Dynamic Positioning Assurance Framework

Risk-based Guidance

(First Edition 2016)

Issued by the

Oil Companies International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
England
Telephone: +44 (0)20 7654 1200
Fax: +44 (0)20 7654 1205

Email enquiries@ocimf.org

www.ocimf.org

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CONTENTS

Foreword

In 1973, the Third United Nations Conference on the Law of the Sea was convened to develop a comprehensive treaty for the oceans. It ended with the adoption in 1982 of a constitution for the seas – the United Nations Convention on the Law of the Sea (UNCLOS). Article 60 of the Convention addresses safety zones as follows:

> The breadth of the safety zones shall be determined by the coastal State, taking into account applicable international standards. Such zones shall be designed to ensure that they are reasonably related to the nature and function of the artificial islands, installations or structures, and shall not exceed a distance of 500 metres around them, measured from each point of their outer edge, except as authorized by generally accepted international standards or as recommended by the competent international organization. Due notice shall be given of the extent of safety zones.

The Convention text provided the basis for the offshore oil field's 500m safety zone as accepted today. Establishing a 500m safety zone around offshore subsea infrastructure and facilities is considered best practice and has, in most cases, become corporate policy. A key feature of the 500m safety zone is the exclusion of any marine traffic not explicitly granted permission to enter that zone. In other words, marine traffic within the zone is highly regulated, allowing for a high degree of maritime risk management.

Between 1982 and 1990, Dynamic Positioning (DP) was in its infancy and North Sea operators were leading the way in creating new DP practices. The Nautical Institute (NI) became involved in DP training accreditation in 1982, after an NI and Association of Offshore Diving Contractors (AODC, now part of the International Marine Contractors Association (IMCA)) member approached the local North of Scotland branch. The branch chairman formed a cross-industry committee to investigate the requirements.

The committee looked into what skills and knowledge somebody would need in order to take over a vessel's positioning controls, in the event of an unforeseen failure of the system. They agreed that DP watchkeepers should be able to identify types of failure, predict reactions to a failure, and have sufficient knowledge and experience to be able to take command of the bridge while waiting for the arrival of the Master. The chairman began to draw up the requirements for a DP training scheme that would meet the agreed safety standards. These included basic minimum watchkeeping levels of competency, which were originally set at the First Mate (Class 2) watchkeeping certificate of competency level. The committee's findings were presented to oil industry representatives at the Offshore Europe Conference and Exhibition in Aberdeen in 1982. They received the full support of attendees.

The committee's recommendations were endorsed by the UK Minister of Energy and the Department of Energy as an official guideline for any DP vessel entering a 500m safety zone around a platform. The Maritime and Coastguard Agency (MCA) issued a Notice shortly afterwards, making note of the Department of Energy's guideline. The committee also established the NI DP log book training scheme and associated accreditation of training centres.

While participation in the NI DP Operator (DPO) training scheme is voluntary, the DPO certification that the NI issues is respected. At its 66th session in 1996, the International Maritime Organization (IMO)'s Maritime Safety Committee (MSC) considered the training of DPOs in relation to the 1989 Mobile Offshore Drilling Unit (MODU) Code. The authority of the NI to issue certification for DPOs stems from IMO MSC Circ. 738 (2006) and directly references IMCA M117 for the criteria for training DPOs. IMCA M117 in turn recognises the NI as the body for certifying DPOs, together with the Norwegian Maritime Directorate (NMD). The NI DPO training scheme became the basis for DP competency which remains in use within the offshore industry today. OCIMF supports the NI as providers of the core DP industry competency scheme.

In 1991, IMCA's predecessor, the Dynamically Positioned Vessel Owners Association (DPVOA), published *Guidelines for the Design and Operation of Dynamically Positioned Vessels* (103 DPVOA). In 1994, the MSC approved its *Guidelines for Vessels with Dynamic Positioning Systems* (MSC Circ.645 as amended). Later versions of the DPVOA/IMCA guidelines have reflected the content of the IMO guidelines. The IMCA guidelines have become the basis for the DP assurance practices currently used within the offshore oil industry.

From 1994 to 2016, a significant amount of technical documentation, procedures, best practices and lessons learned have been produced by the industry. Guidance published by the Marine Technology Society (MTS) DP Committee is particularly notable. These documents emphasise the industrial mission, and focus on operations and operational risk management, along with related gap analysis tools. Supplementing design and equipment guidance with guidance on industrial mission and operations, allied with use of the gap analysis tools, promotes high, consistent standards of operation. MTS guidance is clearly supported by industry. It is frequently referenced by classification societies and regulators such as the US Coast Guard (USCG). In some cases, MTS guidance has been adopted by classification societies and published as recommended practice.

Consistency in the application of DP assurance practices varies across the industry. Although a lot of guidance on the conduct of DP operations is available, there are areas that require further clarity and detailed guidance.

This paper provides guidance for establishing a risk-based DP assurance framework and DP operational best practices.

