a regime of annual testing that is conducted on an incremental basis throughout the year as opportunities arise but needs to be completed within a twelve month period.

DP Mobilization Trials: A series of tests to be carried out at the start of a contract, subject to client requirements, to demonstrate redundancy and functional limitations of the DP system.

DP Field Arrival Trials: A series of checks and tests that confirm satisfactory performance of the DP system and verify the set up mode of operation and DP functions.

DP Location Set Up Checklist: A series of checks to demonstrate that the vessel is properly set up for the location, in particular the satisfactory performance of the position reference systems.

Pre-Dive Checklist:- A series of checks performed prior to commencing diving operations. Main and back up communication tests should be included in this process.

ECR Checklists:- A series of checks and tests that verify that the vessel's set up and configuration of systems and equipment meet the requirements of the necessary mode of operation as determined by the Safest Mode of Operation (SMO) and the DP Class or the Task Appropriate Mode (TAM).

500m Checks:-A series of checks and tests performed before entering the 500m zone of an asset in which set up mode and functions are verified and confirmed.

Approval is then obtained to operate in close proximity to the asset. Main and back up communication tests should be included in this process.

Watch Status/ 6 Hour Checklist:- A series of checks and tests performed by the DPOs to verify and confirm the set up of the DP system prior to taking over the DP watch.

Post DP Incident Trials:- Tests performed to ensure that the corrective/ repair measures taken following a DP incident have properly addressed the causes of the incident and that the vessel's DP system is in a safe and operable condition.

Post DP Modification Trials:- A series of checks and tests that are used to determine the effects of modifications and/ or additions on the DP system and the vessel's subsequent station keeping performance.

Note The nomenclature used for the trials and checklists listed above is based on the guideline document, IMCA M112, : "Guidelines for Auditing Vessels with DP Systems". It is recognized that these trials and checklists could be given other titles.

4.7 DP Operations Manuals

A vessel specific DP Operations Manual should be prepared for each DP vessel.

The vessel specific DP Operations Manual is the most important operational document in the list of required documents. The requirement for a manual has its origins in IMO MSC/Circ 645 (1994) "Guidelines for Vessels with Dynamic Positioning Systems".

The IMO Guidelines require a series of checklists, test procedures and DP operating instructions to be incorporated into one manual.

Each Classification Society has its own specific requirements for a DP Operations Manual, each with different requirements for content.

The recommendations set out below address areas that are not necessarily required by class. They are based on current industry practices.

The manual should contain sufficiently detailed instruction and guidance to enable the vessel to be operated safely in DP and safely execute its intended activities. This will include a clear statement on the DP philosophy for the vessel, the organisation, responsibilities and roles of key DP personnel, training and competency, watchkeeping and manning, vessel technical data and layout, vessel DP capabilities, operating limits, operating modes, the planning and preparation of DP operations, DP operating procedures, emergency procedures, DP incident handling and alert systems and vessel specific trials and checklists that apply uniquely to the vessel.

The manual should specifically address operational interfaces between different vendor systems and equipment to ensure that they are configured and operated properly. This should include interfaces between systems and equipment that are not part of the DP system but which may affect the DP system, such as Emergency Disconnect Systems (EDS) on MODUs, tensioner systems on Pipelay vessels, etc.

The vessel specific manual may also contain generic content, such as company policies, procedures and standing orders.

The manual should represent the way the vessel is operated in DP. For complicated power systems and/ or thruster configurations, it may be useful provide the operator

with a thruster and generator operating strategy (TAGOS) to assist in the decision on what generators and thrusters to use for different circumstances and different equipment availabilities.

Guidance on the contents of vessel specific DP Operations Manuals is provided in the following IMCA guidelines, M103, M109, M117 (contingency training) and in class society DP rules.

4.8 Activity Operational Planning

In recognizing that exposure to risks manifests itself during vessel operations it is recommended that activities performed by DP vessels should be subject to planning and preparation. In planning and preparing for the activities the following should be considered and, where appropriate, documented:

- Configuration for the Safest Mode of Operation (SMO) or, where appropriate, the Task Appropriate Mode (TAM).
- Preparation of the Activity Specific Operating Guidelines (ASOG), including onboard discussion with all relevant stakeholders as part of the pre-project execution/ activity.
- Discussion to be included in pre-project execution readiness checklist.
- Capabilities of the vessel, both intact and residual capability, following Worst Case Failure (WCF).
- Limitations imposed by water depth.
- Consequences of a loss of position and/ or heading.
- Limitations imposed upon operations by residual capability.
- SIMOPS and marine vessel interaction and consequences arising from change of status (Green to Blue, Yellow or Red).
- The activity being performed and the necessary time to terminate to bring vessel to a safe position upon the onset of failure.

