DP Operations
Operational Planning & Decision Support Tools
General operational planning – configuration of DP systems (CAM / TAM) and ASOG to define operational, environmental and equipment performance limits applicable when operating vessel and provide guidance on actions in the event of these limits being exceeded.
DP alert light system
DP setup procedures
DP watch keeping procedures
Environment conditions

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IMO MSC/Circular 1580 states that,

4 OPERATIONAL REQUIREMENTS

4.1 Before every DP operation, the DP system should be checked according to applicable vessel specific location checklist(s) and other decision support tools such as ASOG in order to make sure that the DP system is functioning correctly and that the system has been set up for the appropriate mode of operation.

Although IMO MSC/Circular 1580 applies to vessels and units constructed on or after 9 June 2017 and that vessels and units constructed on or after 1 July 1994 but before 9 June 2017, may continue to be apply the previous version of the Guidelines (MSC/Circ.645), *it is recommended that section 4 of the present Guidelines be applied to all new and existing vessels and units, as appropriate.*

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to define operational, environmental and equipment performance limits applicable when operating vessel and provide guidance on actions in the event of these limits being exceeded

ASOG

IMO MSC/Circular 1580 defines an ASOG as:

> *1.2.1 Activity-Specific Operating Guidelines (ASOG) means guidelines on the operational, environmental and equipment performance limits for the location and specific activity. (For drilling operations, the ASOG may be known as the Well-Specific Operating Guidelines (WSOG)).*

IMCA M 130 define an ASOG as

> ***3.5.4 Activity Specific Operating Guidelines (ASOG)***
> *An ASOG defines the operational, environmental and equipment performance limits for the location and the specific activity the vessel is undertaking. The performance limits are established based on the level of risk. A DP vessel may have several different ASOGs, each applying to different locations, activities and levels of risk. The terms well specific operating guidelines (WSOG), field specific operating guidelines (FSOG) and location specific operating guidelines (LSOG) denote equivalent concepts as applied by specific offshore sectors.*

The ASOG should be developed by those who have appropriate knowledge and understanding of the vessel and its expected operations. Although the development process may involve external specialists this does not alter the strong recommendation that the vessel crew should own the ASOG documents and the processes used to develop them, from inception through to implementation. Importantly, the master and DPOs of the vessel should be involved throughout.

Discussions on the ASOG should be carried out prior to the DP vessel starting operations. These discussions should involve the vessel's master, DPOs, chief engineer, engineer/electric/electronics officers as appropriate and may be included as part of the pre-arrival procedure.

All parties with an interest in vessel activity based operational planning should agree on the contents of the ASOG. And there should be a signature section at the end of the document.

Where a DP vessel is operating at a charterer's offshore installation it is recommended that the ASOG is signed by a representative of the charterer as well as the master, chief engineer and the DPOs. The charterer's representative may be a shore based superintendent or, where possible, the OIM of the offshore installation.

The ASOG should be displayed at the DP control console and in the engine control room. It should be clearly visible to the DPOs and engine room watchkeepers and used by them in setting up and operating the vessel for DP operations as well as providing them with a range of responses to degraded conditions in each mode.

182 MSF Rev. 2 – April 2015 - International Guidelines for The Safe Operation of Dynamically Positioned Offshore Supply Vessels suggests that consideration should be given to the following when developing an ASOG

- *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 out of 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;*

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- *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;*
- *A central component in the ASOG is a proven knowledge of black out recovery capability and time.*

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

	Green	Blue	Yellow	Red
Definition	Normal operations – all systems fully functional and operating within acceptable performance limits	Advisory status – approaching performance limits or reportable alarm status. Operations may continue whilst risks are being assessed. A failure has occurred that does not affect DP redundancy	Reduced status Pre-defined performance limits reached, component or system failure resulting in loss of redundancy	Emergency status – pre-defined operational or performance limits exceeded, component or system failure resulting in loss of control or position, internal or external emergency situation affecting the vessel
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	Commence preparation to safely terminate operations. Specific guidance for vessel types is available in the appendices	Abandon operations. Take immediate action, i.e. initiate emergency disconnect sequence (EDS) to ensure the safety of people, the environment, the operation and the vessel

182 MSF goes on to list typical items that might be contained in the ASOG as:

- *Maximum watch circle radius (if applicable) for worst weather conditions identified for that activity;*
- *Maximum environmental operating conditions, including wind speed and current limits, and wave height;*
- *Weather specific vessel positioning performance, including position and heading excursions;*
- *Maximum offsets permissible from the set point position;*
- *Drive off, drift off scenarios;*
- *Diesel generators, including the minimum number required for the activity, performance limits and failures;*
- *Diesel generator loading;*
- *Thrusters, including the minimum number required for the activity, performance limits and failures;*
- *Thruster loading;*
- *Batteries;*
- *Power management system (PMS) and vessel management system (VMS) status of operation;*
- *Auxiliary systems performance limits and failures, including fuel, seawater and freshwater cooling and compressed air;*
- *Uninterruptible power supplies (UPS) operation, charger output, supply status and failures; DP control system, including operation and performance of DP controllers and failures; DP control system displays, including mimics, performance and failures;*
  DP networks, including operation, redundancy and failures;
- *Position reference systems, including number and types of enabled systems, suitability, performance and criticality to operation and failures;*
- *Sensors, including number of enabled systems, performance and criticality to operation and failures;*
- *Communications, including onboard systems, performance and failures;*
- *Non-essential DP related systems, including ventilation and air conditioning performance and failures;*

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- *Fire, flood, visibility, collision, including threat to the DP operation; Simultaneous operations, including communications with assets.*

Very helpfully 182 MSF contains an example of Activity Specific Operating Guideline (ASOG) of which we supply a sample below although we recommend that you read this document in full.

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	
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

FIGURE 51 - 182 MSF REV. 2 – APRIL 2015 (International Guidelines for the Safe Operation of Dynamically Positioned Offshore Supply Vessels)

GREEN indicates NORMAL OPERATIONS. DP status is GREEN where all items in the GREEN column are met, indicating that the vessel is able to maintain position with adequate redundancy in all critical systems, and have the ability to handle expected environmental variations.

BLUE is an ADVISORY condition which applies to all operations or situations where the vessel HAS NO IMMEDIATE RISK of losing position, but something has occurred that requires a re-evaluation of the risk. Any ADVISORY status should immediately start the risk assessment process. The vessel cannot remain in any ADVISORY status without the DPO

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taking action. After a comprehensive risk assessment, operations may continue with mitigating measures in place where the ADVISORY status may be decreased to GREEN. The outcome of the risk assessment process, however, could also mean increasing to YELLOW preparing to cease operations.

There are no conditions where ADVISORY status should be considered or treated as a normal situation. If the DP system is fitted with consequence analysis this may trigger an ADVISORY status.

An example of the ADVISORY DP status is a failure of one of the main engine starting air compressors. This failure would not normally create a risk to activities that do not consume supplied air but the vessel should postpone any activity that would use a lot of air until the backup compressor is repaired.

YELLOW is a WARNING condition indicating there is a high risk of the vessel losing position should another failure occur. The vessel is still maintaining position although some DP critical equipment will have lost redundancy. In YELLOW DP status, operations the vessel is undertaking should be stopped so that contingency procedures can be initiated, such as getting ready to disconnect a hose line and moving to a safe location. If the DP system is fitted with consequence analysis this may trigger YELLOW status.

An example of YELLOW DP status would be the loss or failure of one bow thruster where the vessel is only fitted with two. In this example redundancy has been lost. The vessel would still be able to maintain position but would lose position if the remaining bow thruster failed.

RED indicates a severely degraded status or emergency. A RED status should immediately initiate a disconnection with all DP reliant operations terminated since the vessel may be losing position.

When RED DP status is initiated it is essential to inform all relevant personnel immediately.

An example of a RED DP status would be a fire in a DP critical compartment or space.

CAM AND TAM

IMCA M103develops the support documents for risk based planning and control to include the creation of CAMs and TAMs. We recommend that you access and read IMCA M 103.

3.5.2 Critical Activity Mode (CAM)

The CAM defines the most fault-tolerant configuration for the DP system and associated equipment. CAM should be implemented for all critical activities undertaken by the vessel. For DP class 2 and 3 vessels the CAM will ensure that a single point failure does not exceed the vessel's identified worst case failure. Where it is permissible to operate with a lesser standard of fault tolerance then the CAM may be replaced by a TAM.

3.5.3 Task Appropriate Mode (TAM)

A TAM is a risk based operating mode in which the DP vessel may be configured and operated such that a single point failure could result in exceeding the vessel's identified worst case failure. A TAM may be applied where a risk assessment has demonstrated that the consequences of exceeding the vessel's identified worst case failure are acceptable.

As with the ASOG CAM's and TAMs should be developed by those who have appropriate knowledge and understanding of the vessel and its expected operations. Although the development process may involve external specialists this does not alter the strong recommendation that the vessel crew should own the CAM and TAM documents and the processes used to develop them, from inception through to implementation. Importantly, the master and DPOs of the vessel should be involved throughout.