Abbreviations

ACID	Assurance Category Identification
AHT	Anchor Handling Tug
AODC	Association of Offshore Diving Contractors
ASOG	Activity Specific Operating Guidelines
CAMO	Critical Activity Mode of Operation
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
DP SME	Dynamic Positioning Subject Matter Expert
DPO	Dynamic Positioning Operator
DPVOA	Dynamically Positioned Vessel Owners Association
ETO	Electro Technical Officer
FMEA	Failure Mode and Effect Analysis
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
MCA	Maritime and Coastguard Agency
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MSC	Maritime Safety Committee (of IMO)
MTS	Marine Technology Society
NI	Nautical Institute
NMD	Norwegian Maritime Directorate
NPT	Non-Productive Time
OVID	Offshore Vessel Inspection Database
OVIQ	Offshore Vessel Inspection Questionnaire
OVMSA	Offshore Vessel Management Self Assessment
OVPQ	Offshore Vessel Particulars Questionnaire
PMS	Planned Maintenance System
PTW	Permit to Work
ROV	Remotely Operated Vehicle
SIMOPS	Simultaneous Operations
SME	Subject Matter Expert
SMS	Safety Management System
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
STS	Ship to Ship
TAM	Task Appropriate Mode (Risk-based mode)
TECHOPS	Technical and Operational Guidance
USCG	United States Coast Guard
WCFDI	Worst Case Failure Design Intent
WSOG	Well Specific Operating Guidelines

Glossary

The following are agreed definitions for terms used within this paper:

Accountable (party) An individual(s) who has authority to approve or reject a vessel for a task or activity.

Best practice A working method or set of recommended practices that are accepted as being the best to use in a particular business or industry. They are usually documented in detail.

Charterer's responsible marine person Company employee who makes the final decision on acceptability of vessel/unit to work, on behalf of the company.

DP 1/2/3 vessels Equipment classes are defined by their worst-case failure modes as follows (from IMO MSC 645):

DP 1 vessel A loss of position may occur in the event of a single fault.

DP 2 vessel 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.

DP 3 vessel A loss of position is not to occur in the event of a single fault in any active component or system. A single failure includes:

1. Items listed above for DP 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.

DPO certificate Issued by the Nautical Institute on completion of offshore training scheme.

DPO certificate, limited Training completed on board vessels classed DP 1.

DPO certificate, unlimited Training completed on board vessels classed DP 1/2/3 where at least 60 DP days have been completed on vessels of DP class 2 or 3.

DP SME Literally 'Dynamic Positioning Subject Matter Expert', these are trained professionals who have demonstrated the competencies outlined in section 2. They may include vessel designers, shipyard personnel, commissioning personnel and operations personnel.

Industrial mission The primary operational role of the vessel. This is typically applicable to Mobile Offshore Drilling Units (MODUs) and construction vessels (e.g. pipe-lay/heavy-lift, subsea Inspection, Repair and Maintenance (IRM) vessels, Remotely Operated Vehicle (ROV) support vessels, etc.). The industrial mission, by definition, for logistics vessels is to support the logistics of oil and gas production and/or exploration activities offshore.

Loss of position and/or heading The vessel position and/or heading is outside the limits set for carrying out the DP activity in progress.

Post failure capability The vessel's resulting capability following a single point failure.

Redundancy An engineering term indicating permanently fitted back-up equipment, to be used in the event of failure of the primary unit.

Technical operator The owner, or any other organisation such as a vessel manager or bareboat charterer, that has assumed responsibility for the operation of vessels including all responsibilities as defined by the International Safety Management Code (ISM Code) or other legislative framework.

Bibliography

These publications represent the guidance that is most widely used in the industry, but does not include all available DP guidance. The latest version should be reviewed.

International Maritime Organization (IMO)

MSC Circ.645 Guidelines for vessels with dynamic positioning systems

MSC Circ.738 Guidelines for dynamic positioning system (DP) operator training

International Marine Contractors Association (IMCA)

IMCA M103 Guidelines for the design and operation of dynamically positioned vessels

IMCA M113 (IMO) Guidelines for vessels with dynamic positioning systems (MSC Circular 645)

IMCA M117 The training and experience of key DP personnel

IMCA M166 Guidance on failure modes and effects analyses (FMEAs)

IMCA M178 FMEA management guide

IMCA M181 Analysis of station keeping incident data 1994 to 2003

IMCA M190 Guidance for developing and conducting annual DP trials programmes for DP vessels

IMCA M191 Guidelines for annual DP trials for DP mobile offshore drilling units

IMCA M212 Example of an annual DP trials report

IMCA M220 Guidance on operational activity planning

182 MSF International guidelines for the safe operation of dynamically positioned offshore supply vessels

Marine Technology Society (MTS)

DP vessel design philosophy guidelines (Part 1 and Part 2)

DP operations guidance (Part 1 and Part 2 (Appendix 1, 2 and 3))

Technical and operational guidance (TECHOPS) published on the MTS DP Committee website:

ODP 01(D) FEA testing

ODP 02(D) Blackout recovery

ODP 04(D) FMEA gap analysis

ODP 05(O) DP operations manual

ODP 06(D) DGNSS position reference sensors

ODP 08(D) Annual DP trials gap analysis

ODP 09(D) A method for proving the fault ride-through capability of DP vessels with HV power plant

ODP 10(D) External interfaces

ODP 11(D) Cross connections

ODP 12(O) Defining activities requiring selection of critical activity mode

Classification Societies

International Association of Classification Societies (IACS) members have specific DP notations (including Rules) and in some cases recommended practice guidance material.