Activities should include day to day operations, any specific operation relevant to the design of the vessel, as well as any unique operations the vessel is called upon to perform.

Appropriate measures should be in place to clearly identify critical tasks/ operational phases of the activity and to ensure that the vessel is set up in Safest Mode of Operation and operating within post WCF capability. Where a decision has been made to operate in a TAM a separate ASOG covering TAM should be produced.

Note The ASOG should be developed by extracting all the relevant information from detailed technical review of the vessel's DP FMEA, operational manuals and project specific procedures. The ASOG should be validated on board.

On a DP MODU, ASOGs are known as WSOGs. Some owners refer to it as WSOC (Well Specific Operating Criteria)

4.9 Communications

The vessel should be equipped with the appropriate primary and secondary equipment needed to communicate between all parties (stakeholders) whilst carrying out the intended task.

Effective internal and external communications is a key tool to manage risk.

Communications in this context include voice, visual (lights/ displays) and audible means (alarms). Means of communication are not limited to the above but include integrated IT systems using wireless network technology that combine communications with other features, including AIS and DGNS.

Operational specific visual and voice communications should ensure that the pertinent information flows between the key operating points as well as to and from assets and/ or other vessels that might be affected by the operation being carried out.

These operating points may be onboard the vessel as well as on other facilities involved with the activity. Communication protocols are to be set up to provide pertinent information regarding intent, current status of planned as well as unexpected events during the execution of the activity.

Continuity of communications during foreseeable emergency situations should be taken into account.

Communications should be taken into account when detailing the roles and responsibilities of key personnel during the planning stages for the intended task, ensuring that a common working language and terminology is used at all times.

Guidance on communications is provided in M103, M182 and M205.

Note The importance of communication to be emphasized by incorporating into the ASOG.

4.10 DP Planned Maintenance

DP vessels should have a structured planned maintenance system that specifically addresses maintenance of the vessel's DP system, equipment and support systems. Relevant guidance is given in IMCA M109.

Planned maintenance should address all equipment that has an impact on the vessel's station keeping capabilities. This should include indirect components such as generator circuit breakers, bus tie breakers, etc. Maintenance should include regular cleaning, calibration, and testing of equipment as outlined in manufacturer's recommendations and industry guidelines.

Records of planned and unplanned maintenance should be kept in an auditable format, either hard copy or appropriate electronic format. These records should include vendor service records as well as maintenance performed by vessel personnel. These records should be kept on board for the period specified by the owner/ operator.

A minimum number of required critical DP spares should be maintained on board. The critical spare inventory should be monitored via a formal inventory program that is closely linked to the planned maintenance system. This should assist in getting back to normal operating condition after equipment failure or DP incident.

- Note The client's due diligence process is usually the main driver in the critical path to return to normal operating condition. Typically, this also involves vendor support as well as the client's DP consultant.
- Note Maintenance on DP related equipment whilst conducting DP operations should be controlled by a documented permit to work system and should always take into consideration the potential alteration of failure modes and increased criticality of failure consequences on DP capabilities and/or redundancy.

4.11 DP Incidents

DP vessels should be provided with and operate appropriate DP incident reporting, investigation and closing out procedures. This should be in accordance with vessel owner or operators' and, if applicable, clients' processes. Documented records should be kept and be capable of auditing.

Where SMO, TAM and ASOG are used as tools to manage DP operations a suggested approach is that, apart from the exceptions in the notes below, any reactive change of DP status from GREEN to YELLOW or RED should be regarded as a DP incident, and should be reported, recorded and investigated.

Note A change of status triggered by prearranged agreement between the Master, and senior onboard decision makers, allowing the vessel to exceed environmental limits should not be regarded as a DP incident.

Note An operator initiated change of status as a result of a conscious decision based on risk analysis of the circumstances where the trigger points have not been reached should not be regarded as a DP incident.

It is recommended that reactive YELLOW and RED DP incidents are investigated as soon as practicable after the DP incident and, where relevant, trials are carried out as part of the investigation process.