Discussions on the CAMs and TAMs should be carried out prior to the DP vessel starting operations. These discussions should involve the vessel's master, DPOs, chief engineer, engineer/electric/electronics officers as appropriate and may be included as part of the pre-arrival procedure.

All parties with an interest in vessel activity based operational planning should agree on the contents of the CAM and TAM. And there should be a signature section at the end of the document.

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Where a DP vessel is operating at a charterer's offshore installation it is recommended that the CAM and TAM is signed by a representative of the charterer as well as the master, chief engineer and the DPOs. The charterer's representative may be a shore based superintendent or, where possible, the OIM of the offshore installation.

The ASOG should be displayed at the DP control console and in the engine control room. It should be clearly visible to the DPOs and engine room watchkeepers and used by them in setting up and operating the vessel for DP operations as well as providing them with a range of responses to degraded conditions in each mode.

182 MSF Rev. 2 – April 2015 (International Guidelines for The Safe Operation of Dynamically Positioned Offshore Supply Vessels suggests that consideration should be given to the following when developing an ASOG

CAM and TAM refer to the system and equipment configurations of DP vessels.

For example, a CAM may require the DP vessel to operate with open bus ties whereas a TAM may permit the vessel to operate with closed bus ties.

A CAM may require a minimum of three independent position references based on different principles whereas a TAM may accept two.

A DP MODU may operate in a CAM where time to terminate an operation in an emergency is long, such as when non-shearable heavy wall drill pipe is passing through the BOP, but in a TAM when time to terminate is short.

IMCA recommend a CA and a TAM for all DP vessels regardless of DP class. A DP vessel will normally have one CAM and TAM, although some vessel owner/operators decide not to operate in TAM.

It is the responsibility of the vessel owner/operator to provide them and they should be based on:

- a thorough knowledge of the DP system;
- the DP FMEA;
- the industrial mission;
- vessel location, and
- risk assessment.

Any DP vessel, including DP class 2 and 3, can have the redundancy concept defeated if its systems and equipment are not configured and operated in the correct manner. The purpose of a critical activity mode of operation is to detail in a clear and unambiguous manner how to configure a vessel's DP system, including power generation, distribution, propulsion and position reference systems, so that the DP system, as a whole, meets its maximum level of redundancy, functionality and operation and is 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 failure3 does not result in a condition exceeding the vessel's identified worst case failure.

The CAM gives tabular guidance to the operator (DPO) on actions to take when the CAMO configuration is not met.

Every DP vessel has a unique CAM configuration. A CAM configuration is derived from a detailed review of the vessel's DP FMEA4 and its operational characteristics. The CAMO configuration should be the default operational mode for a DP vessel, when conducting activities deemed to be critical.

It is suggested that the results of the above review are summarised in a vessel overview document (VOD). The VOD serves as a useful tool to onboard crew as well as on-coming personnel and others involved in the vessel's operations. This should be included in the DP operations manual.

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A CAM table typically uses only two columns; GREEN (Normal) and BLUE (Advisory).

	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.

182 MSF Rev. 2 – April 2015 (International Guidelines for The Safe Operation of Dynamically Positioned Offshore Supply Vessels lists some typical items contained in the CAMO include the following:

- Power plant set up, including whether operating with open or closed bus ties;
- Diesel generators, including confirmation of 100% output in DP;
- Thrusters including confirmation of 100% output in DP;
- Power management, including configuration confirming that auto stop is disabled and black out recovery start is enabled;
- Uninterruptible power supplies (UPS), including confirmation of power supply, function testing, and absence of cross connections;
- Manual controls and independent joystick, including confirmation of readiness and testing of operation;
- DP control system, including availability of consequence analysis, mode availability and selection;
- Position reference systems, including number, availability, testing and selection, absolute or relative systems, polling, optimum placing of targets for type and local area of operation;
- Setting of vessel centre of rotation; such as bow, mid-ships and stern;
- Setting of heading rotation speed and speed of vessel moves; for example 10 degrees per minute and 0.3 m/sec, respectively;
- Sensors, including availability, testing and selection;
- Fuel systems, including confirmation of redundancy, tank levels, standby pump starts, isolations and crossovers;
- Sea water cooling, including confirmation of redundancy, standby pump starts, isolations and crossovers;
- Fresh water cooling, confirmation of redundancy, standby pump starts, isolations and crossovers;
- Compressed air/control air, confirmation of redundancy, safest compressor operating mode;
- DP and engine room manning, including watchkeeping schedules, qualifications and competency of watchkeepers; Trials and checklist completions.

Task Appropriate Mode (TAM) is a risk based mode and should be derived from a comprehensive risk assessment process. Task appropriate mode is 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 blackout 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, environment or equipment.

The conditions under which a DP offshore supply vessel may operate in TAM should be defined and could, for example, relate to operations well clear of the 500 metre safety zone of floating or critical subsea assets and where the consequences of a loss of position have been evaluated and deemed acceptable.

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EXAMPLE Critical Activity Mode of Operation – 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 30 minute endurance prior to field arrival		
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). 30 minute 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 30 minute 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		

FIGURE 52 - TYPICAL CAM - 182 MSF REV. 2 – APRIL 2015 (International Guidelines for the Safe Operation of Dynamically Positioned Offshore Supply Vessels)

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POSITIONING STANDBY

'Positioning standby' is a heightened state of alertness initiated during the vessel's DP operation and may be triggered by a number of different conditions. It is initiated 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 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 initiate:

- A change in configuration from TAM to CAMO;
- 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;

PRACTICAL ONBOARD EXERCISE

Read, know and understand your vessel's ASOG, CAM and TAM. Are there any differences between the CAM and TAM?

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DP ALERT LIGHT SYSTEM

IMO MSC/Circular 1580 states that the DP control station means a workstation designated for DP operations, where necessary information sources, such as ***indicators, displays, alarm panels***, control panels and internal communication systems are installed and that,

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

A system of lights and audible alarms should indicate the DP system status at the appropriate operational/control locations. The required responses to a change in alert level should be determined by risk assessment and documented in tabular format in the ASOG.

IMCA M103defines the colour and sound of alarms and this complements the colour codes in the ASOG, CAM and Tam documents for each vessel type. We recommend you read the document in full and provide the DP Status for a dive support vessel below.

The red alert, accompanied by a distinctive alarm, should additionally sound in the master/OIM's cabin, operations superintendent's cabin (if applicable) and the senior diving supervisor's cabin (if applicable). A local means of acknowledging and silencing these alarms and flashing lights should be provided.

Normal status – GREEN light. Full DP diving operations can be undertaken.

- The DP system is operating as intended;
- Operational, environmental and equipment performance criteria as defined within the ASOG are all categorised as normal;
- The vessel could maintain position in the prevailing environmental conditions after the worst case failure.
-

Advisory status – If an indicator light is used then it is recommended that this be BLUE however alternative arrangements not involving the use of an indicator light are acceptable. Relevant personnel should be notified. Operations can continue whilst risks are being assessed.

- Operational, environmental or equipment performance limits are being approached;
- The DP system is no longer configured as required in the CAM/TAM;
- An advisory condition exists as defined in the ASOG;
- A failure has occurred that does not compromise single-fault tolerance of the DP system.

Degraded status – YELLOW light. The diving supervisor should instruct the divers to suspend operations and move to a safe location. The DPO, after consulting the diving supervisor, should decide if further action is necessary. If the diving supervisor is unable to get clear advice from the DPO then the divers should be instructed to return to the bell or deployment device and obtain a seal or to return to the surface as appropriate.

- 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;
- The vessel's position keeping performance is deteriorating or unstable;
- The vessel would be unable to maintain position in the prevailing environmental conditions after the worst case failure;
- A 'yellow' condition exists as defined in the ASOG for abnormal operational, environmental and equipment performance conditions;
- Any other condition exists which may lead to a suspension of diving activities.

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Emergency status – RED light with accompanying distinctive alarm. The diving supervisor should instruct the divers to return immediately to the bell (or deployment device as appropriate) and obtain a seal. The deployment device should be recovered as soon as possible after due consideration of hazards involved in the recovery. The DPO(s) should use all available means to limit the inability to maintain position while the divers are being recovered.

A system failure or other condition has occurred resulting in an inability to maintain position or heading control or to safely conduct diving operations;

- A 'red' condition exists as defined in the ASOG for hazardous operational, environmental and equipment performance criteria;
- Any other emergency situation which warrants immediate recovery of divers to a safe position.