American Bureau of Shipping

ABS, Guide for Dynamic Positioning Systems

DNV-GL

Recommended Practice DNVGL-RP-E306

Recommended Practice DNVGL-RP-E307

Recommended Practice for FMEA of Redundant Systems RP D102

Oil Companies International Marine Forum (OCIMF)

OVMSA	Offshore Vessel Management Self Assessment
OVIQ	Offshore Vessel Inspection Questionnaire
OVPQ	Offshore Vessel Particulars Questionnaire

1 Introduction

This paper aims to define sound Dynamic Positioning (DP) assurance practices which are scalable based upon the level of risk. It also sets out DP operational best practices focused on external forces. External forces may include tow wires, running risers, anchors, i.e. any force that is unmeasured but that might act on the vessel to exceed its capability. This paper specifically addresses high risk operations (as defined in section 3) both within and outside of the 500m safety zone.

No industry guidance publication or standard currently exists that specifically addresses DP assurance on vessels engaged in offshore oil operations. DP assurance requirements vary widely across the industry, so this is a good opportunity to set out an industry best practice.

The paper recommends integrating the OCIMF risk management tools Offshore Vessel Inspection Questionnaire (OVIQ) and Offshore Vessel Management Self Assessment (OVMSA) with field execution of the industrial mission. These risk management tools are used widely across the offshore industry.

This paper aims to:

- Highlight the value of establishing high quality DP assurance practices, with the aim of promoting consistency and standardisation in maritime risk management where DP vessels are deployed.
- Define recommended DP assurance levels based upon the levels of risk presented across a range of maritime operations where DP vessels are deployed.
- Establish minimum requirements (qualifications, experience and access to resources) for personnel designated as the charterer's responsible marine person and operational Subject Matter Experts (SMEs).
- Recommend that appropriate levels of knowledge are defined for anyone involved in DP activities. These may include Failure Mode and Effect Analysis (FMEA) practitioners, construction and commissioning personnel, operations DP FMEA surveyors, or personnel determining whether a proposed vessel is fit for purpose for the intended industrial mission.
- Provide best practice guidance on DP Operator (DPO) skills development, qualifications and competence assurance.
- Focus on the industrial mission and activity being undertaken.
- Highlight the risks associated with using DP for anchor handling and towing.
- Raise awareness of the risks of using DP1 vessels in high risk operations, e.g. well intervention.

This paper's recommendations support OCIMF's objective of achieving high levels of operational safety and environmental responsibility. This guidance should help promote continuous improvement in vessel-based and shore-based management of DP operations.

As DP technology evolves, so do the regulations surrounding it. SMEs and the charterer's responsible marine person require education and training to keep up to date. These guidelines will help support their continuous professional development.

2 Qualifications, experience and competency of DP personnel

It is essential that the risk management of DP operations on the vessel is looked after by professional mariners who have certificates of competency and relevant experience in this field.

Delivery of incident-free DP operations relies on both vessel-based and shore-based personnel being fully competent in the field of DP.

This section aims to define a best practice approach to the categorisation of competence levels for DP assurance personnel within the offshore industry. Personnel demonstrating these competencies may be regarded as a Dynamic Positioning Subject Matter Expert (DP SME). DP SMEs may include vessel designers, shipyard personnel, commissioning personnel and operations personnel.

2.1 Shore-based DP personnel and DP assurance practitioners

The delivery of incident-free DP-related operations requires a thorough understanding of the risks that may result from a loss of position and the impacts of design, operations, people and processes. DP is a complex discipline that requires experts across a broad range of technical, operational and industrial mission specific areas. Achieving the desired levels of expertise across such a broad range of technical and operational areas (e.g. vessel control, power generation and propulsion and reference systems) requires a multi-disciplinary team. This team may be made up of personnel from both internal and external sources.

The desired level of expertise should apply to all stakeholders who have a role to play with a DP vessel across its lifecycle. These may include: technical operators; marine assurance teams; designers; shipyards; DP equipment vendors; and approval authorities such as classification societies or independent third party verification organisations.

People engaging in DP assurance activities ashore should have:

- A clear understanding of the relevant standards, specifications, regulations, rules, guidance and codes and how to apply them.
- The ability to identify and apply appropriate industry performance metrics for evaluating safe DP operations.
- The ability to interpret requirements accurately and measure them against a performance standard.
- The ability to objectively evaluate proposals or offer alternative solutions and risk mitigations to resolve DP-related issues.

An individual's documented and auditable history of relevant DP experience may be used to assess competence.

2.2 DP vessel-based personnel

Technical operators are expected to operate a robust crew competence programme and to make sure competence is continuously monitored and developed post certification, e.g. through company schemes based on OVMSA stage targets.

2.2.1 DPOs

IMO MSC Circ. 738's acceptance of IMCA M117's definitions of DPO training and certification requirements for all DP positions is fully supported by OCIMF. This certification should be backed up with relevant experience to qualify as a senior DPO.

2.2.1.1 Certification requirements

DP vessels should be manned in compliance with the relevant international or Flag State requirements. Personnel responsible for watchkeeping duties should be certified with the required credentials. Some Flag State authorities may require appropriate endorsements as detailed in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).

2.2.1.2 DPO training requirements

Technical operators should have a set of company specific training requirements and a DP competency plan. This should define required competencies for given operations and any associated training and verification of competency. If a competency plan is not available, companies should refer to this section for guidance.

Technical operators should make sure that DPOs receive classroom instruction or hands-on training on the vessel's specific DP system equipment, including special modes and vessel specific features. The vessel specific DP equipment training may be company-based or vendor-based or both. DPOs should be able to show that they can operate the DP system and Electro Technical Officers (ETOs) should be able to show that they can maintain the DP equipment.

