International Guidelines for

The Safe Operation of Dynamically Positioned Offshore Supply Vessels

IMCA MARINE Safety Forum

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Feedback – If you have any comments on this document, please email us: feedback@imca-int.com

These international guidelines have been produced by a cross-industry workgroup.

Its secretariat has been provided by IMCA – the International Marine Contractors Association – which is also making the guidelines available as part of its publications service. For this purpose, the guidelines may be referred to as 182 MSF.

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International Guidelines for the Safe Operation of Dynamically Positioned Offshore Supply Vessels

Preface

Reliable and robust methods of positioning are required for safe vessel operations near offshore installations.

Dynamic positioning (DP) is well established as a primary method of vessel positioning, in the diving, drilling, construction, accommodation and shuttle tanker sectors, and it is especially suited to deep-water developments.

As the development and management of DP becomes more refined, increasingly logistics support vessels are now more commonly being fitted with DP systems, with an associated increased reliance being given to such systems.

The accepted industry guidance document which forms the basis of safe DP operations is, the International Maritime Organization (IMO) MSC/Circ.645 – Guidelines for vessels with dynamic positioning systems 1997. In June 2017, the IMO updated IMO MSC/Circ. 645, Guidelines for Vessels with Dynamic Positioning (DP) Systems and issued IMO MSC.1/Circ. 1580 with a similar title. The latest IMO document applies to vessels built on, or after, June 2017 whereas the previous document applied to DP vessels built after 1994. The exception, however, is Section 4 of the latter document entitled "Operational Requirements" which is recommended to apply to "all new and existing vessels and units, as appropriate".

However, the new IMO document has much of the same content as the original document, therefore unless otherwise stated, references to IMO MSC.1/Circ. 1580 within this guidance are applicable to all DP vessels.

DP operators should also refer to the relevant DP rules for the main classification societies and all appropriate IMCA and Marine Technology Society (MTS) documents.

Such rules and guidelines are focused principally on design, construction, and the operation of DP vessels and apply the principles of redundancy to, creating a hierarchy of DP equipment classes. They also provide generic requirements for the verification of DP systems, including DP failure modes and effects analyses (FMEA), survey and testing procedures, as well as requirements for vessel operators to develop appropriate operating instructions.

There are also internationally recognised standards for DP training, which are set out in IMO MSC/Circ.738 – Guidelines for dynamic positioning system (DP) operator training. This document recommends the use of IMCA M 117 – The training and experience of key DP personnel [International Marine Contractors Association (IMCA)].

In addition, the 2010 amendments of the IMO International Convention on Standards of Training, Certification & Watchkeeping for Seafarers (STCW) Code introduces new guidance on the training and experience of personnel operating DP systems.

Other training guidance can be found, for example, in the Nautical Institute certification programme.

All these documents are augmented by a range of DP related guidance from IMCA.

The Nautical Institute (NI) and IMCA have collaborated in a joint venture to provide Continuous Professional Development (CPD) to Key DP Personnel who perform a safety critical role onboard offshore DP vessels. The NI manage the administration of the scheme and IMCA manage the content. The scheme is designed to provide vessel owner/operators with evidence that their crews meet CPD requirements according to IMCA M 117, which, by default, is also an IMO requirement. The scheme also promotes safe DP working practices for the benefit of all in the DP community.

In addition to these industry rules and guidelines, the day-to-day operation of a DP vessel is considered as a critical operation and is managed by vessel operators in accordance with their Safety Management System. Many individual charterers also specify their own requirements to help safeguard the integrity of their offshore installations. National and regional requirements are also in force. Whilst reflecting the existing industry framework, the guidelines contained in this document provide vessel operators, charterers, Masters and Officers with sector-specific methods for the safe operation of DP offshore supply vessels.

These guidelines were originally developed by an international cross-industry workgroup and have more recently been updated by the Marine Safety Forum in conjunction with IMCA and the Guidelines for Offshore Marine Operations (GOMO) Group. The intention is that this document will provide guidance, when DP is to be used on an offshore supply vessel, which is suitable for international application.

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Appendices

1 Introduction

1.1 Basis of these Guidelines

These guidelines are based upon the specific characteristics of DP equipped offshore supply vessel operations.

Specifically, unlike many other DP vessel operations, offshore supply vessels can, under normal operating circumstances:

- Terminate supply operations and move away from the offshore installation at very short notice; and/or;
- Continue to manoeuvre using independent joystick or 'manual' control until supply operations can be safely terminated. Note that changing controls whilst close to the installation should be avoided except for in emergency situations.

Such operations are usually only of short duration.

It should be noted, however, that the above may not be possible when handling bulk cargo through hoses whereby safe disconnection times should be taken into consideration.

Furthermore, as offshore supply vessels routinely operate close to offshore structures and therefore pose a significant collision / allision risk, all supply operations close to such structures should be considered as critical activities.

1.2 Application of these Guidelines

These guidelines primarily apply to DP equipped offshore supply vessels but may also include all other types of vessels carrying out supply and other ancillary operations (usually accepted as cargo, anchor-handling and towing operations), that are subject to section 1.1 (i) and (ii) above, when in DP mode either inside, or outside of, the 500 metres safety zone of an offshore installation.

These guidelines do not preclude non-DP-equipped vessels from carrying out supply operations but merely offer guidance to those using DP. Acceptance of the limitations of vessels, and decisions on suitability of DP use inside installation safety zones, shall always lie with the charterer.

1.3 Purpose and Scope

The purpose of these guidelines is to make risk management tools available, to vessel operators, charterers, Masters and Officers that will help ensure safe operation of DP offshore supply vessels in automatic DP mode.

These guidelines form part of an existing framework of rules and guidance issued by various authorities and organisations. Efforts have been made to ensure compatibility with the existing documents wherever possible.

As both the DP and offshore supply vessel sectors are constantly evolving, these guidelines are only fully valid when they were prepared and should be reviewed and updated, where necessary, on a three-year cycle, unless significant changes to industry guidance or technological advancements make such a review necessary, within the 3 year period.

The demands placed upon vessels and the intended work scope are areas that need addressing using these guidelines through the technical and operational capabilities of the vessels themselves or limitations demanded by charterers.

Vessel operators should take these guidelines into account when carrying out DP supply and other ancillary operations. They should also incorporate these guidelines into their own vessel management systems, including preparation of company and vessel documentation in accordance with document IMCA M 109 – *A guide to DP-related documentation for DP vessels*. This can be done simply, by reference, if necessary.

Section 4 (Operations) of this document addresses the application of existing international rules and guidelines and considers such measures as classification society requirements for their DP class notation, and the continuous verification processes.

It provides guidance on what vessel operators should have in place, regarding certification and documentation, and contains guidance but also manning, including levels of training, certification, skills and experience.

Guidance on managing risk within DP operations aimed at minimising the risk of loss of position is also present in Section 4 along with further risk reduction measures, DP operating procedures and DP incident reporting.

This document considers all areas that need to be factored into risk assessment and Activity Specific Operating Guidelines (ASOG) including, but not limited to:

Vessel capability:

- vessel DP equipment class;
- equipment status and performance;
- vessel manning;
- DP watchkeeper/operator experience.

Local conditions:

- proximity to installations;
- available sea room;
- environmental conditions;
- charterer's restrictions.

Detailed guidance is contained within the relevant parts of this document.

1.4 Abbreviations

The following abbreviations are used in these guidelines:

AHV	Anchor Handling Vessel
ASOG	Activity Specific Operating Guidelines
AVM	Automatic Vessel Management
CAM	Critical Activity Mode (of operation)
CCTV	Closed-circuit Television
DG	Diesel Generator
DGNSS	Differential Global Navigation Satellite System

DNV	Det Norske Veritas
DP	Dynamic Positioning
DPO	DP Operator
DPS	DP Specialist
DPVOA	The Dynamically Positioned Vessel Owners Association
EDS	Emergency Disconnect Sequence
FMEA	Failure Modes and Effects Analysis
FPSO	Floating Production Storage and Offloading unit
FSVAD	Flag State Verification and Acceptance Document
GOMO	Guidelines for Offshore Marine Operations
HAZID	Hazard Identification study
HAZOP	Hazard and Operability study
HiPAP	High Precision Acoustic Positioning system
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICS	Integrated Control System
IJS	Independent Joystick
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
ISM	International Safety Management Code
MRU	Motion Reference Unit
MSC	IMO Maritime Safety Committee
MSC/Circ.	IMO Maritime Safety Committee Circular
MTS	Marine Technology Society
NI	The Nautical Institute
NMA	Norwegian Maritime Authority
OIM	Offshore Installation Manager
PMS	Power Management System
PPE	Personal Protective Equipment
PRS	Position Reference System
PSV	Platform Supply Vessel
SIMOPS	Simultaneous Operations
STCW	International Convention on Standards of Training, Certification & Watchkeeping for Seafarers
TAM	Task Appropriate Mode
TLP	Tension Leg Platform
TW	Taut-Wire
UMS	Unmanned Machinery Spaces
UPS	Uninterruptible Power Supply
VMS	Vessel Management System

VOD	Vessel Overview Document
VRU	Vertical Reference Unit
WAAS	Wide Area Augmentation System
WCF	Worst-case Failure
WCFDI	Worst-case Failure Design Intent

1.5 Terms and Definitions

The following limited list of terms and definitions are used in these guidelines. Further definitions can be found in appropriate IMCA and MTS documents.

Ancillary operations	Supply vessel operations involving the transfer of deck, dry bulk and liquid cargoes, or any other marine surface operations such as, for example, anchor handling, and supply to a pipe-laying vessel.
Available (system)	A system that is capable of operating.
Capability plot	A plot that provides an indication of a vessel's DP station keeping ability expressed in a common format.
DP class notation	A notation used by classification societies in grading DP vessels, based upon IMO equipment class principles.
DP footprint plot	A plot designed to record the observed movement of the DP vessel from its desired target location over a defined period.
DP incident	A DP incident is an unexpected loss of position and/or heading, or an unexpected loss of functionality/availability of equipment, that results in a reduced level of redundancy leading to a degraded operational status, or when the DP system performance differs from the operator's expectations.
DP offshore supply vessel	A PSV, AHV or towing vessel which automatically maintains its position (fixed location or predetermined track) by means of thruster force, as defined in IMO MSC/Circ.1580. Other operations may be undertaken by this type of vessel and, unless there is other more relevant guidance, these guidelines should still be applied where appropriate in those cases.
DP system	A complete system necessary for dynamically positioning a vessel, comprised of sub-systems defined in IMO MSC/Circ.645/1580: section 3.
Equipment class	A classification listing utilised in IMO MSC/Circ.1580 to grade the equipment capability of DP vessels, comprising the following classes: DP class 1, DP class 2 and DP class 3.
Hazmat	Hazardous Materials.

Lee-side	A position relative to a structure, where any combination of environmental forces such as wind, waves, swell, wave drift, surface current, surge current, tidal current, including any changes to those factors, could move a vessel away from the structure.
Offshore installation	A fixed or mobile structure, vessel or unit that is used in the offshore oil and gas industry for the exploration, exploitation, storage or transfer of hydrocarbons, or as locally defined.
Online	Equipment actively interfaced with the DP system.
Operating (system)	A computer-based system used to control DP.
Redundancy	The ability of a component, or system, to maintain, or restore, its function when a single failure has occurred. Redundancy can be achieved, for instance, by installation of multiple components, systems, or alternative means of performing a function.
Supply operations	Cargo, anchor handling and towing operations.
Time to Terminate	The time required to terminate the vessel's mission and permit a departure from location.
Weather-side	A position relative to a structure, where any combination of environmental forces such as wind, waves, swell, wave drift, surface current, surge current, tidal current, including any changes to those factors, that could move the vessel towards the structure.
Worst-case Failure	An identified single failure mode in the DP system, resulting in the maximum detrimental effect on DP capability, as confirmed by the FMEA.
Worst-case Failure Design Intent	Worst-case Failure Design Intent is the most significant single failure mode that can be tolerated which has the maximum effect on DP capability, were it to occur. It typically relates to the maximum number of thrusters, generators and control equipment that can simultaneously fail and reduce positioning capability following the single failure.

2 Existing Rules and Guidance

Vessels with DP systems are subject to various international and regional rules and guidelines. This section gives a brief overview.

2.1 International Rules and Guidance

The principal internationally accepted reference on which the rules and guidelines of other authorities and organisations, including classification societies and IMCA, are based upon is IMO MSC/Circ.645 – *Guidelines for vessels with dynamic positioning systems 1994, and* IMO MSC.1/Circ.1580 – *Guidelines for vessels and units with dynamic positioning systems 2017*.

Circular 645 provides an international standard for dynamic positioning systems on all types of DP vessels, built after 1 July 1994 and before 9th June 2017 and Circular 1580 provides the same for vessels built from 9th June 2017 onwards. Their stated purpose is to recommend design criteria, necessary equipment, operating requirements and a test and documentation system for dynamic positioning systems to reduce the risk to personnel, the vessel, other vessels or structures, subsea installations, and the environment, whilst performing operations under dynamic positioning control.

The new IMO document has much of the same content as the original document therefore unless otherwise stated, references to IMO MSC.1/Circ. 1580 within this guidance are applicable to all DP vessels regardless of build year.

The responsibility for ensuring that the provisions of IMO MSC/Circ. 1580 are complied with rests with the operator of the DP vessel.

A central feature of IMO MSC/Circ.645 [1580] is to give guidance on DP equipment classification and redundancy requirements. Equipment classes are defined by their worst-case failure modes, in accordance with the following IMO definitions:

Equipment class 1	Loss of position [and/or heading] may occur in the event of a single fault.
Equipment class 2	Loss of position [and/or heading] is not to occur in the event of a single fault in any active component or system. Common static components may be accepted in systems which will not immediately affect position keeping capabilities upon failure. Normally such 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: any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.) and any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection.

Equipment class 3	Loss of position is not to occur in the event of a single fault as above for class 2 but also for normally static components which could be assumed to fail. This includes all components in any one watertight compartment, from fire or flooding; all components in any one fire sub-division, from fire or flooding, including cables, where special provisions apply under section 3.5.1 of IMO MSC/Circ.1580.

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

IMO MSC.1/Circ.1580 also gives guidance on the functional requirements for all components in the DP system.

2.2 Flag State Verification and Acceptance Document (FSVAD)

Operators should be aware that the annex to MSC/Circ.645, particularly at paragraph 5.2, describes the requirements for an FSVAD.