It is critical to remember that IMO MSC/Circular 1580 states

> *4.3* ***DP operations necessitating equipment class 2 or 3 should be terminated when the environmental conditions (e.g. wind, waves, current, etc.) are such that the DP vessel will no longer be able to keep position if the single failure criterion applicable to the equipment class should occur.*** *In this context, deterioration of environmental conditions and the necessary time to safely terminate the operation should also be taken into consideration. This should be checked by way of environmental envelopes if operating in equipment class 1 and by way of an automatic means (e.g. consequence analysis) if operating in equipment class 2 or 3.*

ABOVE AND BEYOND

DP OPERATIONS GUIDANCE - PART 1 (Rev3 - Apr21)

Time to Terminate

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

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

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DP MODES OF OPERATION

There are several modes of operation that are commonly used in DP systems:

Automatic Mode: In this mode, the DP system is in full control of the vessel's position and heading. The system continuously adjusts the thrusters and other manoeuvring equipment to maintain the desired position.

Manual Mode: In this mode, the DP operator takes manual control of one or more of the axes (heading, surge, sway) usually with the joystick as the input device.

Auto track / Auto Sail Modes: In this mode, the DP system is used to maintain the vessel's position and heading during short transits to do specific activities (cable lay etc).

Auto Pilot Mode: the DP can be used to for longer transits typically where only propulsion thrusters are used for forward speed and steering.

In addition to these MTS DP VESSEL DESIGN PHILOSOPHY GUIDELINES (Rev2 - Apr21) offers notes on the following DP modes of operation.

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

This is a feature that facilitates automatic change of position set- points to follow movements of another floating body. Examples of industrial mission which could benefit by this mode are:

1. *ROV tracking inspection work to automatically follow the ROV.*
2. *Positioning alongside a floating object susceptible to movement such as a TLP, Spar, MODU etc.*

   Note: Trials should be carried out prior to using Follow Target mode for operations described in (2) above. This mode requires the use of both absolute and relative position references. But "out of sync" measurements may be experienced in this mode and prevent its use. In such circumstances, positioning can be accomplished by using only redundant relative position reference sensors and conventional set-point auto DP mode.

3. *Functionality of the conventional follow target mode may need to be enhanced for industrial missions where relative positioning is required off targets which exhibit dynamic movements such as free weather-vaning FPSOs. Such functionality may require the provision of additional sensors and sub-modes. The burden of the development of detailed procedures and additional training requirements should not be underestimated.*

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

This is a feature that is used to address potential instability caused by the stiffness imparted to the DP control systems during set down of the load (tonnes per meter offset). Note that the stiffness is related to the weight of the lift and the geometry of the lift height etc. Instability is not only related to mass but also to the vertical height from the end of the upper end of the lifting device to the load touch down point. The smaller the distance the greater the stiffness. For example, a relatively small load on an A frame with a shorter vertical height could result in destabilizing stiffness. There are known instances of A frames being damaged due to side loads imparted by instability. Vessels whose industrial mission includes lifting should evaluate the need to have heavy lift mode.

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

When pipelaying, pulling in SCRs, hook-up of mooring lines etc. horizontal forces are exerted on the vessel. Vessels undertaking industrial missions where such forces can be experienced should be equipped with means for external

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force compensation. Reliance on the DP control system treating such forces as 'learned' environment has and resulted in loss of position incidents with significant consequences.

The input of forces values for external force compensation can be manual or instrumented. Systems designed to provide and accept input from instruments should be subjected to a robust fault tolerant and fault resistant systems engineering approach. Sensible limits should be applied to these inputs to avoid the DP control system responding to erroneous values.

Fire Monitor Compensation Mode: This is used to compensate for the varying forces exerted on vessel from the fire monitors.

DP vessels outfitted with fire-fighting capability as part of its industrial mission should address effects on DP control of forces related to azimuth, elevation and flow of fire nozzle water. If these are not compensated for directly the DP will consider them as an environmental force. Sudden loss of forces associated with water flow can cause a loss of position incident if inadequately compensated for by design.

Weathervane Mode: This enables the DP vessel to rotate with the wind, current and waves. This can be used when a vessel is operating alone, to minimise the thrust to save fuel etc. There are operations where a second vessel is involved (shuttle tanker off loading, etc) and then the DP controls the vessel around a fixed or moving point called the terminal point. Neither the heading nor the position of the DP vessel is fixed. The heading of the vessel is controlled to point towards the terminal point. The position of the vessel is controlled to follow a circle, called the setpoint circle, around the terminal point. This mode is appropriate for connected shuttle tanker/ FPSO operations.

A variant of this feature has also been used on semi-submersible hull forms with a four thruster configuration. This mode allows the vessel to weather vane using one thruster. The thruster is upstream and the vessel 'hangs' downstream due to current, wind, wave. The heading relative to the environment will depend on which thruster is available and the shape of the semi-sub. This is only meant to be a 'last ditch' mode to allow disconnection rather than drift off.

Monohull vessels with a predominantly aft super structure will naturally head into the wind like a weather vane. Similarly, they will tend to head into the current especially where there are high currents. It may be useful to the DP vessel to take advantage of these two effects when permissible by the industrial mission. Vessels that naturally weather vane as described above can be held on position and heading with a single bow azimuth thruster over the set point. This can be a mitigating feature in designs where the number of thrusters is limited and permits the vessel to bring itself to a safe condition post failure.

NOTE: It is not uncommon for the term "weather vane" to be used to denote "minimum thrust", i.e. where the DP control system allows the vessel's heading to rotate to minimize external forces acting on the vessel and thruster requirements. These terms should not be confused.

Shuttle tanker mode: This is a feature provided on DP tankers designed to offload product from offshore floating installations, typically turret moored FPSOs.

This mode is implemented to take advantage of weather-vaning capability of the FPSO and facilitate the industrial mission of the shuttle tanker without the need to provide it with a large transverse thrust capability. Shuttle tankers by design are provided with adequate thrust in the surge axis. Shuttle tanker mode optimizes thrust requirements on the shuttle tanker by allowing some freedom for misalignment with the FPSO.

Fast current update: This may be required for applications where the heading needs to be changed quickly e.g. mono hull MODUs or the direction of the current forces changes quickly. This is not strictly a 'mode' but a feature to update the model faster than normal. Often the DP will initiate the feature if a significant heading change is demanded.

This needs to be used with caution as the natural time constant of the DP loop in systems with model control is about 15 to 20 minutes. This time lag has been acceptable in most situations as a vessel responds slowly and the sea current typically changes slowly (wind compensation is feed forward). Fast current update decreases the time taken to 'learn' about a new situation. It should be recognized that any improper use of fast current update can

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cause instability and other problems. This feature should not be used to compensate for lack of external force compensation mode.

Track follow Mode: There are two types of track follow called Slow and Fast:

1. Slow Track Follow is used where fore/aft, port/stbd and heading are all controlled to keep the vessel on track or a fixed offset from it. This is typically used for pipe laying, SCR installation etc.

2. Fast Track Follow is used where the vessel heading is steered back towards the track. The heading change applied is broadly proportional to the port/stbd offset from the track. This is typically used for cable laying, seismic streamers, etc.

Axis priority select mode: DP control systems are designed by default to give priority to controlling heading when there is insufficient thrust. This is appropriate for monohulls. Such vessels have the potential to lose position more rapidly if thrust is not prioritized to control heading.

Some industrial missions may require priority in another axis. This should be specified during design, for example, vessels intending to operate beam on to a platform as a default.

GPS only operation mode: Nearly all DP vessels use GPS with some form of differential correction to enhance the accuracy of the raw GPS position calculation. This is not normally a 'mode', it requires the operator to reduce the quality checks on the GNSS data. Normally, the DP would look for a digit in the NMEA string indicating that the solution was corrected (either 'Differential' or 'PPP' etc) if this is not the case the fix would normally be rejected and alarmed. It is possible for the user to change this 'test' to allow the use of raw GNSS fixes. Great care should be taken to ensure that this is restored if a subsequent operation is undertaken requiring precise positioning!

*However, raw GPS may be sufficient for use where the industrial mission does **not require precision position accuracy**.*

DP CONTROL MODE SELECTION

The DP mode control selector forms a common point between all thrusters. The design should ensure that a failure cannot cause the control mode to transfer from auto DP to another mode. In addition, accidental change of mode continues to be a cause of DP incidents so good design and careful operation is critical. IMCA M103states

The means by which control over the thrusters is changed from manual to DP to independent joystick (IJS) is a potential weak point in any DP system. No failure of the selector system should prevent manual control.

The control selector forms a common point between all thrusters. The design should ensure that a failure cannot cause the control mode to transfer from auto DP to another mode. For DP equipment class 3 vessels it is important to ensure no single failure of the control selector switch should cause control to transfer unexpectedly to the backup DP system. This can be achieved by having a separate digital communications interface from the control selector to each thruster field station.

Accidental change of mode continues to be a cause of DP incidents. Locating buttons with critical functions close to less critical functions increases the risk of a critical button being accidentally pushed. Good ergonomic design should position critical push buttons where they are unlikely to be operated inadvertently.

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IMO MSC/Circular 1580 states that

*4.1 Before every DP operation, the DP system should be checked according to applicable vessel specific location checklist(s) and other decision support tools such as ASOG in order to make sure that the DP system is functioning correctly **and that the system has been set up for the appropriate mode of operation**.*

IMC M103specifies that there are five types of operational set up checklists that must be carried out.