Companies should develop criteria for determining which personnel are considered experienced personnel. This could include a minimum requirement of at least two years on a vessel where manual manoeuvres were frequently conducted. Companies may also consider satisfactory completion of shore-based simulator/manoeuvring training, as well as practical experience on board.

Technical operators should develop training programmes for all crew who have responsibility for, or are likely to be involved in, manual control on board. The training programme should consider the various scenarios that vessels might encounter. All training and manual control practice sessions should be documented in a record book. Individuals should maintain a record of their own manual control experience. A senior person on board the vessel should sign off the entries.

2.2.1.3 DPO watchkeeping recommendations

When a vessel is operating in DP mode there should always be two DPOs on watch on the bridge. There are three categories of risk in DP operations: Category A (low risk), Category B (high risk) and Category C (highest risk). These are described in more detail in section 3.3. Category B and C operations require two unlimited DPO certificates. The senior DPO should meet the requirements of a senior DPO as defined by IMCA M117. The senior DPO should be fully able to handle all aspects of vessel DP operations without any direct supervision by the Master.

The qualifications of the second DPO on the bridge can range from 'limited' to 'unlimited' certification status for Category A operations. This will depend on a charterer's risk tolerance and should be based on the risk profile of a vessel's operation. In all cases, charterers should define the qualifications of the second DPO and, if thought necessary, the requirement for additional DPOs without limitation. The second DPO on the bridge should never be a cadet, i.e. they should never be a non-STCW licensed seafarer. When DPO trainees are operating the DP system they should be under the direct and continuous supervision of the senior DPO.

2.2.1.4 DPO minimum watchkeeping proficiencies

To avoid worsening the consequences of a loss of position, DPOs conducting any activities where a loss of position is not acceptable should as a minimum be proficient in:

- Controlling individual engines and thrusters during offshore vessel operations.
- Controlling the vessel under main engines, rudder(s) and thrusters.
- Use of a joystick as a single point of control.
- Determining which axis needs to be in manual control for specific operations. DPOs should show the ability to control the vessel using two axis control in DP, with the other in manual.

Some technical operators maintain two vertical structures of watchkeeping, where DPOs and navigating officers are separated. In these cases, watchkeepers responsible for the navigation watch – but not for operating the DP system – should be able to show that they can do the following in manual mode:

- Maintain position/move away under control after DP drop out.
- Approach ports and move a vessel into a berth.
- Manoeuvre alongside another vessel.

2.2.2 Vessel DP technical personnel

DP technical personnel responsible for the maintenance of the DP system are recommended to complete appropriate training, as outlined in IMCA M117.

It is a recommended best practice that all DP electrical and engineering staff maintain a record of operational experience in a DP record book, for recognition of that service.

2.3 Vessel handling skills

Increasing levels of automation on vessels have led to a noticeable loss of traditional vessel handling and vessel manoeuvring skills. More and more reliance is being placed on the control offered by systems such as DP, not only for manoeuvring and maintaining vessel control and position for the activities the vessel was designed for, but also for other activities.

A number of DP incidents have been made worse by inappropriate human intervention. This is often due to a lack of knowledge and skills, including vessel handling skills, and a lack of understanding of the effects of the various forces acting on the vessel.

The following guidance is aimed at improving vessel handling and vessel manoeuvring skills:

- Technical operators and charterers should recognise the importance of good vessel handling skills to the safety of operations. They should make sure that time is allocated during the planning of operations for the vessel crew to practice manoeuvring. The following minimum expectations for manual handling practice should be combined with competency assessment/demonstration on a simulator, in order to maintain certification as a DPO:

Operation	Practice time
Offshore Support Vessel (OSV), Platform Supply Vessel (PSV), ROV vessels, Anchor Handling Tug (AHT) vessels	Minimum one hour per week, per DPO
Drilling, pipe lay vessels	Minimum one hour per DPO in between wells/operations
DP shuttle tankers, Ship to Ship (STS) operators	Minimum one hour per month

- Vessel ‘standby time’ or ‘downtime’ should be considered as a time for crews to practice manual vessel handling skills. Where vessels do not experience natural periods of downtime, allocating time for practice should be considered.
- Experienced personnel should recognise the longer term benefits of engaging and teaching less experienced personnel in vessel handling using non-DP helm controls during close proximity to other vessels or structures.

2.3.1 Manual control skills

Challenges exist in maintaining vessel handling skills for DPOs. It is critical that all DPOs are capable and are able to take the most appropriate action to move the vessel to a safe location following an issue with the DP system. Vessel operators should develop a range of practices that will help with the ongoing development of skills. In doing so, the following should be considered:

- Use of experienced operators to provide on board training.
- Having training Masters observe and assess bridge personnel.
- Establishing a set of manual vessel manoeuvring competencies.
- Allowing time for manoeuvring practice in a safe location.
- Use of operation specific shore-based training simulators.
- Use of onboard training simulators and computerised training programmes.
- Defining the frequency of manual training practice and maintaining training records.
- Means of assessing, recording and validating skills.
- Conducting practical training in a safe location in a ‘drift off position’ from any other vessels, traffic, subsea obstructions and surface obstructions.
- Conducting practical training and practice in a variety of environmental conditions.
- Conducting practical training and practice in a variety of light conditions (e.g. daylight and darkness).