The purpose of the investigation and the trials should be;

- to assist in identifying the root causes of the incident
- to verify and validate that measures to address the root cause are effective
- to validate that effective measures have not introduced any additional potential to cause failures (both hidden and apparent)

In the event of the occurrence of a DP incident relating to the vessel's configuration as described in the DP FMEA and other documents, it is suggested that the FMEA provider is involved in the incident investigation. This will facilitate lessons learnt to be implemented into the DP FMEA and proving trials program.

Owners/ operators of DP vessels are encouraged to share lessons learned from DP incidents with the wider DP community. DP systems and equipment vendors are also encouraged to do likewise and to share information on unexpected faults, features and failures that are identified in operation. IMCA's station keeping incident reporting scheme provides a suitable channel for disseminating relevant information throughout the DP sector.

4.12 Reporting and Record Keeping

Owners or operators of DP vessels should have an effective reporting and record keeping system.

There should be a clear line of reporting DP related items onboard the DP vessel and between each department and this should involve key DP personnel. There should also be a clear line of reporting between the DP vessel and the company's shoreside management. DP related records should be maintained onboard and, where appropriate, at the company's premises.

The documents and records contained in table A, Section 3.2, should be accessible to key DP personnel and to other interested parties.

DP vessels, on occasion, carry out activities which may be unique to project requirements. Records of these activities including pertinent information from Hazards and Risk Identification (HIRAs) should be made and kept onboard for future reference, both for training and familiarisation processes as well as for reference in case of similar project requirements in the future.

4.13 Competence

Definition Competence is the acquisition of knowledge, skills and abilities at a level of expertise sufficient to be able to perform in an appropriate work setting.

DP vessel owners/ operators should operate a structured competence assurance program that is applied to all key DP personnel with special focus on ensuring vessel and task specific competence.

Guidance is provided in M103, M117 (IMO738)

Vessel specific competency should, as a minimum, be demonstrated in the following areas:

- o Operational modes
- o DP FMEA familiarization
- o DP Operations Manual familiarization
- o Project/ activity requirements
- o Contingency plans, modes and drills

4.14 Manning

Vessels should comply with the statutory requirements for safe manning. Additionally, for DP operations, manning should be in accordance with the following:

DP Bridge Crew

Operation	Minimum Bridge Crew per shift	Minimum Experience
When <u>undertaking critical activities</u> in proximity to surface or sub surface structures See Note 1 below	2 unlimited DPOs on the bridge capable of operating the vessel both in DP and manual control. See Note 2 below.	Unlimited DPO with a minimum of 3 years experience on a vessel engaged in similar operations, at least 6 months of which should have been on the subject or sister vessel. Experience level should be documented and

		auditable. See Note 3 below
Note 1	Critical activities are those activities where the consequences of equipment failure or loss of position are greater than under normal operating circumstances. For example, critical activities on a DP dive support vessel would include those occasions where the Time to Terminate is long, such as when the diver is inside a welding habitat or where the diver's worksite is inside the conductor tubes at a production facility.	
Note 2	The Master should not be considered as one of the required unlimited DPOs for meeting the manning requirements.	
Note 3	It is recognized that in practice, given the near term market conditions owners/operators will be challenged to meet the recommended level of experience for DPOs. Owners/ operators should recognize the associated risk from inexperienced personnel and have plans in place to address them while striving to reach the recommended experience levels.	

Engineers

There should be sufficient licensed engineers on board for all expected operations.

At least one licensed engineer should be available at all times, should be on watch during critical activities and should have at least 6 months experience on similar equipment and operations.

The engineer should be fully cognisant of DP operations, familiar with the vessel's DP FMEA document and the effects of failures of equipment relating to the position keeping of the vessel.

In DP 2 or 3 operations, the engineer should be familiar with the general philosophy of redundancy as it relates to split mechanical, electrical and ancillary systems.

Electrician/ Electrical Engineer

If required on board, an electrician should have appropriate high voltage training/certification, if applicable to the vessel. As with vessel engineers, the electrician/ electrical engineer should have at least 6 months experience on similar equipment and operations.

The electrician should likewise be fully cognisant of DP operations, familiar with the vessel's DP FMEA document and the effects of failures of equipment relating to the position keeping of the vessel.

Notes Where the minimum experience requirements cannot be met a risk based approach should be taken to determine the suitability of personnel and any additional support requirements for intended operations.

For low risk operations guidance is provided in IMCA M182. If used, the guidance provided within this document should be validated against the risks.