IMO MSC.1/Circ.1580, paragraph 5.2 describes the requirement for a Dynamic Positioning Verification and Acceptance Document (DPVAD)

In practice, classification societies implement these requirements on behalf of flag state administrations as 'organisations duly authorised'.

The independence of authorities who issue FSVAD / DPVAD should be maintained. It should always be against IMO MSC/Circ.645/1580 and not class rules.

2.3 Classification Societies

Most classification societies use the IMO principles of equipment class and redundancy requirements, as the basis for their own DP rules. Classification society rules however differ and evolve, and therefore do not exactly mirror the requirements of IMO MSC/Circ.1580. Table 1 provides an overview of classification society DP class notations and the equivalent IMO DP equipment classes. It is, however, prudent to check with the relevant classification society, to obtain its current requirements.

Regardless of Class rules, IMO MSC/Circ.645/1580 should be the basis for all DP operations.

2.3.1 Equipment Classification

		No IMO Equivalent	IMO Equipment Class		
			Class 1	Class 2	Class 3
ABS	American Bureau of Shipping (USA)	DPS-0	DPS-1	DPS-2	DPS-3
BV	Bureau Veritas (France)	DYNAPOS SAM	DYNAPOS AM/AT	DYNAPOS AM/AT R	DYNAPOS AM/AT RS
CCS	China Classification Society (China)		DP-1	DP-2	DP-3
DNV	DNV (Norway)	DYNPOS AUTS	DYNPOS AUT	DYNPOS AUTR	DYNPOS AUTRO
		DPS 0	DPS 1	DPS 2	DPS 3
IRS	Indian Register of Shipping (India)		DP(1)	DP(2)	DP(3)

KR	Korean Register of Shipping (Korea)		DPS (1)	DPS (2)	DPS (3)
LR	Lloyd's Register (UK)	DP (CM)	DP (AM)	DP (AA)	DP (AAA)
NK	Nippon Kaiji Kyokai (Japan)		Class A DP	Class B DP	Class C DP
RINA	Registro Italiano Navale (Italy)	DYNAPOS SAM	DYNAPOS AM/AT	DYNAPOS AM/AT R	DYNAPOS AM/AT RS
RS	Russian Maritime Register of Shipping (Russia)		DYNPOS-1	DYNPOS-2	DYNPOS-3

Table 1 – Principal equivalent leading classification society DP class notations

Note: The equivalency to IMO DP class is approximate only because of differences between the various classifications and the ability of class societies to allow exemptions etc.

These guidelines apply to offshore supply vessels in the shaded area of Table 1, i.e., equivalent to IMO equipment class 1 or higher. This minimum level excludes offshore supply vessels that are fitted with DP systems with lower levels of equipment, although this does not prevent such vessels from following these guidelines where practicable to do so.

Table 1 is not exhaustive. Other classification societies have DP rules. A DP class notation from another classification society should also be acceptable only if it is equivalent to IMO equipment class 1 or higher.

Class societies often publish guidance on failure modes and redundancy concepts.

2.3.2 Explanatory Note relating to Non-IMO Equivalent Classes

The lowest of the four categories in Table 1 refers to systems with a centralised manual control using a single position reference system and no redundancy. Although, by definition, this notation refers to a dynamic positioning system there may, however, be no automatic control element. It may be manual control, albeit through an 'intelligent' joystick.

The category includes DYNPOS AUTS, where the vessel is fitted with an automatic position keeping system, but with no centralised back up manual control system. DYNPOS AUTS does require independent manual control levers for the DP thrusters to be placed in the DP control centre. Only DNV has given a notation to this configuration.

2.4 Regional Rules and Guidance

2.4.1 Overview

There are also DP rules and guidance applicable on a regional basis, full details of which are not included in this document. Vessel operators should also be aware of any charterer's guidance or requirements. Vessel operators should make sure that they refer to the latest edition of the relevant regional rules and/or guidance.

2.5 DP System and Verification

2.5.1 Introduction

Vessel operators should be able to demonstrate to charterers and authorities that their vessels comply with relevant IMO guidelines and classification society rules and they have taken account of other recognised DP guidance. This section gives vessel operators additional guidance on how to achieve that objective.

2.5.2 DP Classification Society Notation

Vessel operators should ensure that their DP offshore supply vessels possess and maintain an appropriate DP class notation issued by a classification society. In cases where the DP system is integrated with other control systems, such as vessel management, thruster controls and position reference systems, this might be reflected in the classification society notation.

2.5.3 DP FMEA

Vessel operators should ensure that FMEA's of the DP system, and where appropriate, associated components and systems, are carried out for each of their DP offshore supply vessels. The main purpose of the DP FMEA is to determine, by analysis, the effects of single failures of any component of the DP system and the consequential effects, on the ability of the vessel to maintain position and heading. For equipment class 2 and 3 vessels the DP FMEA should also specify the worst-case failure design intent and communicate the redundancy concept of the DP system.

Although classification societies do not require DP FMEA's for an equipment class 1 vessel, there may be occasions when charterers, however, do require a DP FMEA to assure the quality of the system design and operation, and to identify the effects of single failure on the operation of the vessel to determine any subsequent mitigation required.

There are industry standards for carrying out FMEAs which are based on paragraph 5.1 of IMO MSC.1/Circ.1580 and classification societies have their own specific rules. There are appropriate guidelines in IMCA M 166 – *Guidance on failure modes and effects analyses (FMEAs)*. Further information on this topic is also contained within Appendix 2.

Equally important is the 5-yearly review of the FMEA. Opportunities to benefit from new guidance and lessons learned, may be missed if the FMEA document is not periodically refreshed. A neglected DP system FMEA may have a knock-on effect to other DP based documents designed to promote safe DP operations and may create an unfavourable impression of the DP vessel, if it is only updated after deficiencies have been identified by a vessel DP Assurance process, or after major upgrades are carried out to the vessels DP system. The FMEA should be treated as a living document that can be leveraged to:

- Ensure the DP system remains robust, resilient, and single fault tolerant;
- Ensure the vessel remains in step with evolving industry guidance;
- Demonstrate the vessel owner's commitment to a process of continuous improvement through the adoption of current industry good practice.

Each FMEA should be verified by an approved set of DP Proving Trials to demonstrate that the analysed effect of identified single failures have the expected outcomes, and that the vessel crew learn from the experience. Original FMEA and Proving Trials reports should be approved by the classification society and evidenced accordingly.

2.5.4 Annual DP Trials

Vessel operators should ensure that annual DP trials are carried out on their DP offshore supply vessels. The purpose of these trials is to ensure that the DP system has been maintained properly, is in good working order and meets the requirements of industry guidelines and assigned DP class notation.

Vessel operators should take account of guidance in IMCA M 190 – *Guidance for developing and conducting annual DP trials programmes for DP vessels*. IMCA recommends that those involved in the preparation and conduct of DP annual trials programmes be accredited according to the IMCA DP Practitioner Accreditation Scheme.

Annual DP trials are not as extensive as DP FMEA proving trials. Annual DP trial programmes should clearly identify (via a trials matrix):

- Tests intended to be undertaken annually (conducted annually during a single period);
- Planned maintenance system checks that can be accepted in lieu of testing (and the required supporting evidence);
- Rolling tests (Tests on specified components or systems that have been identified as not being required annually but should be completed within a five-year period);
- Incremental tests (Tests performed to verify the integrity of the DP system, conducted over a defined period).

Where appropriate, annual trials should include associated integral control systems. Further information on annual trials is contained within Appendix 3.

2.5.5 DP Capability Plots

Vessel operators should recognise the value of DP capability plots. Specifications for capability plots are provided in IMCA M 140 – *Specification for DP capability plots.*

DP Capability Plots are usually developed at the vessel commissioning phase and should be re-calculated after any major DP upgrade.

The purpose of DP capability plots is to determine by calculation, based on assumed propulsive power, the position keeping ability of the vessel in fully intact, certain degraded conditions and in various environmental conditions. DP capability plots should be used in the risk assessment process to determine the safe working limits of the vessel at offshore installations.

Vessel operators should also recognise that recent developments have resulted in DP capability plots being made available online as an added facility in the DP control system. Vessel operators should, however, be aware that such online information is based on theoretical calculation of assumed propulsion/thruster power and may not necessarily represent the vessel's actual DP capability. DP capability plots should be treated with caution and their results assessed for validity against the observed performance of the vessel as measured by DP footprint plots. More information on DP capability plots is contained within Appendix 4.

Important note: DP capability plots do not show vessel excursions when in DP. They show the likely environmental limits within which a DP vessel will return to the target position when an excursion takes place caused by external environmental forces. This can be for intact and degraded conditions, including, for equipment class 2 and 3 vessels, after worst-case failure.

2.5.6 DP Footprint Plots

Masters and DP bridge watchkeepers should, where possible and practicable, conduct DP footprint plots frequently. DP footprint plots are used to measure the actual position-keeping performance of the vessel in the intact, and degraded, conditions and for various environmental conditions. It is prudent to complete footprint plots at the time of annual trials, and whenever opportunities arise thereafter.

DP footprint plots serve two main purposes:

- They show the vessel's excursions from the selected target position within the environmental conditions being experienced, thereby determining the tightness of the position-keeping envelope:
- They also help assess the validity of the vessels DP capability plot.

*Where there are differences between the **measured** footprint plot and the **theoretical** capability plot, vessel operators, Masters and DP Operators (DPOs) should always ensure that the results of the footprint plot take precedence over the capability plot.*

Where results are significantly different from capability plots, then vessel operators, Master and DPO's should consider investigating the reason and (if appropriate) arranging re-calculation of the capability plot. An example DP footprint plot is provided in Appendix 5.

3 Managing Risk in DP Operations – Competence

3.1 Key DP Personnel Competence – Training and Certification

3.1.1 Introduction

Vessel operators should ensure that key personnel involved in DP operations, including DP system maintenance and repair technicians, are competent, given necessary training and have appropriate certification. This covers Masters who are in command of their vessels, Navigating Officers and others who operate the DP control system, engineering Officers and, where applicable, electricians and electronics Officers who maintain and repair other parts of the DP system.

It is recognised that cargo, anchor-handling and towing vessels utilise traditional training and certification regimes but supplement this with additional DP specific training to enable safe DP assisted operations.

Manual and joystick manoeuvring of the vessel close to offshore installations must, however, be a pre-requisite skill, suitably supplemented by approved DP training.

Additionally, competence in change-over procedures between manual or joystick control and DP assisted modes, is of critical importance within the training regime.

It is highly recommended that ship operators develop comprehensive training programmes for ship-handling skills as an essential prerequisite for DP competence.

DP emergency drill scenarios are recommended to assist DP vessel management and DPOs / Engineers and ETOs to conduct DP drills onboard. The benefit of conducting DP emergency drill scenarios is to monitor and learn from the human reactions of key DP personnel. It is also important that the crew are familiar with various DP system setups including their failure modes. Refer to section 4.4 for further details.

Vessel operators should take account of appropriate training standards and guidance contained within:

- STCW 2010 part B v/f – Guidance on the training and experience of personnel operating DP systems;
- IMO MSC/Circ.738 (Rev.2, June 2017) – Guidelines for dynamic positioning systems (DP) operator training;
- IMCA M 117 (Rev.2, September 2016) – The training and experience of key DP personnel;
- IMCA C 002 (Rev.3, June 2020) – Guidance document and competence tables: Marine Division.

DPO certification is facilitated by the Nautical Institute, DNV and Offshore Service Vessel Dynamic Positioning Authority (OSVDPA). The Norwegian Maritime Authority (NMA) also has recognised DNV DPO certification, which is a recognised equivalent to the Nautical Institute (and other international) certification process.

Vessel operators should follow an appropriate DP logbook scheme, where all key DP personnel are issued with, and maintain, a personal DP logbook, within which, details of their DP experience are recorded. Examples are, the Nautical Institute DPO Training Standards and Certification scheme (see: www.nautinst.org) which is required for the application of a DP certificate and, following certification, the IMCA DP logbook, so that the DPOs can keep a continuous record of DP hours, that they have completed.

Other internationally recognised DPO certification and training schemes, may be developed in the future.

Other key DP personnel should also use the IMCA DP logbook to maintain a record of DP experience.

3.1.2 Masters, Navigating Officers and Other Operating Personnel

The following guidance is directed at vessel operators, on how to achieve appropriate competency levels for Masters, Navigating Officers, and other personnel, who operate the DP control system. It has been developed specifically for DP offshore supply vessels, and recognises that, unlike most other DP vessel operations, a supply vessel operating in DP mode can, in most circumstances, be switched to joystick or manual mode, and be manoeuvred away from the offshore installation in a controlled manner.

Masters should verify that DPOs are experienced in transferring the vessel into manual control and manoeuvring safely out of danger (see 'Escape Route' in section 6).

This guidance is based upon existing training and certification schemes, and to IMCA guidance.

3.1.3 Competency Categories – DP Bridge Watchkeepers on DP Offshore Supply Vessels

DP bridge watchkeepers are defined as Masters, Navigating Officers and, where relevant, other persons on watch in the navigating bridge (or other location), who have physical control of the DP control console whilst within the limitations of their competence category.

The senior DPO should provide supervision for the second bridge watchkeeper appropriate to their level of experience and knowledge of DP operations. Only qualified Navigating Officers, with appropriate training and experience, can achieve senior DPO status. This means therefore that all senior DP bridge watchkeepers will be Navigating Officers.

Vessel operators should develop a documented training programme and maintain appropriate records.

Competency recommendations follow in Table 2.

The expression 'vessel type' refers to vessels of similar power, similar propulsion layout and the same DP system.

Master or Navigating Officer Senior DPO as defined in IMCA M 117	♦ STCW Master, Chief Officer or other Officer, in possession of an Officer in Charge of a Navigational Watch Certificate of Competency, appropriate for that class of vessel. ♦ Nautical Institute or equivalent internationally recognised DP certificate. ♦ Full competence demonstrated for operating the offshore supply vessel, in manual control and independent joystick, whilst close to an offshore installation. ♦ Appropriate experience on the vessel type which should be, as a minimum, 14 days. ♦ Appropriate experience of the DP control system type and equipment classification which should be, as a minimum, 14 days. ♦ Knowledge of the vessel's DP FMEA, together with a detailed understanding of the implications of all identified failure modes. ♦ Detailed knowledge of the vessel's DP Operations Manual, including ASOG and CAM, and adequate knowledge of the content of relevant vendor manuals. ♦ Knowledge of relevant IMCA guidelines, including DP incident reporting. ♦ Consideration should also be given to providing bespoke manufacturers' courses for Masters and Officers in this category, particular for the DP control system and position reference systems.
Navigating Officer or 'other person[I] Junior DPO as defined in IMCA M117	♦ STCW Master, Chief Officer or other Officer, in possession of an Officer in Charge of a Navigational Watch with a Certificate of Competency, appropriate for that class of vessel, or other appropriate certification, as required by the DP offshore supply vessel operator. ♦ Has received onboard training of the vessel DP system, using an appropriate logbook to record training received. ♦ The vessel operator should ensure that the DP operator has undertaken a recognised basic induction DP course and has completed the required 30 day familiarisation as per the NI training programme or equivalent scheme, and IMCA guidance. This provides experience in the type of vessel operation and likely manning and should be verified by the vessel Master. ♦ Has proven competency in taking control of the vessel, in manual and independent joystick, and has safely moved the vessel away from the installation.