Means of control should include:

- Controlling the vessel with independent propulsion and local thrusters.
- Controlling the vessel with an independent joystick.
- Maintaining the vessel in one position without changing the heading, in the vicinity of a fixed reference point/object or by using a Differential Global Positioning System (DGPS).
- Maintaining the vessel in one position without changing heading in the vicinity of a fixed reference point/object or by using DGPS with a reduced number of propulsion units.
- Manoeuvring and controlling the vessel (box patterns/heading changes) in the vicinity of a fixed reference point/object or by using DGPS.
- Manoeuvring and controlling the vessel (box patterns/heading changes) in the vicinity of a fixed reference point/object or by using DGPS but with reduced number of propulsion units.
- Transferring in and out of DP to joystick/manual control at all DP stations, including backup.
- Manoeuvring and controlling the vessel as listed above, after worst case propulsion failure as per FMEA.
- Manoeuvring the vessel in DP after loss of all position reference systems.

3 DP assurance framework

DP assurance is recognised as a key requirement in managing maritime risk, maximising safety and reducing Non-Productive Time (NPT). Gaps in DP assurance may result in DP systems that are prone to failure and may lead to process safety events.

DP assurance relies on the ability to validate capability in a number of areas, including procedures, equipment and personnel. DP assurance activities should aim to:

- Help ensure that the criticality of impact/consequences from loss of position for proposed operations is fully understood.
- Review personnel's experience and competency levels, to verify that sound decision making skills are evident both ashore and on board vessels.
- Develop processes required for safe station keeping and identify known responses to potential incidents, upsets or failures.
- Identify the configuration that achieves the highest level of station keeping integrity.
- Validate the technical operator's assessment that station keeping is essential for the DP operation.
- Promote consistent and increased use of established alert level identification and definition tools, e.g. Activity Specific Operating Guidelines/Well Specific Operating Guidelines (ASOG/WSOG).
- Define post failure capability, particularly through use of established limit setting tools that are widely used in industry (e.g. ASOG/WSOG).
- Identify the systems and processes in place to control risk and manage change, to ensure that the redundancy concept is not compromised. Give particular attention to operational risk control and planned maintenance procedures. These should be in the technical operator's Safety Management System (SMS) and Planned Maintenance System (PMS), including Management of Change (MOC) procedures.

The charterer's responsible marine person and DP SME should be independent of:

- The organisation issuing the DP Class notation for the vessel.
- The vessel's designer and builder.
- The technical operator responsible or accountable for the delivery of DP-related operations.

3.1 DP assurance framework aims

This DP assurance framework has been developed to provide a standard model. Its four key aims are:

1. To help the charterer's responsible marine person assess a DP vessel or unit, as well as the technical operator's DP management system, to ensure that everything is working effectively before operations begin.
2. To define appropriate DP assurance tasks that are scaled to the risk of loss of position presented by the operation and vessel.
3. To be suitable for use across all types of offshore marine DP vessels or units and industrial missions.
4. To promote the integration of DP assurance activities with the OCIMF Offshore Vessel Inspection Database (OVID) tools and Marine Technology Society (MTS) guidelines and tools.

The most important aspect of this framework is that the level of assurance recommended should be appropriate for the risk of loss of position in any combination of vessel and industrial mission. This is achieved by ensuring that, irrespective of DP equipment Class notations, the vessel is operated within the post failure capability of the DP system.

3.2 Loss of position and consequences

DP assurance efforts should focus on:

- Understanding the importance of station keeping.
- Understanding the consequences of a loss of position and/or heading.
- Developing appropriate and effective measures that reduce the impact of a loss of position.

Appropriate operational risk mitigation measures need to be in place to reduce the consequences of a loss of position to a defined safe level. This includes identifying operations that require Critical Activity Mode of Operation/Task Appropriate Mode (CAMO/TAM) configurations. A risk assessment should be conducted before operations begin and should consider all aspects of risk involved.

Where a DP equipment component has failed, leading to a cessation of industrial operations (e.g. DP blue, yellow or red alert), operations should only begin again after a risk assessment has been completed. This assessment should explore, as a minimum, the impact on any DP equipment components of the failure, and the vessel's DP redundancy and post-failure capability. The definition of a DP blue or yellow alert will vary between charterers.

3.2.1 DP1 vessels

For DP1 vessels, loss of position may occur in the event of a single point failure. A documented risk assessment focused on the consequences of a loss of position for the proposed industrial mission should be documented.

3.2.2 DP2 and DP3 vessels

For DP2 and DP3 vessels, loss of position should not occur in the event of a single point failure, but loss of redundancy may occur. Operational risk mitigation measures need to be detailed and in place to allow appropriate alignment with industrial operations in the event of loss of redundancy. DP2 and DP3 vessels should be subjected to DP assurance verification so that cause and effect are known and communicated to all stakeholders. This should include a verification of the FMEA and proving trials as well as annual trials.

3.3 Risk-based approach

In some operations, non-redundant DP vessels may be deployed if loss of position is acceptable, either due to the location, the operation or both. Such operations may not require much DP assurance over and above that which is already contained in the OVIQ sets. For more complex operations, additional DP assurance activities are recommended. A full suite of DP assurance activities should be defined for the most complex drilling, well intervention or Simultaneous Operations (SIMOPS).

An Assurance Category Identification (ACID) tool can be used to help identify the level of DP assurance that needs to be followed. In section 3.5, an ACID tool is provided that defines three categories of risk: Category A (low risk), Category B (high risk) and Category C (highest risk). In the ACID tool, users can assess the consequences of a loss of position and match it to the defined risk categories. The ACID tool can be used for any vessel and industrial mission combination.