3.4.5 DP Field Arrival T rials

These checks should be carried out on arrival at the field and conducted outside the 500 metre safety zone. The checks should be repeated when the vessel returns to the field after an absence of more than 24 hours.
The purpose of these checks is to ensure satisfactory operation of the DP system. The checks should include full functional checks of the operation of the thrusters, power generation, auto DP and independent joystick (IJS) and manual controls. The checks also ensure that the DP system is set up correctly and that the manning is adequate.

See also IMCA Information Note No. 1628 – December 2022 Field Arrival Trials

3.4.6 DP Location Set-up Checklist

These checks should be carried out at every working location and may be used as a routine checklist. Where the vessel is to visit a number of offshore installations on a voyage then these checks should be carried out every time the vessel changes from transit mode to auto DP mode.
The purpose of these checks is to ensure that the vessel's station keeping performance at the working location is satisfactory and, in particular, to ensure that the position reference systems are properly set up. The checks also provide a hard copy record of power and propulsion demands and DP control parameters.

Vessel heading should also be adopted at this time to ensure that thruster loads will be acceptable on the working heading and location. The initial stabilisation period should be at least 30 minutes, subsequent periods of stabilisation following moves and heading changes should be determined by the circumstances and conditions. The initial stabilisation period may be reduced to less than 30 minutes where it can be demonstrated that this will not have a detrimental effect on DP model and position keeping dependability, the risk profile of the activity should be considered.

3.4.7 Change of Watch Checklist

The change of watch checklist should include all checks necessary to confirm the status of essential DP equipment and to complete a routine check of the performance and settings of that equipment. The DP sections of this checklist should be completed again following any substantial reconfiguring of essential DP equipment during the watch. The oncoming DPO should verify the contents of this checklist prior to starting the DP watch.

3.4.8 DP Engine Room Check list

Before the vessel approaches within 500 metres of the work site or when requested by the DPO on watch an engine room readiness for DP operations checklist should be completed by the engineer on watch. The purpose of this checklist is to ensure that the engine room systems and equipment are set up correctly for DP with the correct redundancy and the appropriate equipment and switchboard configuration. Appropriate DP checks are additionally to be incorporated within the engine room change of watch checklist.

3.4.9 500m Zone Safety Checklist

These checks should be carried out each time before the vessel comes within 500 metres of any offshore installation.
The purpose of these checks is to ensure satisfactory operation of the DP system. The checks should also confirm that the DP system is set up correctly and that the manning is adequate and that the vessel has communicated with the installation and been given permission to enter the 500m zone.

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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	

FIGURE 53 - MSF 182 Contains a Sample Watch Keeping Handover Checklist (Part 1)

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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																		

FIGURE 54 - MSF 182 Contains a Sample Watch Keeping Handover Checklist (Part 2)

In addition to these MTS DP Operations Guidance - Part 1 adds

DP Field Move Checks

These checks are particularly relevant to DP MODUs and drillships where moves are of short duration and take place inside the field. These checks are less intensive than Field Arrival checks since the rig remains on DP with BOP suspended. The checks ensure the DP system remains fit for purpose.

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500m Checks

500m checks are not normally applicable to DP MODUs. All OSVs and other vessels should undertake 500m checks. Only vessels engaged in support activities to remain within the 500m zone of the DP MODU. The 500m zone is not to be used as a standby location unless required to support a specific activity.

Watch Status/ 6 Hour Checklist

The purpose of these checks is to record the status of the DP system and configuration. The checks should verify that the vessel's station keeping performance at the working location is satisfactory and, in particular, that the position reference systems are properly set up and operating satisfactorily. No testing is carried out for these checks. DPOs should complete the checklist prior to taking over the watch, not during the first few minutes of the watch.

The Marine Safety Forum have issue a document called Marine Operations: 500m Safety Zone that offers some practical advice on set up and operating in the 500m zone under these headings; approach passage & pre-entry; approach (500m - 200m approx.); position set-up; final approach (200m approx. - working position) & alongside working; exiting safety zone. We recommend that you read this document in full but a visual overview has been provided here for you

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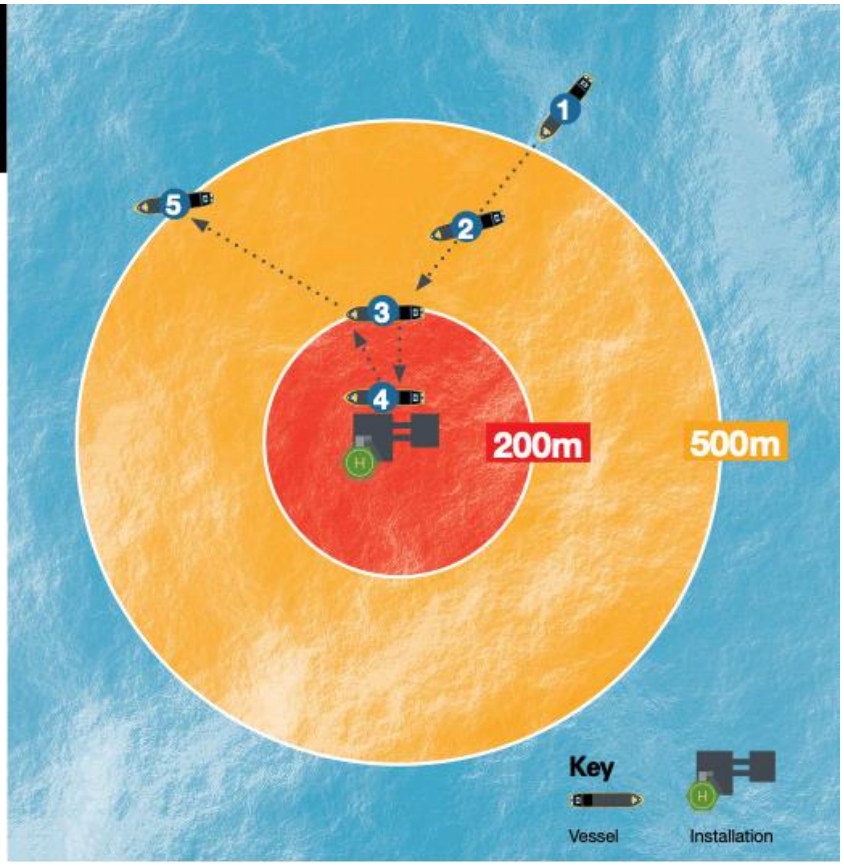
STEP CHANGE IN SAFETY

Produced in association with

MARINE Safety Forum

MARINE OPERATIONS 500M SAFETY ZONE

Pre-Entry > Set up > Working > Exit



1 Approach passage & pre-entry

- Vessel passage plans must not have installations as waypoints. Final waypoint must be offset from the installation
- Establish contact and ensure that radio-working channels are understood
- Pre-entry checks to be carried out in a drift off situation testing interaction / communications with installation. Determine who (on the installation) is responsible for maintaining contact with the vessel
- Should control of the vessel be transferred to another station (e.g. fwd to aft) or a different operating mode is selected (e.g. manual to full DP) then it should be ensured that all manoeuvring arrangements are responding as anticipated before undertaking any close proximity operations
- Discuss the planned approach and proposed work
- Any installation delays expected? Bulk transfer permits? Weather side working risk assessment? Installation staff availability? Notify vessel if any overboard discharges from the installation could affect operations
- DP reference system targets in correct position and ready (reflectors clean etc)
- Identify and set trigger and hold points which determine operation start/stop/hold or prompt a risk assessment or risk assessment review
- Vessel to confirm to installation once ready to enter safety zone

Only once the installation is fully satisfied that the vessel has undertaken the necessary pre-entry checks and that the work plan minimises the length of time the vessel will be required to be in close proximity to the installation should permission to enter the safety zone and proceed to the set-up location be given.

If it has been identified that working in a drift on condition will be required then, **before** permission to enter the 500m safety zone is given, a risk assessment must be undertaken by both the vessel and the installation, mitigations put in place as required and agreement between the OIM and Vessel Master made before allowing operations to be undertaken.

2 Approach (500m - 200m approx.)

Approach and work alongside installation to be made in the same mode as tested during pre-entry process. Should 'mode of operation' or control station be changed then the full range of system checks should be undertaken again to ensure that systems are operating correctly.

A correct approach should have the vessel coming alongside obliquely. The vessel should not approach head on.

- Speed to be 3 knots or less, depending on the vessel type and weather conditions
- Escape routes identified

The faster the vessel comes in the harder it could hit the installation!

3 Position set-up

This is the process whereby vessel personnel determine how adequately the vessel is managing to hold position before starting the final approach. This should be done far enough away so that, if something goes wrong, the vessel crew have enough time to take corrective action.