Table 2 – Competency recommendations for bridge watchkeepers on DP offshore supply vessels

[I] Other persons may include engineers, electricians, electronics Officers, etc.

3.1.4 Competency Categories – Engineers, Electricians and Electronics Officers

Vessel operators should ensure that their Engineering Officers, and, where relevant, Electrical Officers and Electro-Technical Officers are suitably qualified and experienced in DP systems.

Competency recommendations are given in Table 3.

Chief Engineer	♦ STCW Chief Engineer, Second Engineer or Officer in charge of an Engineering Watch with a Certificate of Competency appropriate for that class of vessel. ♦ Appropriate experience on the vessel type which should be, as a minimum, 14 days. ♦ Appropriate experience of the DP control system type and equipment classification which should be, as a minimum, 14 days. ♦ Detailed knowledge of the vessel's DP FMEA and adequate knowledge of the relevant vendor manuals including understanding of the operational limits of the main machinery to operate the vessel within its worst-case failure capability. ♦ Demonstrated a knowledge and understanding of failure modes and expected consequences. ♦ Knowledge of the maintenance requirements for DP systems. ♦ Adequate knowledge of the vessel's DP operating manual, including ASOG and CAM. ♦ Knowledge of relevant IMCA guidelines including DP incident reporting. ♦ Consideration should also be given to providing bespoke manufacturers' courses for Chief Engineers, particularly for the DP control system and maintenance requirements, and, where applicable, power generation, power management and propulsion systems.
Watchkeeping Engineering Officers	♦ STCW Chief Engineer, Second Engineer or Officer in charge of an Engineering Watch with a Certificate of Competency appropriate for that class of vessel. ♦ Adequate knowledge of the vessel's DP FMEA and relevant vendor manuals. ♦ Adequate experience of the vessel type and the nature of DP operations. ♦ Knowledge and understanding of failure modes.
Electrical Officers and Electro-Technical Officers	♦ Although these Officers are not always carried on offshore supply vessels, if so employed, they should have attended relevant courses for their respective roles. ♦ Detailed knowledge of the vessel's DP FMEA and relevant vendor manuals. ♦ Knowledge and understanding of failure modes.

	♦ Consideration should also be given to providing bespoke manufacturers' courses for Chief Engineers, particularly for the DP control system and maintenance requirements, and, where applicable, power generation, power management and propulsion systems.

Table 3 – Competency recommendations for Engineering Officers, Electrical Officers and Electro-Technical Officers on DP offshore supply vessels

Vessel operators should always have, at least one, Engineering Officer, Electrical Officer or Electro-Technical Officer on board, who has received adequate training, to ensure competence and knowledge of the control systems of the vessel (DP, PMS, ICS, AVM, etc.). This is to be able to provide a first level of response to a problem on board, and a person who is qualified to execute recommendations from the vendors of such equipment, when further help is needed.

3.2 DP Offshore Supply Vessel Manning

The level of manning of competent DP personnel on offshore supply vessels is wholly dependent upon the following:

- The way the vessel is being operated;
- The vessel capabilities and hardware configuration;
- The tasks and roles the vessel and crews are being requested to do.

This is summarised in section 4.1.

3.3 Key DP Personnel Continuous Professional Development

IMCA M 117 also requires continuous professional development. It states, "CPD programmes should be an integral part of the vessel owner/operator SMS and should establish the assessment and training periods for key DP personnel and whether this is conducted onboard or ashore"

IMCA and the Nautical Institute have developed a Key DP Personnel CPD application to assist with this requirement. The scheme is designed to help all key DP personnel maintain their technical knowledge of the latest industry guidance and operational best practice. The application expands professional awareness of the latest IMCA/industry guidance; DP safety bulletins; DP exercises and training drills; and assists in improving safety and operational efficiency offshore as well as technical knowledge. Details can be found at: https://www.imca-int.com/certification/key-dp-personnel-cpd/

4 Managing Risk in DP Operations – Offshore Operations

This section presents three operational levels for DP offshore supply vessels when on location in the vicinity of the installation. These three levels should serve as a guide to the requirements for DP equipment class of the vessel, the number of position reference sensors to use, factors for activity-based operational planning, and appropriate manning requirements.

DP operational levels should be carefully considered and will be influenced by factors such as vessel location relative to the installation, separation distance and time to terminate the operation. For DP operational levels A and B, the separation distance between the DP offshore supply vessel and the offshore installation during cargo operations is a key component and this should be agreed between the DP offshore supply vessel and the offshore installation before the start of operations. Some companies, vessel operators and charterers may set a minimum separation distance to maintain between the DP offshore supply vessel and the offshore installation. In setting the separation distance, consideration should be given to such influences as crane jib radii, hose length, size of load and cargo storage location. Where installation data cards are provided, operators are encouraged to use these to indicate the required separation distance. Any deviation from agreed distances should be subject to detailed risk assessment, agreement between all parties, and be properly documented.

4.1 DP Operational Levels

4.1.1 DP Operational Level 'A'

Basic operations - Operations outside of any 500metre safety zone.

DP Equipment Class 1, 2 or 3:

- DP Equipment Class 1 vessels: At least two independent position reference systems operating and online.
- DP Equipment Class 2 & 3 vessels: Three independent position reference systems operating and online, based on at least two different principles, and suitable for the operating conditions. If DP equipment class 3, then one of the position reference systems requires to be located separately according to DP 3 classification rules.

DP Operating Mode:

- In accordance with the Activity Specific Operating Guideline (ASOG).
- May be operated in Critical Activity Mode (CAM) or Task Appropriate Mode (TAM) subject to suitable risk assessment. Reference section 4.2 for further details.
- Vessel shall operate within identified 'worst-case failure' limits for current, locally experienced, environmental force conditions.

Manning:

- DP control station must be manned by at least one Senior DPO as defined in IMCA M 117 and one other bridge watch-keeping Officer.
- At least one STCW certificated engineering Officer on watch in the engine room.

For DP operational levels 'B' and 'C', careful consideration should be given to the choice of independent position reference systems. Where surface installations are present, the use of 'relative' reference systems is preferred due to the possible blocking of DGNS signals by the installation structure itself. Additionally, for floating installations, particularly those which can change heading, 'absolute' reference systems should be available however not online subject to risk assessment.

4.1.2 DP Operational Level 'B'

Standard operations - Operations within any safety zone ("blow / drift off" positioning).

DP Equipment Class 2 or 3:

- DP Equipment Class 2 & 3 vessels: Three independent position reference systems operating and online, based on at least two different principles, and suitable for the operating conditions. At least two relative position reference systems should be provided when working alongside floating structures/vessels. (Note: there are specific risks associated with mixing relative and absolute position references that require careful consideration for each mission). If the vessel is DP equipment class 3, then one of the position reference systems shall be located separately according to DP 3 classification rules.

DP Operating Mode:

- In accordance with the Activity Specific Operating Guideline (ASOG).
- The vessel shall operate in Critical Activity Mode (CAM). Reference section 4.2 for further details.
- Field arrival trials shall be carried out - These are to ensure satisfactory operation of the entire DP system. The checks should include full functional checks of the operation of, the thrusters, power generation, auto DP, the Independent Joystick and manual controls. These checks also ensure that the DP system is configured correctly according to the DP operations manual and associated engine room and bridge checklists.
- Vessel shall operate within identified 'worst-case failure' limits for current, locally experienced, environmental force conditions.
- This mode assumes a short time to terminate operations.

Manning:

- DP control location manned by at least one Senior DPO as defined in IMCA M117, and one Junior DPO (as a minimum) as defined in IMCA M117.
- At least one STCW certificated engineering Officer on watch in the engine-room.

4.1.3 DP Operational Level 'C '

Advanced operations - Operations within any safety zone ("blow / drift on" positioning) or extensive bulk cargo hose operations.

DP Equipment Class 2 or 3:

- DP Equipment Class 2 & 3 vessels: Three independent position reference systems operating and online, based on at least two different principles, and suitable for the operating conditions. At least two relative position reference systems should be provided when working alongside floating structures/vessels. (Note: there are specific risks associated with mixing relative and absolute position references that require careful consideration for each mission). If the vessel is DP equipment class 3, then one of the position reference systems shall be located separately according to DP 3 classification rules.

DP Operating Mode:

- In accordance with the Activity Specific Operating Guideline (ASOG).
- The vessel shall operate in Critical Activity Mode (CAM). Reference section 4.2 for further details.
- Field arrival trials shall be carried out - These are to ensure satisfactory operation of the entire DP system. The checks should include full functional checks of the operation of, the thrusters, power generation, auto DP, the Independent Joystick, and manual controls. These checks also ensure that the DP system is configured correctly according to the DP operations manual and associated engine room and bridge checklists.
- Vessel shall operate within identified 'worst-case failure' limits for current, locally experienced, environmental force conditions.
- This mode assumes a long time to terminate operations.

Manning:

- DP control station manned by at least one Senior DPO and one certificated DPO as defined in IMCA M 117.
- At least one STCW certificated engineering Officer on watch in the engine-room.

4.2 Guidance on Activity-Based Operational Planning

All operations undertaken by DP vessels in the offshore oil and gas sector should be subject to activity-based operational planning and risk assessment, in line with company ISM requirements. This is as relevant to DP offshore supply vessels as it is to other DP vessels, whether engaged in drilling, dive support, accommodation support, or pipelay, etc. It should also be recognised that, in many instances, the risks and consequential losses incurred by DP offshore supply vessels, in the event of a loss of position, are often greater than those experienced by other DP vessel types, mainly due to prolonged presence close to offshore installations.

Activity-based operational planning, where properly implemented, provides an effective barrier against loss of position, and the resultant potential for consequential loss.

Activity-based operational planning:

- Defines the vessel's systems and equipment configuration appropriate to the location, and the activity the vessel is undertaking (CAM or TAM);
- Defines the variable limits in equipment and operational parameters, for the location and specific activity (ASOG), including triggers and criteria that would cause a change in the traffic light system, used in the ASOG;
- Defines the actions to be taken by key vessel personnel, in response to faults, deteriorating conditions and a change in status in the ASOG; and,
- Provides guidance to key vessel personnel in a user friendly, easy to understand, decision support tool.

4.2.1 Critical Activity Mode (CAM)[2]

All DP vessels, including DP class 2 and 3, can have their redundancy concept compromised, if their systems and equipment are not properly configured, and operated in the correct manner. The purpose of a Critical Activity Mode is, to clearly detail, in an unambiguous manner, how to configure a vessel's DP system, including power generation, power distribution, propulsion units, and position reference systems. By properly configuring the DP system it shall as a whole, meet its maximum level of redundancy, functionality and operation and be as fault tolerant and fault resistant, as it can be. For DP class 2 and 3 vessels, the CAM usually defines the most robust, fault tolerant, configuration of the DP system, ensuring that a single point failure[3] does not result in a condition exceeding the vessel's identified worst-case failure.

The CAM document gives tabular guidance to Key DP Personnel, on actions to take when the CAM configuration is no longer met.

Every DP vessel has a unique CAM configuration. A CAM configuration is derived from a detailed review of the vessel's DP FMEA[4], and its operational characteristics. The CAM configuration should be the default operational mode for a DP vessel, when conducting activities deemed to be critical.

Typical items contained in the CAM, include the following:

- Power plant set up, including whether operating with open or closed bus ties, and, for example, specifically, the minimum number of generators that shall be connected to each bus;
- Detail of diesel /shaft generators, including confirmation of the maximum designed output power in DP mode;
- Detail of thrusters and propulsion equipment, including confirmation of the maximum designed output power in DP mode;
- Detail of power management, including configuration, and confirmation of the set-up for auto stop, and black out recovery;
- Detail of the uninterruptible power supplies (UPS), including confirmation of power supply, and functional testing;
- Details of the control power supplies, including alignment with the redundancy concept, and isolation of any cross-connected power supplies, if applicable, and whether they have been validated;
- Use of manual controls and independent joystick, including confirmation of readiness and prior testing;
- Configuration of the DP control system, including use of consequence analysis, mode availability and selection;
- Details of position reference systems, including availability, testing and selection, absolute and relative systems, placement of targets including maximum acceptable operating distance, and maximum water depth for hydroacoustic systems;

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[2] The term 'safest mode of operation' (SMO) has been previously used to describe CAM.

[3] For DP class 3 vessels a single point failure includes the loss of a single compartment through fire or flood. The term 'single compartment' is used in its widest sense and includes large compartments for thrusters/switchboards/engine rooms, etc. It may also include small enclosures containing data and control lines, etc.

[4] It is assumed that the vessel's DP FMEA contains sufficient detail of the vessel's DP system to determine the CAM. Where this is not the case it will be necessary to review as-built drawings of the DP system and associated systems and it may also require a survey of the vessel.

- Detail of sensors, including availability, testing and selection;
- Status of the back-up DP control system (DP Class 3), including alignment of set points with the main DP control system, and confirmation of readiness and testing;
- Configuration of fuel systems, including confirmation of redundancy, tank levels, stand-by pump starts, isolations, and closed cross-over valves between redundant equipment groups;
- Detail of sea-water cooling, including confirmation of redundancy, stand-by pump readiness, isolations, and closed cross-over valves between redundant equipment groups;
- Detail of fresh-water cooling, confirmation of redundancy, stand-by pump readiness, isolations, and closed cross-over valves between redundant equipment groups;
- Detail of compressed air/control air systems, confirmation of redundancy, safest compressor operating mode;
- Details of HVAC, machinery space ventilation and exhaust, and critical equipment air-conditioning;
- Confirmation that automatic sensors, including external force, draft measurement, and latitude correction for gyros, are set to manual;
- Detail of DP and engine-room manning, including watchkeeping schedules, qualifications and competency of the watchkeepers;
- Status of the emergency shutdown (ESD) system (if applicable);
- The configuration and use of hybrid power systems such as battery banks, or fuel cells (if applicable).