The vessel and operation specific documented risk assessment will help users establish what the consequences of a loss of position are. The expectation is that the majority of DP 2 and DP 3 vessels and operations fall under Category B, while the highest risk operations fall under Category C.

Sections 3.6 to 3.8 outline DP assurance activities for each category of risk. It is recommended that users follow the defined DP assurance activities for all vessels and units, including those sub-chartered. The most detailed and comprehensive DP assurance activity is designed to take place when the loss of position has the highest consequences (Category C).

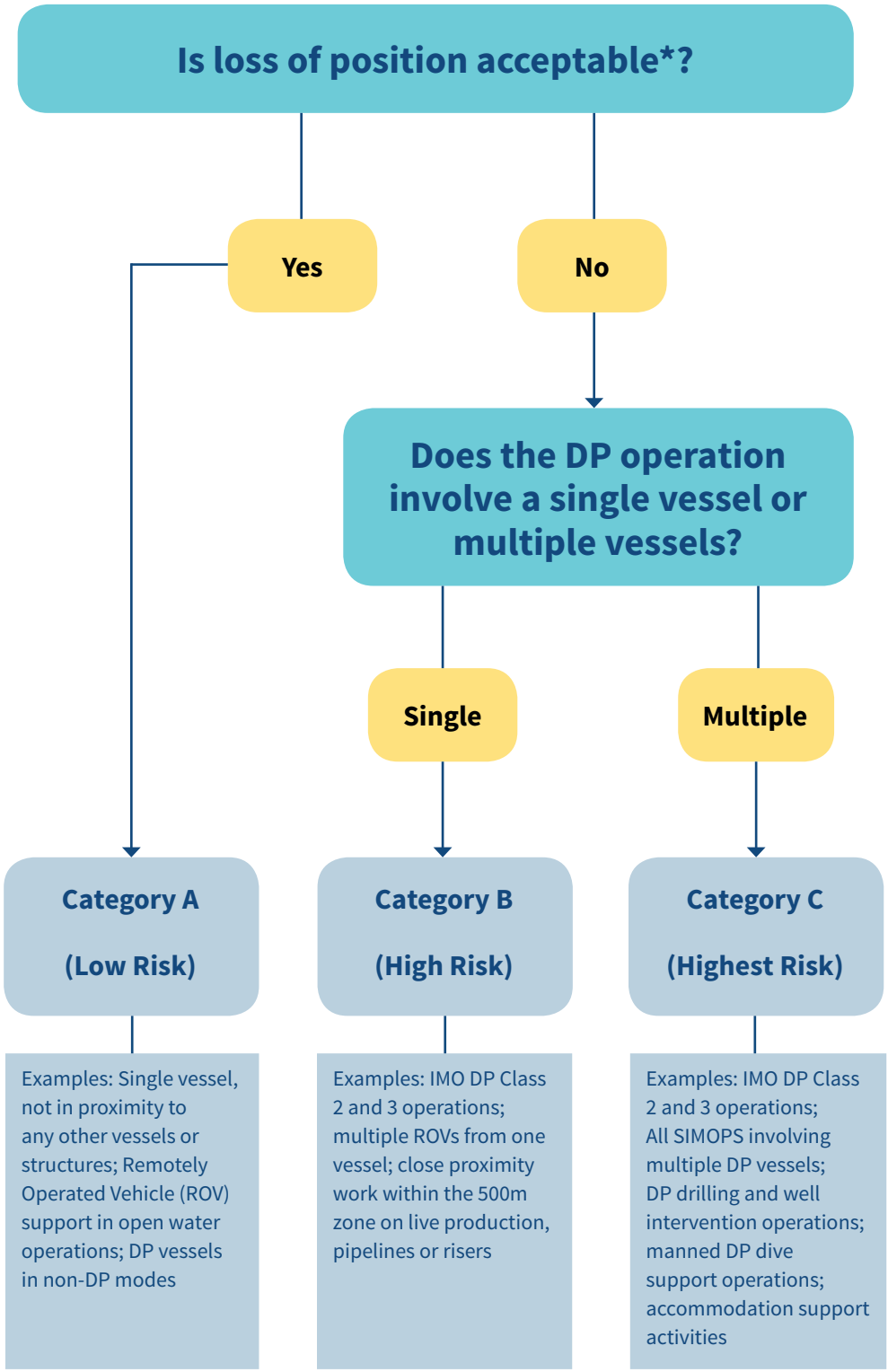
3.4 DP assurance management and records

After conducting the relevant assurance as outlined in the DP assurance framework below, it is recommended that the following reviews are carried out.

- Confirming that DP operational observations and findings from the OVIQ and the range of pre-operation verification elements have been properly addressed by the technical operator.
- Confirming that relevant parts of the technical operator's OVMSA submission and feedback have been incorporated into a continuous improvement plan.

The charterer of the vessel should monitor vessel operator management oversight and maintain records of DP assurance activities.

3.5 DP assurance framework: Assurance Category Identification (ACID) tool



* Where doubt exists as to the level of risk presented for a given vessel/industrial mission combination, select the next highest category of assurance.