It can take some time to acquire a stable position and allow a DP model to build up (up to 30mins)

Position set-up to take place well away from the installation (position such that installation collision avoided if equipment failure occurs during set up checks)

- 1½ x vessel length for drift-off operations
- 2½ x vessel length for drift-on operations

During this time the vessel personnel are to satisfy themselves that:

- DP references and sensors are stable
- Vessel motion is within operational limits
- Vessel machinery operation within limits i.e. power utilisation not greater than 45%

4 Final approach (200m approx. - working position) & alongside working

Once satisfactory set-up checks are complete and permission has been given by the installation to move to the working location, the vessel should be manoeuvred towards the installation in incremental steps (circa 10m) at a time using progressively smaller steps.

If the operation is going to involve working in a 'drift-on' condition, then a joint (installation and vessel) risk assessment must be undertaken.

- Speed ≈ 0.5kts (0.3m/s)
- Minimum separation distances to be maintained

5 Exiting safety zone

Once operations are complete and the vessel is ready to depart the safety zone the following should occur:

- Confirm manifests / DG notes all on-board
- Hose(s) disconnected and clear
- Deck secure (sea fastened) for transit
- Vessel secure
- Move to set-up position
- Depart safety zone in a controlled manner following recommended speeds as per entry process
- Transfer controls once outside safety zone
- Once outside safety zone vessel to obtain instructions (client control etc.)
- Provide ETAs for next location

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FIGURE 55 - MSF - MARINE OPERATIONS: 500M SAFETY ZONE

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IMO MSC/Circular 1580 states that

Personnel engaged in operating a DP system should have received relevant training and practical experience in accordance with the provisions of the 1978 STCW Convention, as amended, the STCW Code, as amended, and the Guidelines for Dynamic Positioning System (DP) Operator Training (MSC/Circ.738, as amended).

See also STCW

See also IMCA M 117

MTS DP Operations Guidance - Part 1 offers some guidance on manning a DP vessel including the following table.

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

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

FIGURE 56 - MANNING - MTS DP OPERATIONS GUIDANCE - PART 1

In addition it stats that for engineers:

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

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

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

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

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And for ETOs

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

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

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

IMCA M 117 stresses the *importance of good team management* and states that owners/operators and suitable procedures should be put in place as required by the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention on Standards of Training, Certification & Watchkeeping for Seafarers (STCW) Code. It also states that:

The concept of continuous professional development is to be encouraged for DP bridge and technical personnel.

Interestingly IMCA M 177 states

If the DPO does not form part of the navigational watch, then they need not have a navigational watchkeeping qualification to current STCW Convention standard or flag state equivalent (this enables engineers and DP electrical and electronics technicians to be DPOs).

And not many people know that! IMA M 177 does offer some guidance on the amount of time (or experience) DP key personnel should have and they acknowledge that when a vessel changes owners and/or operators, or is deployed in a new area, it may be difficult to crew the vessel with adequately experienced DP personnel.

	Previous DP Vessel		Current DP Vessel	
Key DP Personnel	**DP Hours**	**Weeks onboard**	**DP Hours**	**Weeks onboard**
Master/OIM	250	10	100	4
Senior DPO	250	10	150	2
DPO	150	3	50	1
Chief Engineer	250	10	100	4
Senior Engineer Watchkeeper	100	4	50	2
Engineer Watchkeeper	50	2	50	2
DP Electrical and Electronics Technician	250	10	100	4

FIGURE 57 - IMCA 117 - Recommended Minimum Experience on an Established DP Vessel

When joining a new vessel familiarisation is key.

IMCA M 117 Minimum Period of Familiarisation on a Familiar Vessel

A familiar vessel is considered in these guidelines as one that has the same DP control system, or the same type of engines and switchboard configuration and is or has been engaged in similar operations. If the equipment supplier is the same, this will not necessarily mean that the control system is 'familiar' because third and fourth generation DP control systems are likely to be quite different to operate, although the concept of operation may be the same. It can be helpful if vessel owners/operators indicate to clients those systems which are similar within their fleet.

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For new personnel joining a vessel with a familiar control system that carries out critical operations such as diving support, drilling or operations close to installations, there should be a minimum period of familiarisation, as outlined in Table 3. This familiarisation activity should include a structured plan comprising a supervised programme of onboard familiarisation followed by assessment through a company authorised procedure.

Key DP Personnel	Minimum Familiarisation Period	
Master/OIM	24 DP hours	3 days at sea
Senior DPO	24 DP hours	3 days at sea
DPO	24 DP hours	3 days at sea
Chief Engineer	24 DP hours	3 days at sea
Engineer Watchkeepers	24 DP hours	3 days at sea
DP Electrical and Electronics Technician	24 DP hours	3 days at sea

FIGURE 58 - IMCA M 117 Minimum Period of Familiarisation on a Familiar Vessel

Recommended Minimum Experience on a New or Unfamiliar Vessel

A new or unfamiliar vessel is a new or different vessel to some or all of its key DP personnel. Key DP personnel joining a new or unfamiliar vessel should undergo a structured familiarisation programme. Anessentialpartofthisisasupervisedprogrammeofonboardtrainingfollowedbyassessment. A brand new or converted vessel has generally had owner's/operator's acceptance trials as well as commissioning and FMEA trials, all of which may provide an opportunity for key DP personnel to complete assessment tasks and become suitably experienced in less time than when the vessel enters service. The minimum period of familiarisation that has been found to be satisfactory in the past is set out in Table 2.

Where possible, previous DP vessel experience (see section 8.1) and instruction from manufacturers/suppliers is provided onboard during the following time periods or previously at the manufacturers/suppliers' facilities.

Key DP Personnel	Minimum Familiarisation Period	
Master/OIM	50 DP hours	7 days at sea
Senior DPO	50 DP hours	7 days at sea
DPO	50 DP hours	7 days at sea
Chief Engineer	21 days	including 7 at sea
Engineer Watchkeepers	14 days	including 7 at sea
DP Electrical or Electronic Technician	21 days	including 7 at sea

FIGURE 59 - IMCA 117 Minimum Period of Familiarisation on a New or Unfamiliar Vessel

IMCA DP Station Keeping Bulletin 02/19

Unfamiliarity with DP system leads to – DP undesired event

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THE BASICS

Dynamically positioning (DP) vessels have a computer-controlled system that automatically maintains its position and heading in a dynamic seaway by using its own propellers and thrusters.

THE ENVIRONMENT

Vessels in a dynamic seaway experience six degrees of motion, or freedom:

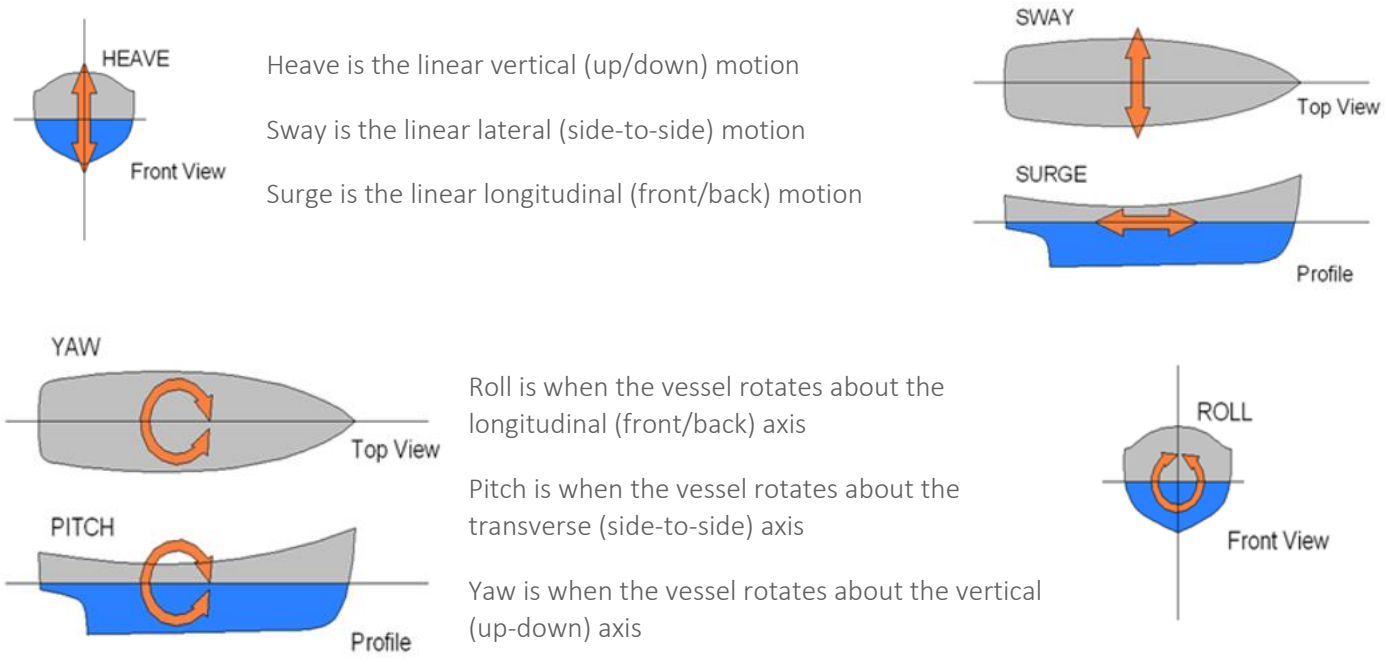

FIGURE 60 - THE VESSEL SIX DEGREES OF FREEDOM

The environment (wind, waves and current) acts on the vessel and creates movement in the 6 degrees described above. We know that the DP attempts to control Yaw, surge and sway. The vessel responds mostly due to waves in pitch, roll and heave.