A copy of the CAM document should be contained within the DP Operations Manual.

4.2.2 Task Appropriate Mode (TAM)[5]

Task Appropriate Mode is a risk-based DP configuration, which will be derived from a comprehensive risk assessment process. Task appropriate mode details how, to configure and operate the vessel's DP system, accepting that a failure, could result in a condition exceeding the vessel's identified worst-case failure, possibly leading to black-out, or loss of position.

A TAM configuration 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 will not result in damage to people, the environment, or property. The conditions under which a DP offshore supply vessel may operate in TAM, should be clearly defined, and could, for example, relate to operations sufficiently clear of the 500metre safety zone of floating or critical subsea assets, only where the consequences of a loss of position have been evaluated and deemed acceptable.

A copy of the TAM may be contained in the DP Operations Manual.

[5] Task appropriate mode (TAM) in this context is not to be confused with thruster assisted mooring (TAM).

Risk assessments used to validate a TAM should take account of the following:

- Fault tolerance/resistance, and fault ride-through capability, of station keeping critical elements;
- Benefits of power plant stability (usually the reason why a TAM is initially considered), compared to the potential for a complete loss of the power plant, and associated consequences.

For diesel-electric vessels, a Task Appropriate Mode could mean operating with closed bus ties, whereas a Critical Activity Mode may require open bus tie configuration.

4.2.3 Critical or Task Appropriate Mode - Tabular Format:

The CAM, or TAM, typically use only two columns in a traffic lights style with green (normal) and blue (advisory). It is possible that the green (normal) conditions for TAM may differ from the CAM.

Status	Green	Blue
Definition	Normal operations – all systems and equipment fully operational, DP verification processes completed, and DP set up confirmed.	Advisory status – where any GREEN conditions are not met.
Response	For DP operations to commence and continue the conditions in the GREEN column must be met.	Conduct risk assessment to determine whether to continue, change position or cease operations.

Table 4 – Critical activity mode – outline

An example of a CAM can be found in Appendix 9.

4.2.4 Activity Specific Operating Guidelines (ASOG)

Activity Specific Operating Guidelines differ from CAM and TAM, in that they relate, specifically, to a known location and activity and how, for example, system failures may be addressed.

The ASOG should define operational, environmental and equipment performance limits, for the DP vessel, with respect to the specific activity that the DP vessel is undertaking. Therefore, an ASOG should be updated for each different type of activity and location where the vessel is to work, and when conditions differ. It is often the case that an ASOG is prepared for a project with multiple scopes of work, and the most stringent criteria can therefore be applied throughout.

To develop an appropriate ASOG, the following need to be fully considered:

- The technical suitability of the vessel for the specific activity;
- The identification of the vessel's CAM / TAM (if applicable);
- An understanding of the vessel's station keeping capabilities, following a worst-case failure;
- Environmental conditions in relation to the intended work location;
- The consequences of a loss of position and/or heading.

The vessel's operational personnel and, where applicable, shore-based support personnel, such as the Company operations or technical departments, should be trained in risk identification and risk assessment processes, and should play a key role in the development of the ASOG. Client-specific requirements may be included.

The completed document should be signed by the vessel's Master, Chief Engineer, senior Watchkeeping Officers and DPO's, and, where applicable, reviewed by the Company operations and technical departments. The sign-off requirements will depend on each company's management structure.

The ASOG contains information pertinent to the vessel's station-keeping ability, taken from operational procedures that were developed to execute the industrial mission. Any changes to procedures, should be assessed to determine whether they may also affect the ASOG and so avoid conflicting requirements. The ASOG may be modified whilst on location, subject to the full agreement of the Master, and in strict accordance with the Company's Management of Change procedure.

A typical ASOG for a DP vessel will cover the following items:

- Settings for speed of vessel rotation, and speed of vessel moves, for example, 10 seconds azimuth per minute and 0.3 metres per second respectively;
- Whether thruster biasing is permitted and, if so, the maximum release levels shall be defined;
- Maximum allowable environmental operating conditions, including wind speed limits, current and tide limits, and maximum allowable wave heights;
- Limitations on weather-specific vessel station-keeping performance, including position, and heading excursions, within a defined period;
- Maximum excursions permissible from the set point position;
- Drive-off and drift-off scenarios;
- Availability of diesel generators (or other energy sources), including the minimum number required for the activity, their performance limits, and the effect of potential failures;
- Loading of diesel generators (or other energy source);
- Availability of thrusters, including the minimum number required for the activity, their performance limits, and the effect of potential failures;
- Maximum permissible thruster loading;
- The status of operation of the Power Management System (PMS) and Vessel Management System (VMS);
- Auxiliary system performance limits and failures, including fuel, sea-water cooling, fresh-water cooling and compressed air;
- UPS operation, charger outputs, supply status, and the effect of failures;
- DP control system, including the operation and performance of DP controllers and the effect of failures;
- DP control system displays, including mimics, performance, and the effect of failures;
- DP networks, including operation, redundancy, and the effect of failures;
- Position reference systems, including the number of enabled systems, their performance, and their criticality to the operation, and the effect of failures;

- Sensors, including the number of enabled systems, their performance and their criticality to the operation, and the effect of failures;
- Communications, including onboard systems, their performance, and the effect of failures;
- Any non-essential DP related systems, including ventilation and air-conditioning, their performance, and the effect of failures;
- Unplanned events, such as, fire, flood, restricted visibility, collision, and their potential threat to safe DP operation;
- Simultaneous operations, including communications with installations (see IMCA M 203 – Guidance on simultaneous operations (SIMOPS);
- The maximum watch circle radius, if applicable, in relation to the maximum environmental conditions identified for that activity;
- The inclusion of hybrid power systems (if applicable) and batteries to power generation.

A copy of the ASOG should be contained in the DP Operations Manual.

4.2.5 Tabular Format

Guidance in the ASOG is presented in four categories, as follows:

4.2.5.1 Green DP Status

Green status indicates 'normal' operations. Planned operations can be undertaken within agreed safe limits.

- The DP system is operating correctly and is configured in accordance with approved CAM or TAM;
- Operational, environmental, and equipment performance criteria, are all categorised as being normal.

4.2.5.2 Blue Advisory DP Status

If an indicator light is used, then it is recommended that this is a blue light. Operations can continue, whilst risks are being assessed:

- Operational, environmental, or equipment performance limits, are being approached;
- An event, or failure has occurred, that does not compromise single-fault tolerance, of the DP system.

After dynamic risk assessment, operations may either "continue with mitigating measures", or the "advisory status will be raised to yellow". The outcome of the risk assessment process could also mean returning to green status. There are no conditions where the advisory status should be considered, or treated as, a normal situation. If the DP system is fitted with consequence analysis, a position-keeping consequence warning, may trigger an 'advisory' or 'yellow' DP status.

4.2.5.3 Yellow DP Status

Yellow indicates a condition that may require a suspension of operations.

- A failure in the DP system has occurred leaving the DP system in an operational state, but with its DP redundancy compromised. An additional failure in that system may result in an inability to maintain the vessel's position and/or heading;
- Operational, environmental, or equipment performance limits, have been reached;
- Any other condition that may lead to a suspension of the operation.

The vessel is still maintaining position, although some DP critical equipment will have lost its redundancy. When in a 'yellow' DP status, preparations should be made, to suspend any operations the vessel is undertaking, in a controlled manner. If the DP system is fitted with consequence analysis, a consequence alarm may trigger a 'yellow' status.

4.2.5.4 Red DP Status

RED indicates a ***severely degraded status, or emergency***. A condition has developed which requires an immediate termination of operations:

- A system failure, or other condition, has occurred that results in an inability to maintain position, or heading control;
- Operational, environmental, or equipment performance limits, have been exceeded;
- Any other emergency situation has occurred, that warrants the most rapid termination possible to take place, for the activity being undertaken.

A Red status should immediately initiate a termination of all DP reliant operations as the vessel may be losing or is likely to lose position.

When a Red DP status is initiated, it is essential to inform all relevant personnel, involved in the operation, immediately.

ASOG Table Outline:

An ASOG table uses four status columns: green (normal), blue (advisory), yellow (degraded) and red (emergency).

An example of an ASOG can be found in Appendix 10.

4.3 Guidance on the Application of CAM, TAM and ASOG

The above three processes should be undertaken by all those involved with the vessel's position keeping operations. It is essential for the Master, Chief Engineer and DPOs of the vessel to be knowledgeable of the technical and operational considerations that go into the development of the ASOG. They must participate in the development of the ASOG as far as practicable. It is imperative that the vessel crew take ownership of the ASOG.

The CAM / TAM and ASOG are to be based on:

- A thorough knowledge of the DP system;
- The DP operational manual;

- The DP FMEA;
- The industrial mission;
- The vessel location and all consequences of a loss of position, and/or heading;
- Risk assessment.

A DP vessel can have one, or more, CAM and TAM, although some vessel owner/operators may decide not to operate in TAM. The CAM/TAM should specify, a minimum number of thrusters, and generators, to be in use, at any time, throughout the activity. The owner/operator is responsible for the CAM and TAM, including determining the situations requiring CAM, and where a TAM may be used. However, the client may expect to be involved, in the decision-making process.

In general, CAM should be the default, and any decision to operate in TAM, should be substantiated by robust, and documented, risk assessments, with the risk-owner, accepting and signing-off on the consequences.

When developing a specific ASOG for a project, it is necessary to refer to information for the location, the activity, the expected environmental conditions, and, if available, from project plans, procedures and drawings.

All three documents, if applicable, should be kept up to date, and combined into one readily available document. There should be a signature section at the end of the combined document.

Where a DP offshore supply vessel is operating at a client's offshore installation, it is recommended that the combined activity-based operational-planning document, be signed by a representative of the client in addition to the Master, Chief Engineer and DPO's. The client's representative could be a shore-based superintendent or, possibly, the OIM of the offshore installation.

The final combined activity-based operational-planning document should be displayed at the DP control console, and in the engine control room. It should be clearly visible to the DPO's and engine room watchkeepers, and used by them, in setting-up and operating the vessel for DP operations, but also providing them with a range of responses to degraded conditions, for each mode.

4.3.1 Considerations when Developing CAM, TAM and ASOG

When developing the CAM, TAM and ASOG consideration should be given to the following:

- Capabilities of the vessel, for both the intact condition and degraded condition, following a worst-case failure (WCF) as defined by the FMEA study, and appreciation of the limitations imposed upon operations, in the degraded condition, after such a failure;
- An understanding of the limitations imposed by weather conditions, water depth, and tidal influences, on the vessel's position-keeping capability;
- Consequences of a loss of position and/or heading, both within, and beyond, the limits that have been predetermined in the ASOG;
- Simultaneous operations (SIMOPS) and the effects of vessel interaction when the DP offshore supply vessel is operating in close proximity to other vessels, including the consequences of any change in status of own vessel, or other vessels, e.g., Green to Blue, Yellow, or Red;

- The activity being performed, and the necessary time delay to safely terminate that activity, before being able to manoeuvre the vessel to a safe position, following a failure;
- The primary component of the ASOG, being a proven knowledge of black-out recovery capability, and the time taken to recover.

4.3.2 The Initiation of 'Positioning Standby'

'Positioning standby' is a heightened state of alertness, initiated during the vessel's DP operation, which may be triggered by several different conditions. The purpose is to bring all station keeping critical elements (equipment, people, and processes) to a higher state of readiness, for a defined period, with the objective of preventing a loss of vessel position.

'Positioning standby' ensures that:

- All necessary equipment is available and/or running;
- All personnel are in position to quickly respond to an event and so prevent an escalation.

'The initiation of positioning standby' may require:

- A change in configuration from TAM to CAM;
- Immediate or planned cessation of non-critical activities.

Examples of 'positioning standby' are:

- Heavy lift operations;
- Increase in time to terminate;
- Deteriorating weather;
- Station keeping equipment issues;
- Other non-specified difficulties.

4.4 DP Drills and Emergency Response Drills

Scenarios for DP drills should be relevant to operational activity, and be built around the DP FMEA and ASOG, ensuring that all personnel, know what actions to take, and what to expect when operating parameters are approaching defined limits, or exceeding these limits. During normal DP operations, planning for emergency scenarios, proactive thinking, and situation handling, are of prime importance. For instance, during the build-up to severe weather, the initiation of "safely terminate the operation" may be compromised, due to perceived, or experienced, pressure to continue the operations for as long as possible.

The vessel DP operating manual, FMEA (FMECA), FMEA Proving Trials, Annual DP Trials and Capability Plot reports, should always be readily available to operational personnel for information and reference. Drill scenarios can also be developed from DP station keeping events, reported as part of the IMCA DP event reporting scheme.

4.5 DP Operating Manual

A vessel specific DP operations manual should be prepared for each DP offshore supply vessel.

IMO MSC.1/Circ.1580 requires 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 operating manual, each with different requirements for content.

This 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.

This vessel-specific manual should also contain generic content, such as company policies, procedures and standing orders, but specifically, should represent the way the vessel is operated in DP.

The vessel-specific DP operating manual should contain, as a minimum:

- Organisation, roles and responsibilities of key DP personnel and shore-side management;
- Competency, training, watchkeeping and manning regimes;
- Vessel specifications and data;
- DP philosophy (including operating modes);
- DP system description;
- DP standing orders;
- DP operating instructions;
- DP checklists – field arrival, location, watchkeeping and handover (bridge and engine room);
- Annual tests and procedures with summary reports;
- Initial and periodic tests and procedures with summary reports;
- Example of tests and procedures after modifications and non-conformities;
- Detailed description of power management, thrust, control and reference systems;
- Emergency procedures (including blackout recovery);
- Decision support tools such as ASOG (including DP system configuration (CAM);
- Incident reporting;
- Capability plots and DP footprints;
- Details of all repairs, modifications and servicing, attributable to the DP system.