3.6 DP assurance framework: Category A (low risk)

Element	Standard and/ or Tools	Task	Best Practice
Vessel inspection	OVIQ OVPQ	Charterer reviews the annual inspection.	Create a continuous improvement plan based on the observations and responses to the DP operations OVIQ questions. Maintain up-to-date OVPQ.
Technical operator management capability	OVMSA	Charterer reviews the operator's OVMSA. Confirm following is in place: • Planned maintenance. • Permit to Work (PTW). • Incident reporting/ learnings.	Charterer reviews the OVMSA and uses it to create a continuous improvement plan/contract management plan.
Vessel DPO manning	IMO MSC 736 IMCA competence assurance	The minimum DPO manning as defined in 'Best Practice' should be met.	Minimum requirement is for two DPO certificates for each watch while the vessel is engaged in DP operations – one unlimited DPO and one basic DPO (or higher; cadets are not allowed to fill this position).

3.7 DP assurance framework: Category B (high risk)

Element	Standard and/ or Tools	Task	Best Practice
Vessel inspection	OVIQ OVPQ	Charterer reviews the annual inspection. Risk assess and address all DP operational observations before commencing any DP operations.	Create a continuous improvement plan based on the observations and responses to the DP operations OVIQ questions. Maintain up-to-date OVPQ.
Technical operator management capability	OVMSA	Charterer reviews the operator's OVMSA, with emphasis on elements specific to DP operations.	Review the OVMSA and use it to create a continuous improvement plan/contract management plan.
Vessel DPO manning	IMO MSC 736 IMCA competence assurance	The minimum DPO manning as defined in 'Best Practice' should be met.	The minimum requirement is for two unlimited DPO certificates for each watch while the vessel is engaged in DP operations.
System design and Worst Case Failure Design Intent (WCFDI)	IMO MSC 645 Redundancy concept (or equivalent) Assigned Class notation	Charterer's shore-based personnel review the WCFDI and verify against the principles of the design philosophy. The DP design philosophy should be assessed against the requirements created by the proposed industrial mission by a review of the FMEA (updated following any modifications).	Review should include: • Capability plots. • FMEA (as written). • Acceptance tests. • Periodic testing requirements. • Maintenance* • Inspection* *Include management and oversight.
DP proving trials	IMO MSC 645 and Class notation	Charterer's responsible marine person reviews evidence that DP proving trials have taken place.	DP proving trials should be completed every five years.

Element	Standard and/ or Tools	Task	Best Practice
Annual DP trials	IMO MSC 645, Class, IMCA, MTS	Charterer's responsible marine person reviews evidence that annual DP trials have taken place.	Record observations from trials, convert into lessons learned and incorporate into future training programmes.
DP operations manual	IMO MSC 645 and Class notation	Charterer's responsible marine person to review.	
ASOG/WSOG/ critical activity DP operations manual (reviewed for each new activity and/or annually in common risk missions/ locations)	IMCA M220 or MTS DP operations guidance	Charterer's responsible marine person to review. The technical operator is accountable for the establishment of appropriate alert levels (ASOG/WSOG, CAMO and TAM).	Recommend that the charterer's DP SME updates and verifies the operations manual, to comply with the industrial mission requirements.
Management bridging document between technical operator and vessel charterer	Individual charterer's Contractor Safety Management System requirements	Bridging document to be agreed upon by technical operator and vessel charterer.	

3.8 DP assurance framework: Category C (highest risk)

Element	Standard and/ or Tools	Task	Best Practice
Vessel inspection	OVIQ OVPQ	Charterer reviews and validates the annual inspection. Risk assess and close out all DP operational observations before commencing any DP operations.	Create a continuous improvement plan based on the observations and responses to the DP operations OVIQ questions. Maintain up-to-date OVPQ.
Technical operator management capability	OVMSA	Charterer reviews the operator's OVMSA, with emphasis on elements specific to DP operations.	Charterer reviews the OVMSA and use it to create a continuous improvement plan/contract management plan.
Vessel DPO manning	IMO MSC 736 IMCA competence assurance	The minimum DPO manning as defined in best practice should be met.	The minimum requirement is for two unlimited DPO certificates for each watch while the vessel is engaged in DP operations.
System design and Worst Case Failure Design Intent (WCFDI)	IMO MSC 645 Redundancy concept (or equivalent) MTS TECHOPS gap analysis tool	Charterer's shore-based personnel review the WCFDI and verify against the principles of the design philosophy. The DP design philosophy should be assessed against the requirements created by the proposed industrial mission by a review of the FMEA (updated following any modifications).	Review should include: • Capability plots. • FMEA (as written). • Acceptance tests. • Periodic testing requirements. • Maintenance* • Inspection* *Include management and oversight.
DP proving trials	MTS TECHOPS gap analysis tool	DP SME to review trials under direction of charterer's responsible marine person.	DP proving trials should be completed every five years.

Element	Standard and/ or Tools	Task	Best Practice
Annual DP trials	MTS TECHOPS gap analysis tool	DP SME to review trials under direction of charterer's responsible marine person.	Record observations from trials, convert into lessons learned and incorporate into future training programmes. If changes to the DP system are required as the result of a review: • Engage with DP system designer, equipment manufacturer and Class. • Implement MOC process.
DP operations manual	MTS TECHOPS gap analysis tool	DP SME to review manual under direction of charterer's responsible marine person.	
ASOG/WSOG/ critical activity DP operations manual (reviewed for each new activity and/or annually in common risk missions/ locations)	IMCA M220 or MTS DP operations guidance; DNV RP 307	DP SME under direction of charterer's responsible marine person. The technical vessel operator is accountable for the establishment of appropriate alert levels (ASOG/WSOG, CAMO and TAM).	Recommend that the charterer's DP SME updates and verifies the operations manual, to comply with the industrial mission requirements.
Management bridging document between technical operator and vessel charterer	Individual charterer's Contractor Safety Management System requirements	Bridging document to be agreed upon by technical operator/marine drilling contractor and vessel/unit charterer.	