5 ABBREVIATIONS

AIS	Automatic Identification System
ASOG	Activity Specific Operating Guidelines
DGNSS	Differential Global Navigation Satellite System
DGPS	Differential Global Positioning Satellite system
DP	Dynamic Positioning
DPO	DP Operator
ECR	Engine Control Room
ESD	Emergency Shutdown System
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes and Effects and Criticality Analysis
GPS	Global Positioning (satellite) System
IMCA	International Marine Contractors Association
IMO	International Maritime Organisation
IT	Information Technology
LBL	Long Baseline
MTTR	Mean Time to Repair
MRU	Motion Reference Unit
SIMOPS	Simultaneous Operations
SMO	Safest Mode of Operation
SBL	Short Base Line
SSBL	Super Short Base Line
TAGOS	Thruster and Generator Operating Strategy
TAM	Task Appropriate Mode
TTT	Time to Terminate
VRU	Vertical Reference Unit
WSOG	Well Specific Operating Guidelines

6 REFERENCE STANDARDS/ GUIDELINES

Source	Title	Revision No. and Date	DP Operations Content
IMO	Guidelines for Vessels with Dynamic Positioning Systems	IMO MSC/Circ 645 1994	Internationally recognized basis for the design, equipment, testing, verification and operation of DP vessels
Class	Classification Society DP Equipment Rules, Survey Rules and associated rules.	ABS, DNV, LRS, GL, BV, KR, etc., 2010	DP equipment, DP operations manuals, DP trials, DP surveys, DP certification and DP class notations
USCG	Use of Dynamic Positioning (DP) by Offshore Supply Vessels (OSVs) for Oil and Hazmat Transfers	USCG D8 Policy Letter Ltr-01- 2003	DP classification guidance, DP operating guidance, DP training and certification guidance
IMCA	Guidance on Failure Modes and Effects Analysis	M166 2002	DP FMEA/FMECA
IMCA	Methods of Establishing the Safety and Reliability of DP Systems	M04/04 2004	DP FMEA/FMECA
IMCA	FMEA Management Guide	M178 2005	DP FMEA management
IMCA	Guidelines for the Design and Operation of DP Vessels	M103 Rev 1 2007	Design philosophies, DP FMEA, redundancy, annual DP trials, checklists, DP operations, communications, manuals, manning, training, DP capability plots
IMCA	Standard Report for DP Vessels Annual Trials	M139 1997	Reporting format for annual DP trials, DP auditor competency
IMCA	A Guide to DP Related Documentation for DP Vessels	M109 Rev 1, 2004	DP operations manual – TOC, DP documentation, vessel operations manual, planned maintenance
IMCA	International Guidelines for the Safe Operation of DP OSVs	M182 Rev 1, 2009	DP FMEA, annual DP trials, checklists, manning, DP capability plots, incident reporting and investigation, risk based approach to DP operations
IMO	Guidelines for Dynamic Positioning (DP) Operator Training	IMO MSC/738 Rev 1, 2006	Internationally recognized guidance for DPO training and experience
IMCA	The Training and Experience of Key DP Personnel	M117 Rev 1, 2006	Training, experience and certification requirements, onboard Familiarisation for key DP personnel
Nautical Institute	The Nautical Institute Dynamic Positioning Operator's Certificate	January 2010 Revision	Detailed guidance on the implementation of NI's internationally recognized DPO certification scheme
IMCA	Station Keeping Incident Form for DP Vessels	2008	Incident report form for DP vessels (DP construction, OSVs, etc.)
IMCA	Station Keeping Incident	2006	Incident report form for DP tankers,

Source	Title	Revision No. and Date	DP Operations Content
	Form for DP Tankers, FPSO, etc.		FPSOs, etc
IMCA	DP Incident Reports – Annual Summary and Analysis – all years	1994 - onwards	Useful analysis and summary of DP incidents submitted to IMCA by member company vessels
IMCA	Specification for DP Capability Plots	M140 Rev 1, 2000	DP capability plots, worst case failure
IMCA	Guidance on Simultaneous Operations	M203 2010	Simultaneous operations
IMCA	Guidance on Operational Communications	M205, D046 2010	General guidelines, diving operations, lifting operations
IMCA	Guidelines for Annual DP Trials for DP Mobile Offshore Drilling Units	M191 2008	Annual DP trials, guidelines for incremental annual DP trials
IMCA	Common Marine Inspection Document (CMID)	Issues 6 and 7	Inspection report format and TOC for inspection, inc., DP section in Issue 6
IMO	International Safety Management (ISM) Code	ISM Code 2002	International standard for the safe management and operation of ships and for pollution prevention