4.6 List of DP Operating Procedures

Arrival checks	Arrival checks should be carried out before the vessel comes within 500 metres of an installation. The purpose of the arrival checks is to ensure satisfactory operation of the DP system and should include full functional checks of the operation of the thrusters, power generation, auto DP, and joystick/manual controls. The checks should also ensure that the DP system is set up correctly for the appropriate DP capability class, e.g., the bridge manning should be in accordance with DP capability class requirements. These checks should be documented and kept on board the vessel and are done once for each location/ operation (an example is in Appendix 6).
Communications	There should be an effective means of communication between the DP offshore supply vessel and the offshore installation. In most cases this will be by VHF and will link the DP control console with appropriate personnel on the installation. These are likely to be the crane driver, deck foreman and radio room. Communications should be tested before arrival. There should also be effective communications between the DP console and the vessel crew on deck.
Approaching the installation	The vessel should be manoeuvred at a safe speed when within 500 metres of the installation. The vessel should not approach the installation unless authorised to do so. When making a final approach to the installation, the vessel should not head directly towards it, but steer an offset course. Where a final approach is made to the installation having conducted DP set up checks, this approach should be conducted on DP or in manual control using the DP joystick. In line with the joint Step Change in Safety/Marine Safety Forum "Marine Operations: 500m Safety Zone" guidance, the vessel is required to enter the 500m zone at no more than 3 knots to the set-up position approximately 200 metres from the installation, and once the DP Model has fully built, the final approach shall be no faster than 0.5 knots.
DP location set-up checks	Location set-up checks should be carried out on every occasion, and before the vessel moves into the final working location. The principal objectives of these checks are to assess the vessel's station keeping performance at the working location, and to ensure that the position reference systems are properly set up. These checks should be carried out at a safe distance from the installation, in the region of 200 metres. They should also be carried out, wherever possible, at a location where, in the event of a loss of thrust, the vessel would drift clear of the installation. These checks should be documented and kept on board the vessel. Time should be allowed for the DP model to build-up (the recommended period is 30 minutes).
Change of working location within the 500m zone	If the vessel is required to relocate to a different working face or adjacent installation, this will require a formal re-evaluation of working conditions, position references, communication and revisiting of checklists and escape routes. When changing location, the vessel should move to a set up position of approximately 200m clear of the installation(s) to assess the new conditions prior to returning to work.

Close-proximity time	Close-proximity time at the working location should be kept to a minimum. The vessel should only remain in the working location when supply operations are being carried out. During periods of inactivity, e.g., when the installation crane is not available for cargo transfers, the vessel should move a safe distance away from the installation. Wherever possible, when undertaking hose transfers, sufficient hose length should be given, to allow the vessel to increase the separation distance.
Separation distance	The separation distance at set-up between the vessel and the installation should be carefully selected. The distance should be agreed between the vessel and offshore installation before the start of operations. The separation distance should take account of the combined movements of the vessel and the installation, where the installation is not fixed in position (such as an FPSO, spar buoy or TLP). The separation distance should be as large as is attainable in the circumstances, without adversely affecting the safety of the supply operation. Wherever possible, such as when hose transfers alone are being carried out, consideration should be given to maximising the distance by extending hose length. Client minimum distances, should be adhered to.
Selecting a safe working location	A safe working location should be selected for every supply operation. It is safer to work on the lee-side of the installation rather than the weather-side. Even where the ASOG shows that vessels may operate on the weather side, it is always preferable to set up on the lee-side. Other elements to be considered in selecting a safe working location include the position, and reach, of the installation cranes, obstructions on the installation, and interaction with installation thrusters.
Safe working heading	The most appropriate vessel heading should be selected, on the basis that it may be necessary to make a rapid escape from the installation, by driving ahead or astern. It can be an advantage to provide a good steadying vector, by placing the vessel such that environmental forces are opposed by a steady state thrust output.
Escape route	An escape route should be identified. The escape route should provide a clear path for the vessel to follow, when making a routine, or emergency, departure from the installation. Other vessels should stay clear of the escape route. Other considerations may include the environmental conditions/aspect and the resultant power management requirements when escaping against the weather. The escape route should, if possible, extend 500 metres from the installation. Where circumstances demand (due to critical failures), consideration should be given to a safe anchorage clear of the installation, always considering the surrounding subsurface infrastructure. Client permission may be required for any anchoring activities.
Environmental forces monitoring	Environmental forces are never constant. Wind, current, and swell should be monitored continuously, as should their effects on position keeping. Electronic monitoring methods, such as wind sensors, and resultant force vectors, provide the DP control system with inputs, but these methods should be supported by visual monitoring, and forecasting. Great care should be taken where there is likely to be sudden wind and/or current changes, such as approaching weather fronts. Preventative measures may require the vessel to cease operations during these periods and move off to a safe location. Great care should also be taken, in areas where lightning strikes are likely. Preventative measures may also require the vessel to cease operations during these periods and move off to a safe location.

Maintaining a safe working location	A safe working location should always be maintained near the installation. In particular this will require constant vigilance, in respect of a possible cumulation of several hazards. These could include, for example, those from environmental forces and other potential dangers, such as marine and airborne traffic, or cargo operations. It will also require the vessel to operate within its design parameters, and within the range of the vessel's DP capability plots. Consideration should be given to unrestricted view of the work area from the DPO position. CCTV, or an observer, could be of assistance. The vessel's worst-case failure design intent (DP) should always be taken into consideration
DP watchkeeping handovers	Wherever possible, watch-handovers should take place when the vessel is in a steady state, and where the vessel is settled in position. Using a checklist handover ensures that all relevant information is passed on to the oncoming watchkeeper (see Appendix 7 for an example of a checklist).
Onboard engineering, electrical and electronics support	An engineer should be available on watch in the engine control room when the vessel is within 500 metres of the installation. Regardless of whether a vessel is equipped with, or without, UMS/EO, the engineer should be in the engine control room. Good practice requires a manned engine room for all DP operations. Wherever possible, electricians and, where carried, Electronics Officers should be on call, when the vessel is inside the 500-metre zone. Engineers, Electricians, and Electronics Officers should take account of the following when the vessel is inside the 500-metre zone: ♦ Do not start, stop, or carry out maintenance on any machinery, or equipment, that could affect the DP system whilst the vessel is in DP mode. When in doubt, a check should be made with the DP bridge watchkeeper. ♦ If problems, or potential problems, are detected with any DP, or associated equipment, during a DP operation, then the DP bridge watchkeeper shall be informed immediately.
Critical and allowable vessel excursions	Critical, and allowable, excursion limits should be set. The critical limit should not exceed half of the separation distance between the vessel and the installation. The allowable limit should not exceed half of the critical limit.
Electronic off-position warning and alarm limits	The electronic warning limit should not exceed the allowable excursion limit detailed above. The electronic alarm limit should not exceed the critical excursion limit detailed above. For example, where the separation distance is 10 metres, the warning limit should not exceed 2.5 metres, and the alarm limit should not exceed 5 metres. However, wherever possible, the warning and alarm limits, should be less than the critical and allowable excursion limits. From the risk assessment, enter parameters for acceptable excursion, and ensure all operators are familiar with set limits and necessary actions thereof, and that these are clearly displayed adjacent to the DP console.

Electronic off-heading warning and alarm limits	The electronic off-heading warning limit should be set at a value, that does not result in movement of any part of the vessel, greater than the allowable excursion limit. The electronic off-heading alarm limit should be set at a value that does not result in movement of any part of the vessel, greater than the critical excursion limit. However, wherever possible, the off-heading warning and alarm limits, should be set at lower values. In setting the off-heading limits, consideration should be given to the alignment of the vessel and the installation, and the vessel's point of rotation. From the risk assessment, enter parameters for acceptable excursion, and ensure all operators are familiar with set limits, and necessary actions thereof, and that these are clearly displayed adjacent to the DP console.
Position and heading changes	Changes to vessel position and heading are frequently necessary during supply operations, when supply vessels are alongside fixed installations, typically because of wind and/or current changes, or for operational reasons. Such changes should be carried out in small increments. Operators should be aware of the potential dangers of several cumulative changes, e.g., that they may affect the line of sight, for some position reference systems, such as optical systems. Ensure that the centre of rotation is correctly set for the type of operation.
Power consumption and thruster output limits	Consideration should be given to the use of the Guidelines for Offshore Marine Operations (GOMO) as good practice, for operational limitations. The power and thruster limits will depend on the nature of the vessel/ installation interface. Refer to the CAM, TAM and ASOG as appropriate. For vessels that are operating to DP class 2 or 3 standards, the limits should be set so that the vessel will be left with sufficient power and thrusters to maintain position after worst-case failure – based on running machinery. For DP offshore supply vessel capability 1 operating outside of a safety zone, the vessel operates to the intact capability in given environmental conditions. Methods of monitoring power consumption and thruster output limits include, the use of the DP computer system's consequence analyser, and effective DPO watchkeeping. After a failure, the main objective is to make the situation safe. The process of returning to work involves carrying out a risk assessment, considering all possible scenarios. This risk assessment will determine whether it is safe to return to DP operations. Regional and or charterer's requirements may take precedence.
Consequence analyser	Where consequence analysers are fitted, they should be used.
Safe operating limits	Safe operating limits are primarily based on power consumption and thruster output levels. However, in the setting of safe operating limits, consideration should also be given to other relevant factors such as a mariner's awareness of the weather environment, the nature of the operation, the safety of the crew, and the time needed to move clear. Safe operating limits should be governed by risk assessment.

Position reference systems	Wherever possible, when multiple position references are in use, they should be independent of each other, and should be based on different principles. Relative position references should be used at installations that are not fixed in position, such as FPSOs, spar buoys and TLPs. Relative systems include, for example, optical or microwave systems. The use of both relative and absolute position reference systems together can cause conflicts particularly with moving targets. A possible example of 'three position references' could be a laser system, a microwave system and DGPS system, all being online.
Interfacing with third party equipment	Caution should be exercised, when the DP system shares information with third-party equipment, such as DGPS, and gyro heading, such that performance reliability of the DP systems, are not adversely affected. The need for additional trials should be considered to ensure no adverse conditions have been introduced, by way of a management of change.
Change of operating control mode	There may be occasions during a normal supply operation, when it is appropriate to change over from auto DP control, to joystick, or manual control. In such a case, the vessel will revert to conventional supply vessel mode, and be subject to appropriate controls. Where the vessel transfers control from DP to manual or joystick control, transfer back to DP control should be subject to a repeat of the location set-up checks. Another possible issue, in relation to control, is that the preferred location for the DP control console would be the aft end of the bridge, to allow the DPO, an unrestricted view of the work deck and installation. Where this is not possible, some other suitable solution, should be available, to observe external conditions, e.g., Closed-Circuit Television Monitors mounted at the DP control console, or an observer stationed on the bridge with an unrestricted view.
Standby time	There may be frequent occasions where the vessel is stood down from cargo operations for a period. Such 'standby' time should be put to good use. Operations-free time allows opportunities to practice skills, such as manual and joystick ship-handling, DP operating experience, and taking DP footprint plots whilst clear of the installation. This time is best used, for training and familiarisation purposes, including drills.
Vessel thruster efficiency at different drafts and trims	Changes to the vessels draft and trim will often occur at an installation. A shallow draft can have an adverse effect on thruster efficiency, particularly for bow tunnel-thrusters. This can result in a significant loss of thruster effect, resulting in poor station keeping, and an impact on thruster redundancy. Wherever possible, preventative measures should be taken, to always maintain an appropriate draft and trim, when at an installation. This may require ballasting operations.
DP alert status	The operational status of a vessel in DP control, should be continuously monitored. Vessel operators should consider providing an internationally accepted, industry-standard, system, which utilises a concept of red, blue, yellow, and green status levels. This system does not necessarily rely on lights or alarms, although, it is useful to have an appropriate method on board, to alert the relevant crew, to changes in status level.

Table 5 – List of DP operational procedures

4.7 DP Station-Keeping 'Event' Reporting

DP station-keeping 'Event' records, are of enormous help to the industry. DP station-keeping 'event' reports, that have been collected and analysed, over a period of more than 20 years, have helped with the understanding of faults and errors, and have provided manufacturers, trainers, and operators, with valuable assistance, for their own contributions towards, the safe and efficient use of DP.

Reportable station-keeping 'Events' can be categorised, as follows:

- a **DP Incident** is the consequence of a major system failure, environmental condition, or human factor, which has resulted in a loss of DP capability of the vessel.
- a **DP Undesired Event** is the consequence of a system failure, environmental condition, or human factor, which has caused a loss of redundancy and/or, compromised the DP capability of the vessel.
- a **DP Observation** is any event, that has not resulted in a loss of redundancy, or has compromised the DP operational capability of the vessel but is still deemed to be worthy of sharing with others.

There should be an effective DP station-keeping Event reporting procedure which gives guidance on how incidents should be categorised, details of which, should be included in the vessel's DP Operations Manual. Vessel operators are encouraged to participate in IMCA's DP station-keeping Event reporting scheme.

It should be noted that, even the least serious events, can be of importance for analysing incident data.

Vessel operators should ensure that all station-keeping Events are investigated fully, the root causes are identified, and that appropriate measures are implemented to prevent a recurrence. Vessel operators should also ensure, that information and lessons learned, are made known to other company vessels and, where appropriate, to the wider industry community.

5 Managing Risk in DP Operations – Practical Application

The guiding principles for safe DP operations are, comparing locally experienced and expected environmental conditions with spinning reserve, against a possible loss of half the available power and thrust.

DP capability is based on overall redundancy and the ability of the vessel to maintain a desired position, within normal excursions of the control system, and the prevailing environmental conditions.

An effective DP system design is one, where the experienced proven worst-case failure (derived from the FMEA of the vessel) is less than, or equal to, the intended system design. Tolerance of a single point failure is achieved through provision of 'redundant' systems.

Adequate position-holding capability is achieved, from the provision of adequate residual power and thrust.

DP capability plots when produced, are presented as a polar diagram, with several envelopes, depicting the theoretical ability of the vessel, to maintain position in a pre-defined environment. These are calculated for various combinations of thrusters in service, including worst-case failure status. The capability plots are often produced for a scale of increasing wind speed, with a fixed current velocity and wave height. These usually show, all three environmental forces acting from the same direction, as this has the most effect on station-keeping ability.

In conventional diesel-electric DP vessels, the switchboards are separated into two (or more) independent sections, with power supply to the different thrusters distributed between these sections. Consequently, if a failure of one of the switchboard sections occurs, then typically, around 50% of all thruster capacity will be lost.

Hybrid vessels may, however, have multiple engine rooms with complex switchboards and control systems that can provide more power redundancy, with up to 75% in some cases.

For the vessel to remain fault tolerant and be able to withstand a defined worst-case failure event, the DP operators must ensure that the system is always capable of maintaining vessel position, within the following acceptable defined limits;

i) Currently experienced environmental conditions or forecasted conditions (worst-case weather working conditions).

ii) Available power online – redundancy shall be based on systems that are 'immediately available' for use, namely running machinery (spinning reserve).

It is the available remaining power after a defined worst-case failure condition (noted above) that is considered as 'spinning reserve' to allow a vessel to maintain position, as defined in IMO MSC.1/Circ.1580.