4 Use of manual mode to manage unmeasured external forces on a DP vessel

Requirements regarding bridge watchkeepers (navigation watch and DP) require confirmation that, as a minimum, all vessel-based DPOs are required to understand:

- The impact of non-environmental external forces on the DP vessels.
- That towing and anchor handling operations should not use the three axis auto DP.

Non-environmental external forces might be present during:

- Anchor handling
- Towing
- Pipe/cable lay
- Heavy lift mode
- Riser transfer
- Riser pull-in
- Mooring

4.1 Modes on a DP vessel

DP vessels are outfitted with several modes and these are usually:

- Auto DP (three axis control of surge, sway and yaw).
- DP joystick.
- Independent joystick system.
- Manual.

Within auto DP there is usually a way of taking manual control of any of the three axes. When just one of the three axes is not in auto DP control, the vessel is no longer considered to be in auto DP.

Within auto DP there are other industrial mission specific modes, e.g. track follow, follow target and pipe lay modes. The use of the follow target mode, and the practice of changing DP modes when close to surface facilities, should be risk assessed. They should not be attempted unless the appropriate position reference sensors and control system parameters are in place. Change of centre of rotation during DP operations should not be attempted when the tolerance for a loss of position and or heading is low (e.g. when in proximity to surface facilities).

The vessel specific DP operations manual should have clear descriptions of the different modes of operations and detailed procedures, given as step-by-step instructions, for changing mode. The DP operations manual should also clearly say which modes can be used for specific industrial mission activities.

The ASOG/WSOG that is developed for the activity should clearly state which modes are permitted or prohibited for a particular activity.

4.2 Managing the DP system when non-environmental external forces are applied to the vessel

A number of potential near misses and actual incidents have occurred when vessels operating in DP mode were either moving out of position or applying unnecessary or excessive power as a result of unmeasured non-environmental external forces. When such non-environmental external forces are applied to a vessel, the DP system may attempt corrections that overcompensate.

DP equipment vendors have incorporated features that help with the conduct of complex activities that use DP. Such features include accounting for non-environmental external forces by the DP control system.

An example of activities where the use of three axis auto DP may not always be appropriate is where a non-environmental external force is applied to the vessel, such as when towing or anchor handling, or when positioning floating production facilities offshore.

When a 'pulling' force is applied to a vessel, such as a use of a pennant during towing or anchor handling operations, the DP control system will translate this as an external force and will apply propulsion power in the opposite direction to the force. The DP system will apply maximum force in an attempt to return the vessel to the position or heading set into the system. In some cases, this will result in a demand of 100% of available load plus the auto start of standby power. The vessel will become power-limited or thrust-limited and, when the applied force exceeds vessel capability, failure in a weaker component could result. This failure may be the failure of vessel equipment, the failure of tow/work wires or chains, or the weak point might be the stability of the vessel as it is overcome with transverse force that exceeds its capability.

The use of full three axis auto DP during anchor handling and towing operations is not recommended. Instead, the following controls may be considered, after a risk assessment:

- Heading (yaw) control.
- Automatic sway control. Thrust must be available, unless there is a large angle between the towing wire and the DP vessel.

The use of a vessel in auto DP may be a viable option for activities where either the external pulling force is measured or calculated in accordance with sound engineering principles and used as a manual input into the DP control system, or where the forces are minimal. Activities where auto DP might be used include:

- 'Pre lay anchor' activities where a high degree of position accuracy is often required and the forces applied by the anchor lines are both minimal and controlled.
- Controlling the vessel when connecting/disconnecting buoys, to avoid tension in riser pennant during connection/disconnection operations only.
- Station keeping above the anchor while waiting for the rig to tension up before chasing back in permanent chaser systems.
- Standby on static tow, when there is zero weight and no thrust on/against the wire.
- Where the opportunity exists to measure the external force as an input to the DP system, such as in pipe lay operations.
- The routine practice of pulling in the riser, with directional pull from the riser load or while being held in place by a holdback vessel.

Before engaging in the above types of activity an appropriate risk assessment should be made to make sure that the forces are not likely to become variable or excessive, or potentially exceed the vessel's capability. This review and risk assessment should be properly documented and cover all stakeholders, including vessel DPOs and/or Masters who will be asked to perform the work.

The automatic input of non-environmental external forces into the DP system should be avoided, unless an effective systems engineering approach can be taken to analyse all potential failure modes of such systems. Input should also be capable of being disabled and entered manually. The results of analyses should be proven by field trials.

4.3 Recommendations

Three axis auto DP is not recommended for:

- Operations during the installation of production facilities.
- Anchor handling operations.
- Towing operations.

All external forces likely to affect a DP vessel should be accounted for and be either measured or calculated. There should be a manual means of entering such forces into the DP control system. Automatic input is not recommended unless it is accompanied by a detailed systems engineering approach and a robust proving trials programme.

Manual mode of DP is recommended if unknown or unmeasurable variable forces are involved.

A voice for safety

Oil Companies
International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom

T +44 (0)20 7654 1200
F +44 (0)20 7654 1205
E enquiries@ocimf.org
ocimf.org