For every DP vessel there is a maximum environment it can theoretically hold surge, sway and yaw (in its degraded state!)

There is one thing that can be relied upon and that is the environment will change! A critical part of the DPOs responsibilities is to monitor the environment with respect to thruster and engine loading. Predicting when the environment may cause problems is a judgement that come with experience, and it is far from theoretical.

In large wave conditions the smaller vessels, when they pitch the fwd tunnel thrusters come close to coming out of the water, and in that condition at that moment the thrust will be minimal.

One issue is the DP ability to hold heading and position well enough for the industrial mission to proceed safely. The other is with the current/wind/vessel motion can the industrial mission be performed (deck movement, lifting wind speed, sea current for divers etc). These decisions are not solely the responsibility of the DPO.

If the mission has to be paused it is vital that the time to terminate is clear to all (ASOG etc). Some can be terminated quickly (PSV deck lifts) while others take more time (pipelay abandon, ROV retrieval from deep water etc)

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If the mission allows, changing heading relative to wave direction may help with roll/pitch etc

It is clear that being aware of published weather bulletins is vital, but some areas have rip tides local squalls etc and other challenges that are sometimes only observed by the crew.

At the other extreme if the environment is very benign the thruster loads may become small relative to the engine capacity, thruster bias modes may need to be adjusted. In such conditions heading may not be critical, but if the environment were to build it may be critical to change to an appropriate heading which may need the agreement of the industrial mission teams and may take time. Be prepared.

Unrelated to 'forces' are aspects of the environment such as snow, fog etc some of these can have an effect on the Position reference systems and some to the safety of the operation.

Some operations close to production units may mean that the crew has to be aware of contamination of the environment in terms of combustible gas etc. This would normally be part of the Risk assessment carried pout prior to the operation.

Most DP systems have an 'on line' capability plot function where the prospective environment can be 'tested' in terms of station keeping forces.

THE VESSSEL

Position reference sensors, combined with wind sensors, motion sensors and gyrocompasses, provide information to the computer about to the vessel's position, heading and the magnitude and direction of environmental forces affecting its position. These are all discussed in depth later.

The computer program contains a mathematical model of the vessel that includes information about the wind (above waterline) and underwater profiles of the vessel and the location of the thrusters. The mathematical model is adaptive, that is, it will 'learn' and continuously adapt to changes in the vessel or environment.

This knowledge, combined with the sensor information, allows the computer to calculate the required steering angle and thrust output for each thruster.

IMO MSC/Circular 1580 defines an a DP system as:

> *1.2.11 Dynamic Positioning system (DP system) means the complete installation necessary for dynamically positioning a vessel comprising, but not limited to, the following sub-systems:*
>
> *.1 power system;*
> *.2 thruster system; and*
> *.3 DP control system.*

and a DP control system as:

> *1.2.10 Dynamic Positioning control system (DP control system) means all control components and systems, hardware and software necessary to dynamically position the vessel. The DP control system consists of the following:*
>
> *.1 computer system/joystick system;*
> *.2 sensor system(s);*
> *.3 control stations and display system (operator panels);*
> *.4 position reference system(s);*
> *.5 associated cabling and cable routeing; and*
> *.6 networks.*

Below is a simple DP architecture diagram. The number, location, and configuration of the DP system components determines the vessels DP equipment class and its redundancy. This will be discussed later.

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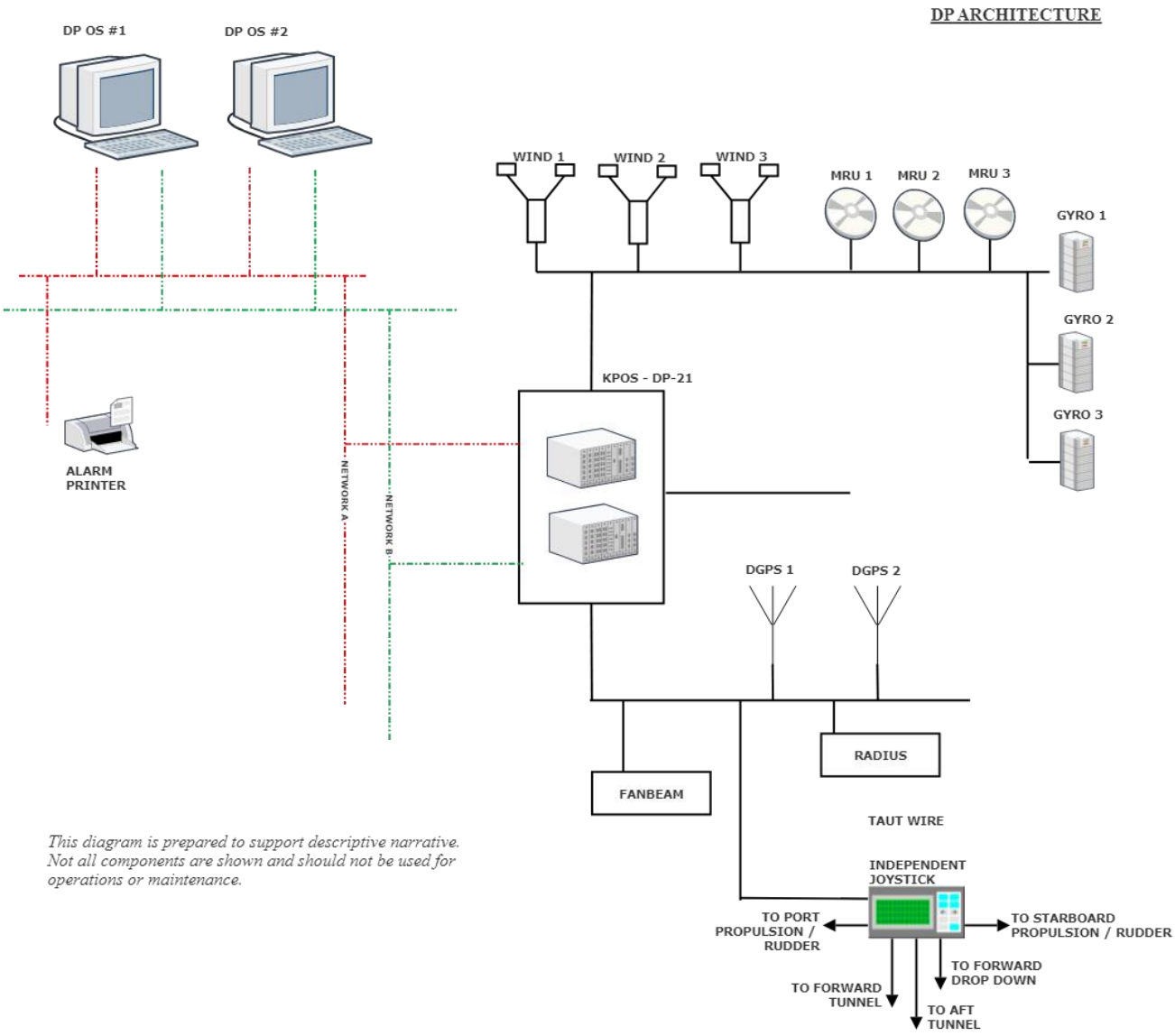

FIGURE 61 - Simplified DP Architecture

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DP OPERATIONS MANUAL

There is no single standard that addresses the development of a DP Operations Manual.

However, the importance of providing effective and unambiguous guidance to vessel operational teams has been acknowledged, especially given the demographics of the vessel operational teams, the dilution of skills prevalent in industry and limited experience in the conduct of the industrial mission.

TECHNICAL AND OPERATIONAL GUIDANCE (TECHOP) TECHOP (O-01 - Rev1 - Jan21) DP OPERATIONS MANUAL JANUARY 2021 offers the most comprehensive guidance on what should be in a DP Ops Manual. It states that the DP Operations Manual should contain relevant information on:

- *Company policies and procedures.*
- *Vessel specific information with emphasis on:*
- *The redundancy concept of the vessel.*
- *The configuration that achieves the highest level of integrity of the power plant and station keeping critical equipment (Critical Activity Mode – CAM).*
- *Alternate configurations (Task Appropriate Mode) that may be used.*
- *The process that is in place to identify operations that must be operated in CAM and those operations that can be operated in TAM.*
- *The processes that are in place to protect and defend the redundancy concept.*
- *The necessary training and drills required to be carried by the personnel tasked with delivery of DP operations.*
- *Industrial mission specific information.*

Usefully MTS have created a gap analysis tool in this TechOp so you can compare your DP operations manual with the requirements listed above.