Appendix 1 Relevant Publications

Check appropriate websites for latest revisions of each document.

Reference	Document Title
IMCA M 103	*Guidelines for the design and operation of dynamically positioned vessels*
IMCA M 109	*A guide to DP-related documentation for DP vessels*
113 IMO	*Guidelines for vessels with dynamic positioning systems (MSC Circular 645)*
IMCA M 117	*The training and experience of key DP personnel*
IMCA M 119	*Fires in machinery spaces on DP vessels*
IMCA M 125	*Safety interface document for a DP vessel working near an offshore platform*
IMCA M 140	*Specification for DP capability plots*
IMCA M 166	*Guidance on failure modes and effects analyses (FMEAs)*
IMCA M 190	*Guidance for developing and conducting annual DP trials programmes for DP vessels*
IMCA M 206	*A guide to DP electrical power and control systems*
IMCA M 220	*Guidance on operational activity planning*
IMCA M 247	*Identifying DP system components and their failure modes*
IMCA M 252	*Guidance on position reference systems and sensors for DP operations*
IMCA C 002	*Guidance document and competence tables: Marine Division*
IMCA	*DP Station keeping event bulletins and Annual DP station keeping event reports*
IMCA	*Safety Flashes*
MTS Guidance	*https://dynamic-positioning.com/documents/operations/*
MSF Guidance	*MSF/Step Change in Safety "Marine Operations – 500m Zone*

Appendix 2 DP FMEA

For detailed information regarding the FMEA process, please refer to IMCA M166, Guidance on Failure Modes & Effects Analysis (FMEA).

The offshore industry first began using the FMEA technique in the 1970's and 1980's. Current requirements for redundancy demonstrations on DP vessels, derive from an approach developed during the mid-1980's for the Norwegian Maritime Directorate (NMD), now the Norwegian Maritime Authority (NMA). It was intended that the technique will improve upon the classification rules dating back from the mid-1970's. The NMD approach was adopted by the DP Vessel Owners Association (DPVOA) in 1991, introducing the annual audit. The DPVOA was a trade organisation which merged with the Association of Offshore Diving Companies (AODC) to form IMCA. The NMD document was developed into an international standard by the International Maritime Organization (IMO) in 1994 (IMO MSC Circular 645 – Guidelines for Vessels with Dynamic Positioning Systems).

In June 2017, the IMO updated IMO MSC/Circ. 645 and issued IMO MSC.1/Circ. 1580 with a similar title. The latest IMO document is applicable to vessels built on or after June 2017, whereas the previous document applied to DP vessels built after 1994; the exception being section 4 of the latest document titled "Operational Requirements", which is recommended to be, "*applied to all new and existing vessels and units, as appropriate*". However, the new IMO document has much of the same content as the original document.

The IMO MSC.1/Circ. 1580 document states:

"*Failure Modes and Effects Analysis (FMEA) means 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*".

The document also states:

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

Classification society requirements have since been adjusted, for consistency with this IMO document.

IMCA M 166, Guidance on Failure Mode Effects Analysis Guidance, Chapter 2.7, Updating of an FMEA states:

The FMEA will no longer be valid unless it is systematically updated and maintained on a regular basis. Updates could, for example, include changes to operating procedures, modifications to DP hardware or software and to confirm compliance with the latest industry guidance, etc., over the life cycle of the vessel. A systematic FMEA review throughout the vessel's life cycle, should be an ongoing process with formal completion at least once every five years. The objective of FMEA review is to:

- Ensure the DP system remains robust, resilient, and single fault tolerant.
- Remains in compliance with evolving industry guidance.
- Demonstrate the vessel operator's commitment to a process of continuous improvement, from the adoption of current industry good practice.

Any DP modifications to a vessel, or system, may require specifically targeted testing to verify and validate those modifications, some examples of which could be, but are not limited to, upgrades or additions of PRS's or hardware required for power generation, distribution and/or propulsion systems, being modified or added.

In most cases, these changes may also necessitate the update of related documentation, for example, DP Annual Trial Programmes, DP Operations Manuals and Decision Support Tools, such as ASOG.

IMO MSC.1/Cric.1580, Guidelines for Vessels and Units with Dynamic Positioning Systems, Chapter 5.1.1.4 states:

A survey, either general or partial, according to circumstances, should be carried out every time a defect is discovered and corrected, an accident occurs which affects the safety of the DP vessel, or whenever any significant repairs, or alterations, are made. After such a survey, necessary appropriate tests should be carried out to demonstrate full compliance with the applicable provisions of the Guidelines.

Appendix 3 Annual DP Trials

IMCA M 190 provides guidance for the development and conduct of annual DP trial programmes, for DP vessels. Chapter 4 provides guidance on the development of trials, linking responsibilities, competence, types of tests, planned maintenance routines, or survey of records in lieu of test, amongst other things. Chapter 5 deals with the trials themselves, covering the planning of trials, persons who would normally attend, their responsibilities and output of the trials, including management of resultant actions. Chapter 6 gives practical guidance on the format and content of trial reports.

IMCA recommends that those undertaking Annual DP Trials, are accredited according to IMCA's DP Practitioner Accreditation Scheme, to ensure a suitable level of knowledge, experience, overall competence, and engagement in Continuous Professional Development.

IMCA M 190 has key definitions as detailed below:

DP Annual Trials Programme:

A programme of tests to satisfy the annual survey requirements of Guidelines for vessels and units with dynamic positioning (IMO MSC/Circ. 1580).

Annual DP Trial:

A series of tests to verify the integrity of the DP system, conducted annually during a single period. Refer to M 190, section 4.11.

Incremental Tests:

Tests performed to verify the integrity of the DP system, conducted over a defined period. Refer to M 190, section 4.12.

Rolling Tests:

Tests on specified components or systems that have been identified as not being required annually but should be completed within a five-year period. Refer to M 190, section 4.10.

Independent Witness:

A sufficiently qualified and experienced individual removed from the day-to-day operational control of the vessel. Refer to M 190 section 5.2.

Trials Co-ordinator:

An individual responsible for co-ordination of the DP annual trials programme. Refer to M 190 section 5.4.

The industry norm is for trials to be carried out as a single, separate event. Where the trials are held on this basis, vessel operators should ensure that they are witnessed by a third party. This could be an independent third party, or any competent person separate from the relevant operational team, such as the Master or Chief Engineer of another vessel, or an appropriate shore-based technical specialist. IMCA recommends that this individual is IMCA DP Practitioner Accredited.

Vessel operators should ensure that the vessel's key DP personnel participate actively in the conduct of the annual DP trials programme, regardless of the form that it takes. Documented records of the annual DP trials should be kept on board the vessel for the use of the crew and be made available to charterers as required.

Continued validity of the flag state verification and acceptance document (FSVAD) / DP verification and acceptance document (DPVAD) should be assessed.

Appendix 4 DP Capability Plot

Following are three examples of DP capability plots. Further details can be found in IMCA M 140 – *Specification for DP capability plots.*

KONGSBERG

DP Capability Plot

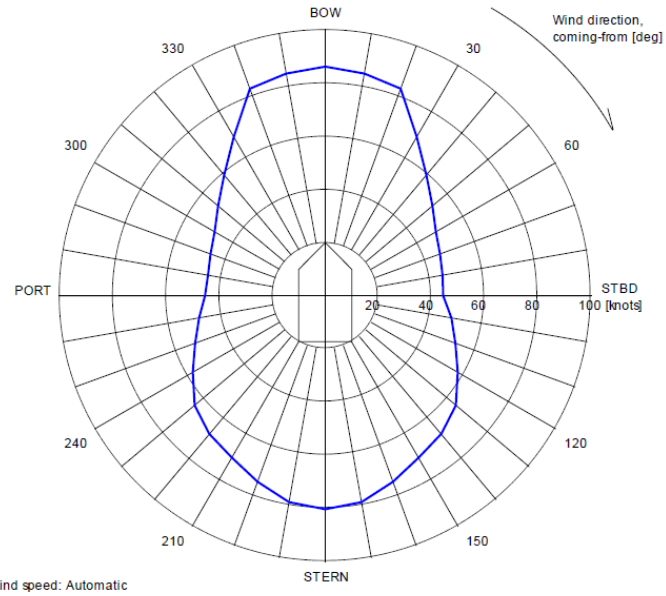
MERWEDE PROJECT 3444

Case number	:	1
Case description	:	Intact
Thrusters active	:	T1-T5
Rudders active	:	

Input file reference	:	Foot_2310_d.scp
Last modified	:	2007-02-18 13.30 (v. 2.5.1)
Length overall	:	131.7 m
Length between perpendiculars	:	117.7 m
Breadth	:	22.0 m
Draught	:	6.3 m
Displacement	:	10000.0 t (Cb = 0.60)
Longitudinal radius of inertia	:	29.4 m (= 0.25 * Lpp)
Pos. of origin ahead of Lpp/2 (Xo)	:	0.0 m
Wind load coefficients	:	Calculated (Blendermann)
Current load coefficients	:	Calculated (Strip-theory)
Wave-drift load coefficients	:	Database (Scaled by Breadth/Length)
Tidal current direction offset	:	0.0 deg
Wave direction offset	:	0.0 deg
Wave spectrum type	:	Pierson-Moskowitz
Wind spectrum type	:	N.A.
Current - wave-drift interaction	:	OFF
Load dynamics allowance	:	None
Additional surge force	:	0.0 tf
Additional sway force	:	0.0 tf
Additional yawing moment	:	0.0 tf.m
Additional force direction	:	Fixed
Density of salt water	:	1026.0 kg/m³
Density of air	:	1.226 kg/m³
Power limitations	:	ON

#	Thruster	X [m]	Y [m]	F+ [tf]	F- [tf]	Max [%]	Pe [kW]	Rudder
1	AZIMUTH	-58.0	-6.0	38.3	-22.4	100	2350	
2	AZIMUTH	-58.0	6.0	38.3	-22.4	100	2350	
3	TUNNEL	49.0	0.0	25.1	-25.1	100	1720	
4	TUNNEL	46.0	0.0	25.1	-25.1	100	1720	
5	AZIMUTH	42.5	0.0	19.6	-11.4	100	1200	

Limiting 1 minute mean wind speed in knots at 10 m above sea level



Wind speed: Automatic
Significant wave height: IMCA (North Sea)
Mean zero up-crossing period: IMCA (North Sea)

Rotating tidal current: 1.00 knots
Rotating wind induced current: 0.000*Uwi knots

Figure 1 – Sample capability plot 1: All thrusters available vessel intact

DP Capability Plot

KONGSBERG

MERWEDE PROJECT 3444

Case number : 2
Case description : SWB PS Failure
Thrusters active : T2, T4-T5
Rudders active :

Input file reference : Foot_2310_d.scp
Last modified : 2007-02-18 13.30 (v. 2.5.1)

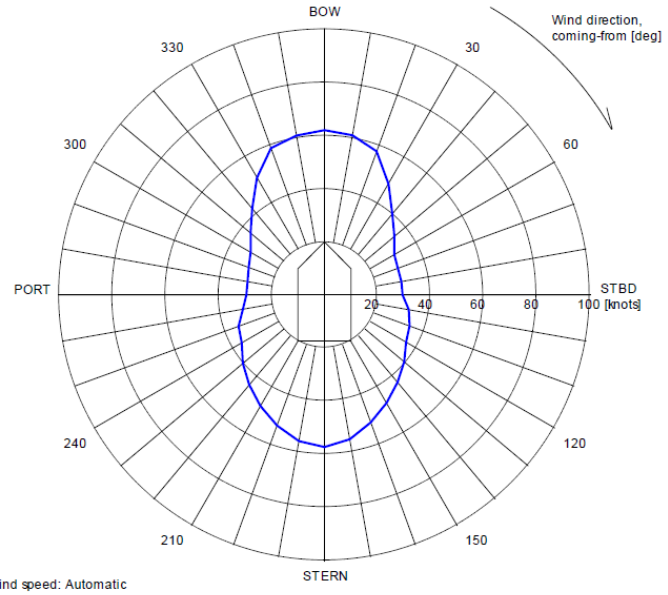
Length overall : 131.7 m
Length between perpendiculars : 117.7 m
Breadth : 22.0 m
Draught : 6.3 m
Displacement : 10000.0 t (Cb = 0.60)
Longitudinal radius of inertia : 29.4 m (= 0.25 * Lpp)
Pos. of origin ahead of Lpp/2 (Xo) : 0.0 m
Wind load coefficients : Calculated (Blendermann)
Current load coefficients : Calculated (Strip-theory)
Wave-drift load coefficients : Database (Scaled by Breadth/Length)

Tidal current direction offset : 0.0 deg
Wave direction offset : 0.0 deg
Wave spectrum type : Pierson-Moskowitz
Wind spectrum type : N.A.
Current - wave-drift interaction : OFF
Load dynamics allowance : None
Additional surge force : 0.0 tf
Additional sway force : 0.0 tf
Additional yawing moment : 0.0 tf.m
Additional force direction : Fixed
Density of salt water : 1026.0 kg/m³
Density of air : 1.226 kg/m³

Power limitations : ON

#	Thruster	X [m]	Y [m]	F+ [tf]	F- [tf]	Max [%]	Pe [kW]	Rudder
- 1	AZIMUTH	-58.0	-6.0	38.3	-22.4	100	2350	
2	AZIMUTH	-58.0	6.0	38.3	-22.4	100	2350	
- 3	TUNNEL	49.0	0.0	25.1	-25.1	100	1720	
4	TUNNEL	46.0	0.0	25.1	-25.1	100	1720	
5	AZIMUTH	42.5	0.0	19.6	-11.4	100	1200	

Limiting 1 minute mean wind speed in knots
at 10 m above sea level



Wind speed: Automatic
Significant wave height: IMCA (North Sea)
Mean zero up-crossing period: IMCA (North Sea)
Rotating tidal current: 1.00 knots
Rotating wind induced current: 0.000*Uwi knots

Figure 2 – Sample capability plot 2: Worst-case failure loss of port side switchboard

DP Capability Plot

KONGSBERG

MERWEDE PROJECT 3444

Case number : 3
Case description : SWB SB Failure
Thrusters active : T1, T3, T5
Rudders active :

Input file reference : Foot_2310_d.scp
Last modified : 2007-02-18 13.30 (v. 2.5.1)