IMCA M 109 A Guide to DP Related Documentation for DP Vessels Rev 3.1 October 2020 also offers a structure that the DP operations manual should follow. We recommend you access this document.

PRACTICAL ONBOARD EXERCISE

Find your vessel DP operations manual. Does it contain the chapters as outlined above. Are they in a user friendly format?

ABOVE AND BEYOND

Complete the gap analysis tool in TECHNICAL AND OPERATIONAL GUIDANCE (TECHOP) TECHOP (O-01 - Rev1 - Jan21) DP OPERATIONS MANUAL JANUARY 2021 for your current vessels DP operations manual

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DP LOGS AND CHECKLISTS

See also DP Set Up Procedures

PURPOSE, OVERVIEW OF EXPECTATIONS / REQUIREMENTS

IMCA M 109 A Guide to DP Related Documentation for DP Vessels Rev 3.1 October 2020 suggests a list of DP related logs that should be kept onboard such as:

- *DP log describing times and dates of various DP operations, such as, for example:*
  - *vessel going into DP*
  - *diving or other operations requiring DP, for example:*
    - *times of diving bells leaving surface and reaching working depth*
    - *times of divers leaving/entering diving bell and reaching/leaving worksite*
    - *instructions that were received from dive/subsea operation control*
  - *other relevant activities depending on type of operation (for example as listed in 4.3)*
  - *key DP personnel coming on/going off shift*
  - *faults occurring in DP system(s)*
  - *times and details of connecting lines to installations;*
- *DP hours log with running total of time spent in DP;*
- *DP operator logbook which should give running total of time operator spends on DP operations (see for example the IMCA DP logbook);*
- *All data logging devices relevant to the DP operation including electronic, video, voice tape and any other.*

The following should also be available and kept up to date:

a file with a history of all relevant DP trials carried out on the vessel;

- a file with the results and recommendations of audits carried out on the vessel;
- a file of verifying footprints for the vessel. these should be checked occasionally against the capability plots to ensure they are accurate;
- a file with relevant drift trial data, verification of drift trial software;
- a file with the CVs of the key DP personnel;
- vessel DP familiarisation and training records;
- a maintenance file with records of all maintenance, including service reports, FMEA studies and modifications carried out on the DP system and related equipment including sensors;
- records of engine and thruster operating hours; records of engine and thruster lube oil and fuel oil analysis;
- records of power switchboard maintenance;
- records of communications systems maintenance.

IMCA M103includes a table of all the DP documenting you should have onboard.

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CAPABILITY PLOTS AND FOOTPRINT PLOTS

CAPABILITY PLOTS

See section Capability Plots

Whilst the published Capability plots are required by class etc, they are of limited value to the DPO in the day to day operations. They are a very specific set of conditions, as they are really designed to compare vessel A with vessel B, and tend to be optimistic, looking for the 'biggest numbers'.

The DPO has the wind, wave, current magnitudes and directions on that day in that location. An indication of capability will be the thruster loads being used. This also allows an assessment of what the surviving thruster would run at if a WCF occurred.

The on-line capability can be useful to impose the WCF and to apply any predicted weather change.

FOOTPRINT PLOTS

The calculated position keeping capabilities which are provided by the DP capability analysis should be supplemented by real time measurements and observations. These real time observations and measurements are used to develop DP footprint plots.

DP footprint plots measure the vessel's real station keeping performance (accuracy) in specific equipment configurators and environmental conditions. They determine the vessel's actual position keeping ability in various thruster configurations and environmental conditions and can be used for comparison with DP capability plots.

DP OPERATIONS GUIDANCE - PART 1 (Rev3 - Apr21) state that DP Footprint Plots are

> *constructed, by observation onboard the vessel in real time conditions. The plots are of the vessel's DP station keeping performance and limitations in various environmental conditions (wind, seastate and current) and in various thruster/ power configurations, including all thrusters running, loss of most effective thruster and after worst case failure.*
>
> ***DP FOOTPRINT PLOTS***
>
> *4.5.1 DP Footprint Plots should also be produced on board. DP Footprint Plots are not theoretical. They are actual measurements of the vessel's DP station keeping performance in the actual environmental conditions and thruster configuration at the time the plot was taken. DP Footprint Plots should be taken whenever opportunities arise, such as during standby periods, weather downtime or on arrival at the field. Plots should be taken for the thruster configurations used in the DP Capability Plots, i.e. fully intact, loss of most effective thruster(s) and after worst case failure.*
>
> *4.5.2 Some DP systems have a software application that produces DP Footprint Plots electronically. DPOs can also produce DP Footprint Plots by manual methods using a plotting sheet.*
>
> *4.5.3 DP Footprint Plots serve two main purposes.*
>
> - *They provide a scatter plot of vessel positions at regular intervals around the required set position (this shows accuracy of station keeping)*
> - *They also provide comparison points on the limiting wind speed envelope given in the theoretical DP Capability Plots (this shows wind speeds at which it was seen that the vessel was unable to maintain position, thus validating or contradicting the theoretical DP Capability Plots for the various thruster configurations.)*
>
> *4.5.4 DP Footprint Plots serve other purposes, including learning and familiarisation opportunities for DPOs and in providing snapshots of vessel station keeping behaviour for specific locations and activities.*

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

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

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

MSF 182 offers guidance for conducting DP footprint plots as follows

A DP footprint plot is designed to record the observed movement of the DP vessel from its desired target location over a period of time. 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 and the desired or target position is at the centre of the circle.

- *Select a safe location away from structures, other vessels, etc.;*
- *Make entries on the lines in the top right hand corner, identifying when, where and by whom;*
- *Indicate in the vessel outline which of the thrusters is selected and on line for the duration of the plot;*
- *Complete the environment boxes, putting a value against all of the forces and directions. Draw arrows on the plotting chart to indicate force and direction. Note that values for current should preferably be from an independent current meter. If not available, estimates for current from other appropriate sources include surface current charts and the DP estimated current;*

Indicate which of the position references are on line for the duration of the plot;

Select the concentric scale. One division could equal 1 metre, so that the total scale extends to 5 metres from the centre, or, if more vessel movement is expected, one division could equal 2 metres, hence increasing the total range to 10 metres from the centre;

Start plotting by marking with an X at regular intervals, say every 30 seconds, the observed position of the vessel in relation to the target position. The vessel's position can be taken from the DP system display screen;

Continue plotting until sufficient information is gained about the vessel's position keeping performance in the given environmental conditions. A completed plot will show the accuracy with which the vessel kept position. Plots can also show the occasions when the vessel is unable to keep position, i.e. when there is insufficient thruster force for the given 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 the 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 maximum environmental conditions in which a DP vessel should not lose position.

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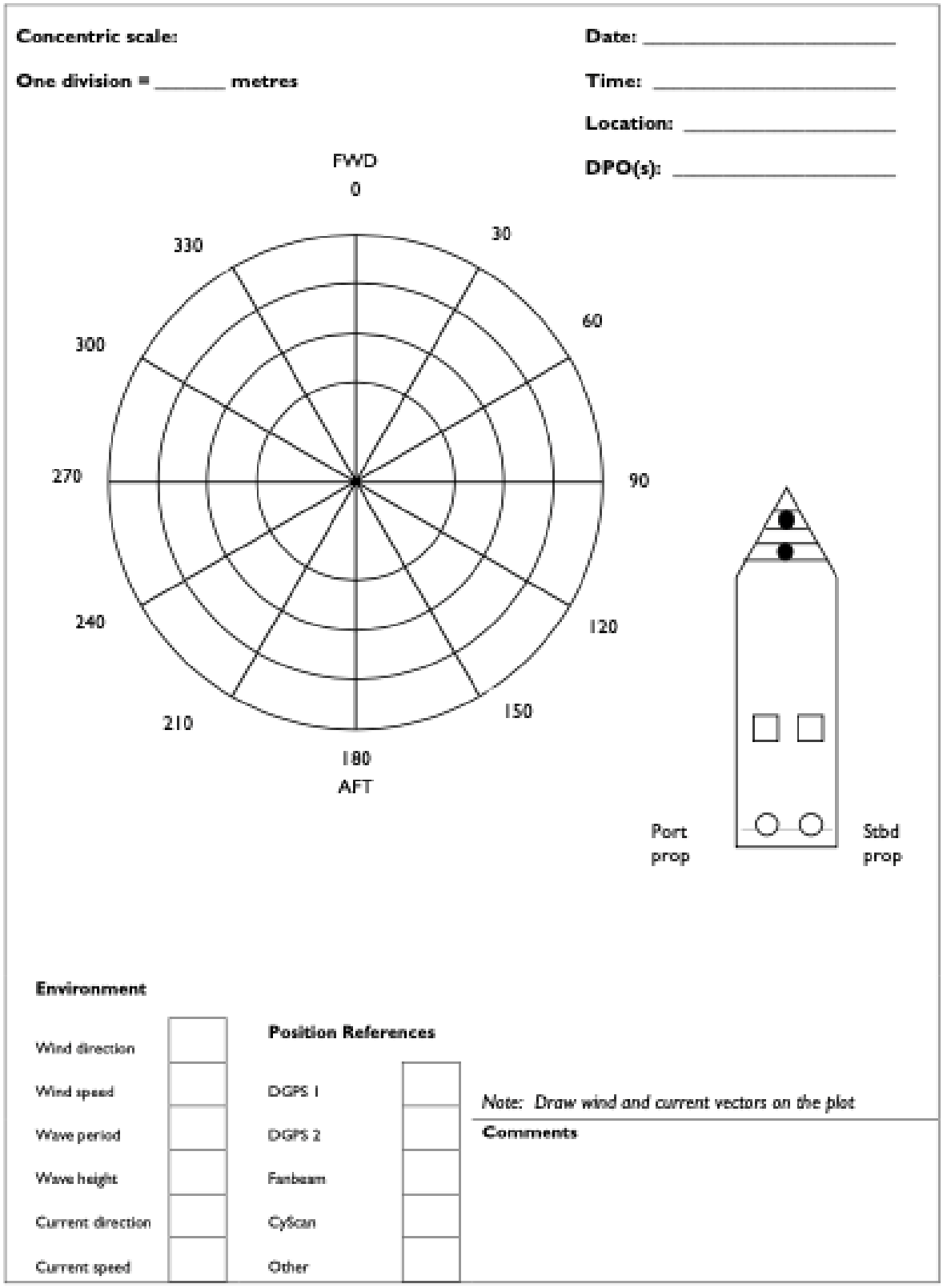

FIGURE 62 - TEMPLATE International Guidelines for the Safe Operation of Dynamically Positioned Offshore Supply Vessels

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CONSIDERATIONS FOR SIMULTANEOUS OPERATIONS INVOLVING DP AND NON-DP VESSELS

SIMOPS (simultaneous operations) are described as the potential clash of activities which could bring about an undesired event or set of circumstances, e.g. safety, environment, damage to assets, schedule, commercial, financial etc.

SIMOPS occur in marine operational activities associated with offshore operations in support of offshore exploration and production. SIMOPS are defined as performing two or more operations concurrently.

These activities typically include, but are not limited to, the following:

- A vessel undertaking a non-routine operation within an installation's 500m zone.
- Subsea umbilical's, risers and flowlines (SURF) operations.
- Field developments with multi-vessel/contractor operations.

Vessels include, for example, diving support vessels, heavy lift vessels, supply boats, barges, pipelay and cable lay, accommodation, seismic, survey, ROV vessels, and vessels operating in dynamic positioning mode. Installations cover, for example, fixed and floating production platforms, drilling rigs, DP production units, FPSOs and FPUs. SIMOPS often involve multiple companies (owners, contractors, subcontractors, vendors), large multi-disciplined workforces and a wide range of daily, 24-hour, routine and non-routine construction and commissioning activities.

It is important that SIMOPS are identified at an early stage before the work commences. SI MOPS may come about as the result of the following issues:

Schedule clashes, e.g. activities in same area at same time.

- Physical clashes, e.g. anchor patterns, loss of position.
- Failure impacts, e.g. explosions, leakage, gas etc.;
- Interference between platform operations and vessel operations;
- Contracts and third party interfaces, e.g. liabilities, risk/insurance;
- Environmental impacts, e.g. currents, icebergs, weather limitations;
- Territorial clashes, e.g. 500m zone, existing infrastructure;
- Any other combined/simultaneous activity in the area of operation which could compromise project success criteria.

IMCA have issued IIMCA M 203 Guidance on simultaneous operations (SIMOPS) and we recommend you read it. Below is an extract showing the life cycle model for SIMOPS.

DP Event Bulletin	ITEMS
DP Event Bulletin 01/22 – April 2022	Case Study – Masking of PRSs – SIMOPS

MTS Paper on SimOps

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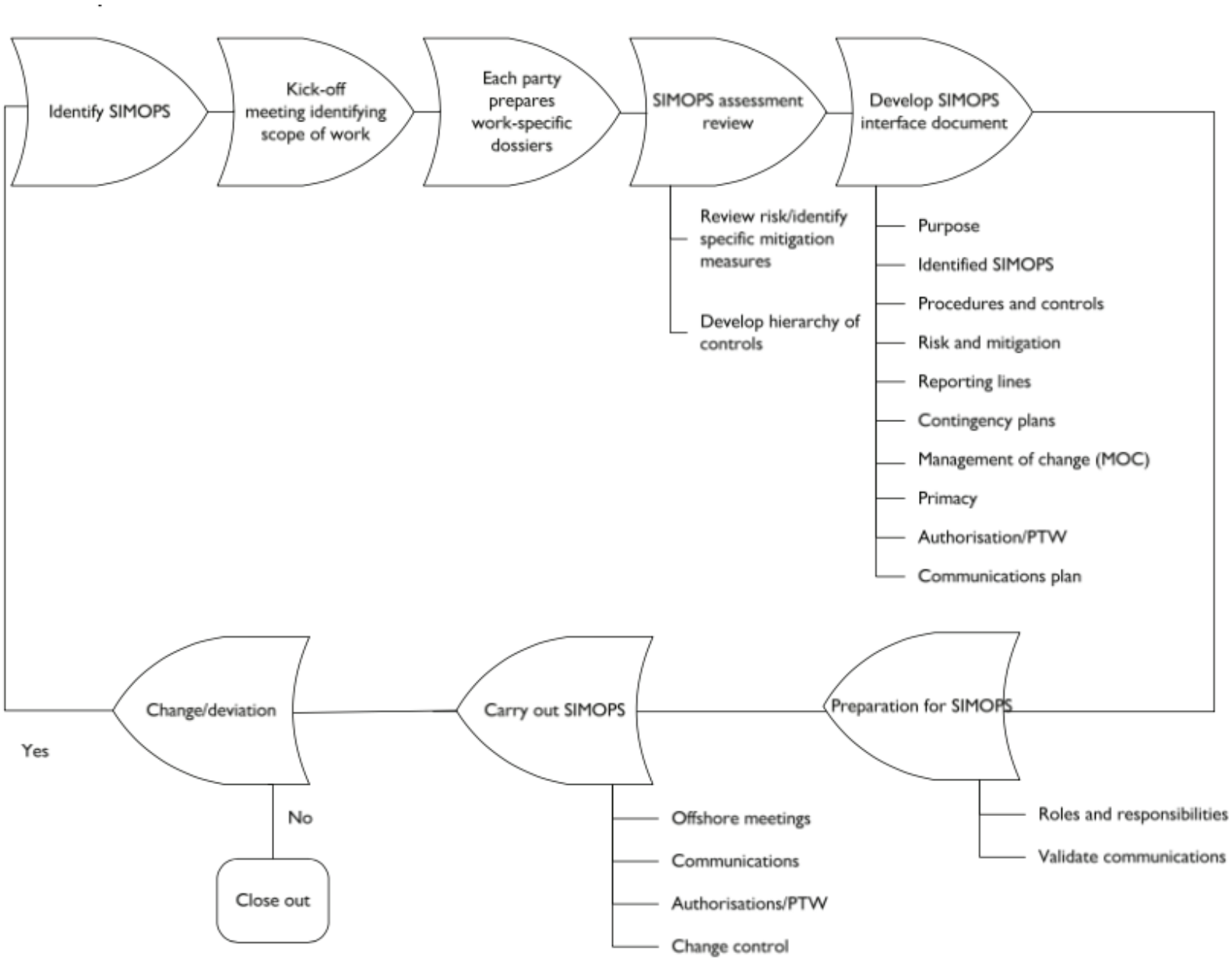

Figure 63 - SimOps flow diagram

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Of particular use to the DP vessel crew, deck and engineering officers is the section 4.7 of that document that emphasises the role of communications between interested parties including the PIC, the person-in-charge or controlling authority or entity directing field operations.

- *Once the SIMOPS has started, it is important that there is regular communication between all involved parties.*
- *Daily Meetings During the whole duration of the SIMOPS work, a daily conference call (or meeting if feasible) should be held between the representatives of the involved parties to review the progress of the current SIMOPS activity and to organise the planning and safety of the remaining work.*
- *Regular Communications During the SIMOPS the communications plan identified in the SIMOPS interface document should be followed. Regular checks should be made and documented between vessels in the 500m zone. During certain critical activities it may be desirable to initiate continuous, real-time communications, either two-way or by one vessel describing the operation and the others listening. The communications plan should have identified the preferred means of continuous communications to ensure that important information is received and directed to the appropriate person or PIC*

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