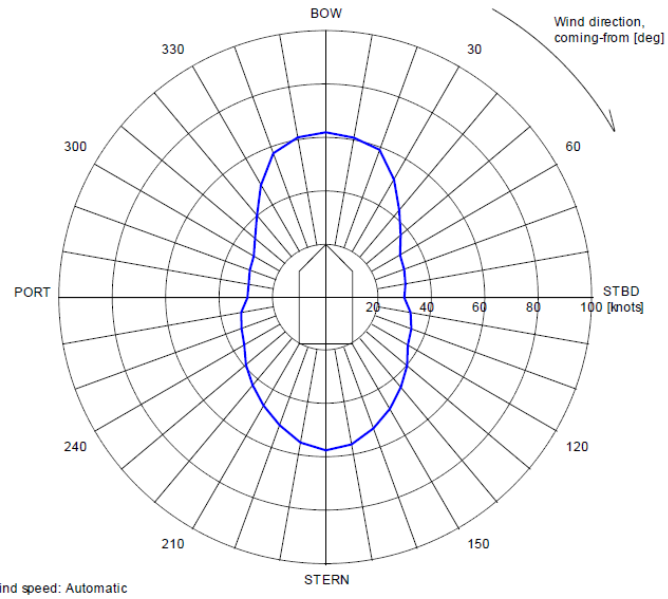
Length overall : 131.7 m
Length between perpendiculars : 117.7 m
Breadth : 22.0 m
Draught : 6.3 m
Displacement : 10000.0 t (Cb = 0.60)
Longitudinal radius of inertia : 29.4 m (= 0.25 * Lpp)
Pos. of origin ahead of Lpp/2 (Xo) : 0.0 m
Wind load coefficients : Calculated (Blendermann)
Current load coefficients : Calculated (Strip-theory)
Wave-drift load coefficients : Database (Scaled by Breadth/Length)

Tidal current direction offset : 0.0 deg
Wave direction offset : 0.0 deg
Wave spectrum type : Pierson-Moskowitz
Wind spectrum type : N.A.
Current - wave-drift interaction : OFF
Load dynamics allowance : None
Additional surge force : 0.0 tf
Additional sway force : 0.0 tf
Additional yawing moment : 0.0 tf.m
Additional force direction : Fixed
Density of salt water : 1026.0 kg/m³
Density of air : 1.226 kg/m³

Power limitations : ON

#	Thruster	X [m]	Y [m]	F+ [tf]	F- [tf]	Max [%]	Pe [kW]	Rudder
1	AZIMUTH	-58.0	-6.0	38.3	-22.4	100	2350	
- 2	AZIMUTH	-58.0	6.0	38.3	-22.4	100	2350	
3	TUNNEL	49.0	0.0	25.1	-25.1	100	1720	
- 4	TUNNEL	46.0	0.0	25.1	-25.1	100	1720	
5	AZIMUTH	42.5	0.0	19.6	-11.4	100	1200	

Limiting 1 minute mean wind speed in knots
at 10 m above sea level



Wind speed: Automatic
Significant wave height: IMCA (North Sea)
Mean zero up-crossing period: IMCA (North Sea)
Rotating tidal current: 1.00 knots
Rotating wind induced current: 0.000*Uwi knots

Figure 3 – Sample capability plot 3: Loss of starboard switchboard

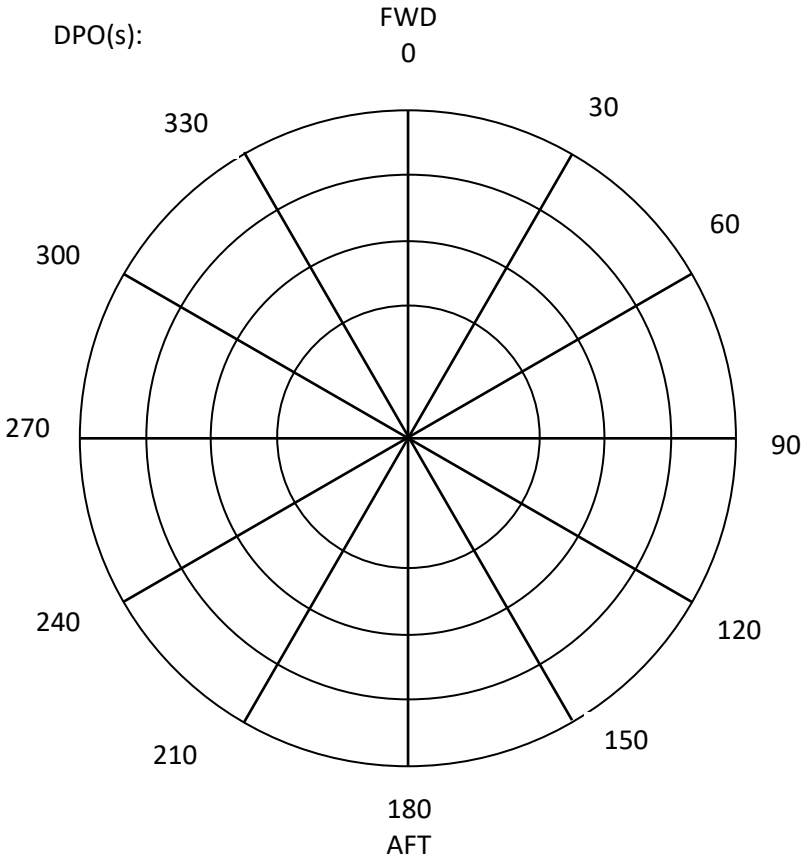
Appendix 5 DP Footprint Plot

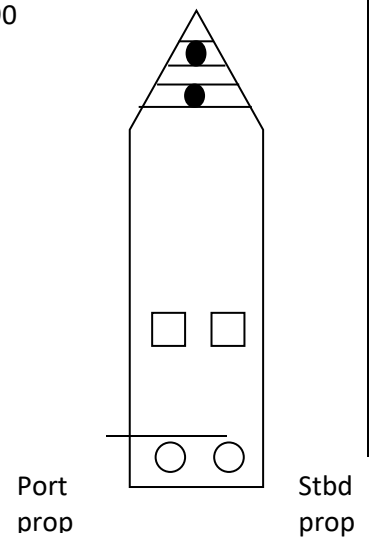
Concentric scale: Date:

One division = _____ metres Time:

Location:

DPO(s):





Environment	
Wind direction	
Wind speed	
Wave period	
Wave height	
Current direction	

Position References	
DGPS 1	
DGPS 2	
Fanbeam	
CyScan	
Other	

Note: Draw wind and current vectors on the plot

Comments

Current speed	

Guidance for Conducting DP Footprint Plots

A DP footprint plot is designed to record the observed movement of the DP vessel from its desired target location, over a defined period. Thruster configuration is selected at the beginning of the plot. The environmental forces of wind and waves are known from visual observation. Current is usually estimated.

A DP footprint is polar in outline with the bow head up at 0 degrees, at the desired or target position, and with the vessel in the centre of the circle.

- Select a safe location away from structures, other vessels, and hazards;
- Complete the section in the top right-hand corner, identifying when, where and by whom;
- Indicate in the vessel outline, which of the thrusters are selected and online, for the duration of the plot;
- Complete the environment boxes, putting a value against all forces and their directions. Draw arrows on the plotting chart to indicate force and direction. Note that values for tide/current should preferably be from an independent current meter. If not available, estimates for tide/current from other appropriate sources such as surface current charts and the DP estimated current;
- Indicate which of the position references are online for the duration of the plot;
- Select the concentric scale. One division could represent one metre, so that the total scale extends to five metres from the centre, or, if more vessel movement is expected, one division could equal two metres, hence increasing the total range to ten metres from the centre;
- Commence plotting the observed position of the vessel in relation to the target position by marking an 'X' at regular intervals, for example every 30 seconds. The vessel's position can be taken from the DP system display screen;
- Continue plotting until sufficient information is gathered for the vessel's position-keeping performance using the local environmental conditions. A completed plot will show the accuracy with which the vessel has kept position. Plots can also show the occasions where the vessel is unable to maintain position, i.e., when there is insufficient thruster force for the experienced environment. (This is a good check of the relevance of the calculated DP capability plots).

DP footprint plots should be conducted whenever opportunities arise. Accumulated knowledge of the vessel's position-keeping performance and expected vessel excursions, are helpful when selecting separation distance, critical, and allowable, excursion limits.

Note: A DP footprint is different to a DP capability plot. A DP capability plot shows by calculation the maximum environmental conditions, for which a DP vessel should not lose position.

Where the facility exists, a vessel's DP footprint can be captured by enabling the 'snail trail' function followed by a screen dump. It is recommended that this method is used in addition to the hard copy DP footprint plot described above.

Appendix 6 DP Vessel Specific Location Checks Document (EXAMPLE)

DP vessel-specific location checks are to be carried out before the vessel commences DP operations, or after any mode change.

These checks are to ensure satisfactory operation of the DP system. It is essential that full operational checks of the thrusters, power generation, auto DP and joystick/manual controls, are carried out. The checks also ensure that the DP system is set up correctly and that DP manning is adequate.

Completed checklists should be kept on board the vessel in accordance with the company's document control procedures.

Note that DP vessel checklists require to be "vessel specific" related to the installed equipment onboard.

Notes:

- Tick, or circle, 'YES' or 'NO' throughout the checklist;
- 'YES', indicates that the item is operating satisfactorily;
- Where 'NO' is given as an answer, an explanation should be given;
- These checks are to be carried out by the DPOs on watch, signed and dated.

1 Main Engines					
Port Main Engine	YES	NO	**Starboard Main Engine**	YES	NO
Both main engines are required for DP class 2.					

2 Power Generation								
Aux DG 1	YES	NO	**Aux DG 2**	YES	NO	**Aux DG 3**	YES	NO
Two auxiliary DGs are required for DP class 2. *Three auxiliary DGs are required when the main crane is to be used.* **Comment**								

3 Main Stern Propulsion					
Port Z-Drive Thrust	YES	NO	**Starboard Z-Drive Thrust**	YES	NO
Port Z-Drive Rotation	YES	NO	**Starboard Z-Drive Rotation**	YES	NO
Both z-drives are required for DP class 2. **Comment**					

4 Bow Tunnel Thrusters					
Bow Thruster 1	YES	NO	**Bow Thruster 2**	YES	NO
Both bow tunnel thrusters are required for DP class 2. **Comment**					

5	Thruster Control				
Independent Joystick (IJS)	YES	NO	**Manual**	YES	NO

Test IJS and manual thruster controls in all axes to maximum thrust levels.

Comment

6	DP Console				
Operating System 1	YES	NO	**Operating System 2**	YES	NO

Lamp test and full function test of DP control console.

Test position and heading movements in auto DP control.

Test change over from auto DP to IJS and manual thruster control and back.

Comment

7	Position Reference Systems (PRS)							
DGPS 1	YES	NO	**DGPS 2**	YES	NO	**DGPS 3**	YES	NO
Fanbeam	YES	NO	**HPR 400**	YES	NO	**Other**	YES	NO

Test all PRS individually and in combination.

Three PRS are required to be available for DP class 2, two of which are to be independent, e.g., two DGPS plus one Fanbeam or 'HiPAP', is an acceptable combination.

Comment

8	Gyros							
Gyro 1			**Gyro 2**			**Gyro 3**		
Heading	YES	NO	**Heading**	YES	NO	**Heading**	YES	NO

Record gyro headings

Comment

9	Wind Sensors							
Anemometer 1				**Anemometer 2**				
Speed	**Direction**	YES	NO	**Speed**	**Direction**	YES	NO

Record wind speed and direction

Comment

10	Motion Sensors (MRU)							
MRU 1				**MRU 2**				
Pitch	**Roll**	YES	NO	**Pitch**	**Roll**	YES	NO

Record pitch and roll values

Comment

11	Heading (Hdg) and Position Settings		
Hdg Wg = º	**Hdg Alarm = º**	**Pos Wg = m**	**Pos Alarm = m**
Comment			

12	Consequence Analysis Activated?	YES	NO
Consequence analyser is required for DP class 2.			
13	**DP Alarm Printer Active and Clear?**	YES	NO

14	Machinery Alarm Printer Active and Clear?	YES	NO
Comment			

15	Environment
Sea State	**Current Speed and Direction**

16	Offshore Location
Field Name	**Water Depth**

17	DP Operators
Enter the names of all DPOs who will operate the DP system during the voyage.	
DPO Name	**DP Qualification (full or limited)**
Signed	**Time and Date**
Signed	**Time and Date**

Appendix 7 Sample DP Watchkeeping Handover Checklist

Time and Date	:	/ /	:	/ /	:	/ /
General						
Online computer	A	B	A	B	A	B
Auto-switch on						
Consequence analysis	Off	Class 2	Off	Class 2	Off	Class 2
Alarm page clear						
Vessel mode	Auto Pos	Follow Sub	Auto Pos	Follow Sub	Auto Pos	Follow Sub
Gain	Low / Med / High		Low / Med / High		Low / Med / High	
Position set-point	N		N		N	
	E		E		E	
Vessel speed	m/s		m/s		m/s	
Limits pos/head	m	°	m	°	m	°
Rate of turn	°/min		°/min		°/min	
Posplot range	m		m		m	
References						
Selected	DGPS1 / DGPS2 / TW / HiPAP		DGPS1 / DGPS2 / TW / HiPAP		DGPS1 / DGPS2 / TW / HiPAP	
HiPAP Pole	Up	Down	Up	Down	Up	Down
Transponder no.s						
Deployment						
Divers	In	Out	In	Out	In	Out
Others						
Follow Target						
ROV	In	Out	In	Out	In	Out
TP no./location						
Reaction radius	m		m		m	

Sensors																		
Gyros	1	2	3				1	2	3				1	2	3			
Wind																		
Compare																		
Environment																		
Wind dir/speed (T)	°	kts					°	kts					°	kts				
Current dir/speed (T)	°	kts					°	kts					°	kts				
Thrusters																		
Online	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Mode	Var.	90/270					Var.	90/270					Var.	90/270				
Set-point/F.back																		
Rudder zero																		
Power																		
Generators online	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Available	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Clutched in	1	2	3	4			1	2	3	4			1	2	3	4		
Available power	kW						kW						kW					
Maximum used	kW						kW						kW					
Communications																		
Field																		
Dive control																		
ROV																		
Deck/crane																		
Others																		
DPO Signature																		

Appendix 8 DP Station Keeping Event Reporting

Background

IMCA (and its predecessor DPVOA), has been collecting DP station keeping event reports provided by members and publishing them as annual summary reports since 1991. IMCA reviewed the system in 2005 to make the reporting process, and form, more meaningful, and easy to use. IMCA also decided in 2007 that DP incident reports would also be accepted in the submitting company's format, providing the necessary details can be extracted from these. IMCA further revised the reporting template in 2016, to simplify the categories of events, as detailed below.

Current Categorisations

The following categories of DP events have been proposed and agreed by IMCA. These categories should be used in conjunction with the current *IMCA DP Event Reporting Form*, available free from IMCA-DP-event-reporting-form.pdf (windows.net)

DP Incident

- A major system failure, environmental or human factor, which has resulted in loss of DP capability resulting in, or should have resulted in, a 'Red Alert' status. For example:
  - A thruster fails incorrectly and acts as an undesirable force on the vessel, resulting in the loss of station keeping.
  - The DP network has failed with errors, and all control is lost, such that the main DP system loses position keeping capability.
  - The incorrect setup of an auxiliary system, causes the transfer of a fault to both redundancy groups.
  - A blackout leads to a loss of position.

DP Undesired Event

- A system failure, environmental or human factor, which has caused a loss of redundancy and/or compromised DP capability, resulting in, or should have resulted in, a 'Yellow Alert' status. For example:
  - Failure of a DP Controller causing a loss in redundancy of the main DP system.
  - A position reference has a valid signal input but with interference and is not rejected.
  - A partial blackout, where the vessel holds position, but has no redundancy.

DP Observation

- An observation is an event that has not resulted in a loss of redundancy, or has compromised DP operational capability, but is still deemed worthy of sharing
  - Failure of a thruster which does not result in a loss of redundancy.
  - Circuit breakers in a distribution panel are incorrectly labelled.
  - An incorrect alarm description appears on the DP system, causing momentary confusion.

Guidance for Completing the IMCA Station Keeping Incident Form

Incident Types:

1) DP incident
2) DP undesired event
3) DP observation

- Observations & Undesired Events may lead on to DP Incidents;
- Identify the option on the IMCA Station Keeping Event Form, which represents the greatest potential for a hazardous event:
- All sections of the form should be completed:
- For incident types 1, 2 and 3, please indicate 'Initiating Event', 'Main Cause' and 'Secondary Cause', where appropriate, on the IMCA Station Keeping Event Form, e.g.:
  - 'Initiating Event' – Additional thrust required due to increasing environmental conditions.
  - 'Main Cause' – Stoppage of thrusters.
  - 'Secondary Cause' – Operator error.
- The IMCA secretariat can aid and advise, with completion of the form.

Appendix 9 Example of Critical Activity Mode (CAM)

Please note that this example is based upon a CAM where the operator applied specific requirements on the vessel and may not necessarily apply to all cases.

EXAMPLE Critical Activity Mode– Name of Logistics Vessel				
No TAM operations permitted				
This set-up applies when the vessel is carrying out DP operations within the 500m zone of an offshore facility – AFI (agreed for implementation)				
Date				
Vessel to be set up and stabilised on DP before entering the 500m zone. Exiting the 500m zone may be done on joystick, manual or DP				
Condition	Green	Advisory		
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES		
Action	Continue normal operations	Informative/ consultative status (risk assessment)		
Switchboard set up	All bus ties OPEN	Any other configuration		
SG1, SG2, AG1 and AG2 (testing)	SG1 and SG2 online. AG1 and AG2 standby	Any other set-up, or problems found		
Emergency generator	Selected to auto start and available for immediate use. Auto start/connect, and load tested prior to arrival on field	Any other configuration or known deficiencies reducing redundancy		
Blackout drill (single fuel system)	Blackout drill conducted for all DPOs and engineers onboard, procedures in place	Any DPOs on watch or engineers not performed blackout recovery drill in last six months		
DP power supply	All UPS units fully functional, not operating on bypass and tested on load 24 hours prior to field arrival. Note: Batteries must be at optimum charge level before entering 500m)	Any other configuration or known deficiencies reducing redundancy or endurance. Not tested for 30minute endurance prior to field arrival		

Condition	Green	Advisory		
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES		
Action	Continue normal operations	Informative/ consultative status (risk assessment)		
24Vdc power systems (load test)	All fully functional with DC10 and DC20 cross connect breakers open (breaker F3 open in both panels) plus DC30 and DC40 cross connect breakers open (breaker F3 open in both panels). 30minute battery endurance test carried out on DC10, DC20, DC30, DC40, DC50 24 hours prior to field arrival. Note: Batteries must be at optimum charge level before entering 500m)	Any other configuration or known deficiencies reducing redundancy or endurance. Not tested for 30minute endurance prior to field arrival		
24Vdc power systems (battery chargers)	All on main feed to charger	Any other set-up or problems found		
Main engines (drive)	Operational and tested to 100% at field arrival	Engine not capable of 100% command or problems found		
Propellers and rudders (configuration)	One pump running on each (seawater cooling, freshwater cooling, steering pumps) with standby pumps ready for operation	Any other set-up or loss of any rudder		
Bow thrusters 1 and 2	Thrusters tested to 100% command in both directions on manual (fwd and aft) and DP at field arrival	Thrusters not capable of 100% command or problems found		
Stern thrusters 1 and 2	Thrusters tested to 100% command in both directions on manual (fwd and aft) and DP at field arrival	Thrusters not capable of 100% command or problems found		
Thruster/main propellers/rudders manual levers	Tested and fully operational on field arrival	Any known deficiencies		
Independent joystick	Tested and fully operational on field arrival	Any known deficiencies or not tested at field arrival		

Condition	Green	Advisory		
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES		
Action	Continue normal operations	Informative/ consultative status (risk assessment)		
Manual control	Within 24 hours the captain and each DPO practise holding vessel on position for 10 minutes	Not completed		
Thrust levels checked to within ASOG level outside the 500m zone at operational heading	Within operating limits	Above operating limits		
Emergency stops	Stops tested from the bridge on field arrival	Stops not tested or function not operational		
Thrusters, main propellers and rudders	All online and selected in DP system	Any known deficiencies, problems, or issues		
DP control system	Consequence analysis enabled; no alarms active	Any other set-up		
DP related maintenance	Not being carried out	Requested by permit to work		
DP reference system	Median check set-up and enabled, with three references online	Less than three references online, position reference deviation >3m		
DGPS	Both units operational and available	Any other set-up		
DGPS (configuration)	DGPS 1 on IALA, DGPS 2 on WAAS	Any alarms or other set-up		
DGPS (line of sight)	Field of operation is clear of possible obstruction by cranes, superstructure, etc.	Possibility of masking by cranes/structures		
Relative pos ref (Cyscan)	Operational	Not operational or faulty	Note: Only snatch lifts permitted (no hose transfers or heavy lifts)	
Rig movement (check at 100m off and during operation)	Footprint or shading not preventing use of DGPS	Movement or shading of rig such that DGPS cannot be used in conjunction with relative systems		
Wind sensors	Both available	Any other set-up		

Condition	Green	Advisory		
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES		
Action	Continue normal operations	Informative/ consultative status (risk assessment)		
Gyros	All three units operational and visual heading reference available. Alignment less than 1 degree	Any other set-up		
Gyros (north speed correction)	Auto speed and latitude not enabled	Any other set-up		
VRUs	Both VRUs online, no alarms, alignment less than 1 degree	Any other set-up		
Radar and traffic	Both radars on and 100% operational; and no traffic with conflicting closest point of approach	Any other situation		
Communications (internal and external)	All vessel's hardwired and portable communications equipment operational	Loss of any principal item of communications equipment		
Environment: current, wind, existing weather and forecast	Reviewed and found within DP capability and DP footprint plots	Any other condition		
Position and heading alarms	Tested OK; heading warning and alarm set at 3 and 5 degrees, respectively; position warning and alarm set at 3 and 5 metres (10 and 15 ft) respectively	Any other condition		
Escape route (in degrees true)	Escape route identified and agreed with field operations	Escape route compromised or that possibility during time span of planned operation		
Speed or moves inside 500m zone	From 500m to 200m, <=0.5 m/sec; from 200m to work location <=0.3 m/sec	Any other setting		
Thrust values when exiting 500m zone on joystick or manual	200m <25% (minimum to safely pull away); 200m-500m <50% (minimum to safely pull away out of 500m zone)	Approaching 25% or 50% respectively		

Condition	Green	Advisory		
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES		
Action	Continue normal operations	Informative/ consultative status (risk assessment)		
Ventilation	All fans running in engine and thruster rooms	Any problems found		
Air conditioning	Adequate cooling of DP computer area on bridge and switchboard room	Any known deficiencies		
Watertight doors	All closed	Any open		
Engine room manning	Engine room manned	Engine room not manned		
Bow thruster room	Checked regularly every watch for machinery function, flooding, etc	Not checked		
Fuel systems	Supply and return cross connections closed. Both port and starboard supply and return lines open. Day tanks de-watered / sludged regularly during watch. Day tanks filled via purifier prior to entering 500m	Any other set-up or level alarm for day tanks. Any sign or potential threat of fuel oil contamination, blockage or supply failure		
Air system	Both air compressors fully operational, auto start function tested and reservoirs full	Any other set-up		
Freshwater cooling system	All freshwater cooling systems operational. Standby pump tested prior to arrival on field	Any other configuration or known deficiencies reducing redundancies		
Seawater cooling system	All system 100% operational. Standby pump tested prior to arrival on field	Seawater temperature alarm		

Example of Activity Specific Operating Guideline (ASOG)

Please note that this example is based upon an ASOG where the operator applied specific requirements on the vessel and may not necessarily apply to all cases.

Activity Specific Operating Guidelines – Name of Logistics Vessel				
This set-up applies when the vessel is carrying out DP supply operations within the 500m zone of an offshore facility				
Condition	Green	Advisory	Yellow	Red
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES	YES	YES
Action	Continue normal operations	Informative/ consultative status (risk assessment)	Safely terminate operations and be ready to move off. Vessel to safe position and on joystick or manual if applicable. Orderly removal of the vessel from the 500m zone if necessary	Cease operations – leave 500m zone immediately
Weather forecast	Within operating limits	Approaching operating limits	Exceeding operational limits	
Checklists: 6H; watch; 500m	Completed	Not completed or abnormalities noted		
Drive off	All systems operating correctly	Immediately when recognised by DPO		Unable to bring vessel under control
Drift off	All systems operating correctly	Immediately when recognised by DPO		Unable to bring vessel under control
Vessel footprint/weather related excursion	On position	Position limits reach 3m (10 ft)	Approaching 5m (15 ft)	
Heading excursion	On heading	Heading limit reached 3 degrees	Approaching 5 degrees	
Heading and position control (thruster load/ DP feedback)	Heading and position control achieved with <45%	Approaching 50%	More than 50%	
Shaft generators SG1-2	SG1 and SG2 online, AG1 and AG2 standby. No alarms	Any other set-up or alarms	Any generator failure	
Shaft generator loads	Both generators <45%	Any SG approaching 50%	Either >50%, or failure of a generator	
DP UPSs	No UPS in bypass, no alarm	Any UPS in bypass or alarm	Loss of one DP UPS	

Condition	Green	Advisory	Yellow	Red
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES	YES	YES
Action	Continue normal operations	Informative/ consultative status (risk assessment)	Safely terminate operations and be ready to move off. Vessel to safe position and on joystick or manual if applicable. Orderly removal of the vessel from the 500m zone if necessary	Cease operations – leave 500m zone immediately
24Vdc system	All 24Vdc active and fully charged, no alarms	Any alarms	Loss of a 24Vdc system or charger failure	
Main propulsion (drive engines and rudders)	Both enabled, no alarms	Any other set-up, any alarms or poor control	Loss of either port or starboard	
Bow thrusters available	Both enabled, no alarms	Any other set-up, any alarms or poor control	Loss of any bow thruster	
Stern thrusters available	Both enabled, no alarms	Any other set-up, any alarms or poor control	Loss of any stern thruster	
Fuel systems	No alarms	Any sign or potential threat or fuel oil contamination, supply line blockage, or any other supply failure	Loss of any generator due to fuel oil contamination, line blockage, or any other supply failure	
DP control system (power mimics)	All displays check and up to date	Any incorrect information	Incorrect information that affects DP operation	
DP control system (controllers/operator stations)	All controllers and operator stations online	Any alarms or poor performance	Loss of one network	
DP network	Both networks available, no alarms	Any alarms or poor performance	Loss of one network	Complete loss of networks
Position references	All fully operational and verified there is no conflict between relative and absolute position reference systems due to movement of reflector, reflective clothing etc. on the platform	Any alarms or poor performance	Only one remaining	
Heading sensors (gyro)	All three gyros enabled	Gyro alarms, loss of one gyro	Failure of two gyros	

Condition	Green	Advisory	Yellow	Red
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES	YES	YES
Action	Continue normal operations	Informative/ consultative status (risk assessment)	Safely terminate operations and be ready to move off. Vessel to safe position and on joystick or manual if applicable. Orderly removal of the vessel from the 500m zone if necessary	Cease operations – leave 500m zone immediately
Wind sensors	Both available	Mismatch alarm or loss of either wind sensor	Both wind sensors failure and gust conditions	
VRUs/MRUs	Both units available	Mismatch alarm or loss of one unit	Loss of two units	
Loss or problem with any essential communications (engine control room/deck/ platform)	Redundant communications	One system remaining	No communications	
Machinery ventilation and air conditioning	Operational ventilation and air conditioning	Any reduced ventilation or air condition	Reduced ventilation or air conditioning resulting in power reduction	
Starting air	No alarm	Any alarm		
Fire	No fire or active alarms	Any fire alarm	Fire confirmed	
Flood	No bilge alarms active, no flooding	Multiple bilge alarms	Flood confirmed	
Visibility	Daylight with good visibility	Any other condition		
Collision (errant vessels)	No collision imminent/ minimum approach >500m	Minimum approach will be <500m	If collision possible	Collision imminent
Change from green DP status of any other vessel in the field	Green	Advisory	Advisory	Advisory
Comms/interaction with other vessels	Vessels operating normally with no known problems	Communications problem or possible position conflict	No communications or definite position conflict	
Comms with rig	Redundant communications	Communications problem	One communications system remaining	

Condition	Green	Advisory	Yellow	Red
Notify Master, chief engineer, client rep (if on board) and rig/ platform	NO	YES	YES	YES
Action	Continue normal operations	Informative/ consultative status (risk assessment)	Safely terminate operations and be ready to move off. Vessel to safe position and on joystick or manual if applicable. Orderly removal of the vessel from the 500m zone if necessary	Cease operations – leave 500m zone immediately

DPO Name:

Captain Name:

Engineer Name:

Chief Engineer Name

Client Name: