The following case studies and observations have been compiled from information received by IMCA. All vessel, client, and operational data has been removed from the narrative to ensure anonymity. Case studies are not intended as guidance on the safe conduct of operations, but rather to assist vessel managers, DP operators and DP technical crew in appropriately determining how to safely conduct their own operations. Any queries should be directed to IMCA at dpreports@imca-int.com. Members and non-members alike are welcome to contact IMCA if they have experienced DP events which can be shared anonymously with the DP industry.

List of DP Events

1 Position Reference Problems again! – Dangers of recalibrating

1.1 Overview

A diving vessel was operating in approximately 25m of water depth. Four Position Reference Systems (PRSs) were in use, two DGNSS & two HPRs, weighting of the PRSs was equal for all four selected into DP Control.

The vessel was asked to make a series of moves, during this time the HPR references both began to drift in the opposite direction to the two DGNSSs, thruster activity increased.

The DPO on duty decided to re-calibrate DGNSS#1, in doing so deselected DGNSS#1 from DP Control. This resulted in a greater weighting being applied to the HPRs. This caused the vessel to drive off position in favour of the HPR position referencing. Over the next 40 minutes, all PRSs were re-calibrated resulting in a 40m position loss.

1.2 What Happened?

DGNSS#2 was under-weighted when DGNSS#1 was deselected – consequently the DP model relied on the flawed HPR positions.

Every time a PRS was recalibrated, it created a new origin for that reference, effectively walking the vessel away from the original set point. Original equipment manufacturer (OEM) operator manuals should be consulted as they hold a wealth of information which is often overlooked.

According to the OEM investigation report, water column conditions and reflections contributed to bad position data from the HPRs.

1.3 Conclusion

Shallow water environments pose specific challenges for hydroacoustic systems due to factors like multipath interference, reverberation, surface and bottom reflections, sound speed variability, ambient noise, and sedimentation. Addressing these issues requires a combination of advanced technology, adaptive strategies, and a thorough understanding of the local marine environment.

The choice of PRS (specifically hydroacoustic) was not suitable for 25 m of water depth in this case. The crew should be aware that the reliability of HPR in such shallow water can be significantly degraded. The transducer head and the transponder head on the seafloor may also not have sufficient vertical separation. An alternative option may have been the use of Taut-wire. It is noted that the vessel was fitted with two lightweight Taut-wire systems.

Many DP event reports involving "PRS recalibration" have been sent to IMCA in the past. This is often one of the most misunderstood tasks a DPO can perform. No matter what type, the first PRS that the DP controller enables and accepts establishes the "reference origin" or the origin in the internal coordinate system. The "reference origin" is shown in relation to subsequent PRSs that are enabled. To recalibrate the "reference origin" all PRSs must be disabled, and the first PRS enabled will determine the new "reference origin". In theory, every "recalibration of the reference origin" will result in a change in the vessel's geographical position.

OEM operator manuals contain a wealth of information which will aid the operator. Further bridge exercises and drills are encouraged with an emphasis on loss or degraded PRSs. The ramifications of recalibrating the reference origin must be thoroughly comprehended.

2 Follow the ASOG – It's there for a reason

2.1 Overview

A DP vessel was conducting remotely operated vehicle (ROV) operations beside an oil platform. As this was a Critical Activity Mode (CAM), the vessel was operating a split bus with two generators connected to each switchboard.

One of the generators connected to the port switchboard failed and tripped, there was no effect on vessel station keeping and the remaining connected generator was able to accept the extra load transferred. However, the vessel was operating in a degraded mode and the risk of worst-case failure was greater.

Per the ASOG, the vessel moved to a yellow alert level, the ROV was called back to its Tether Management System (TMS) and the vessel started to move in a controlled manner away from the platform.

Shortly after, and before the vessel left the 500m zone, the port redundant group blacked out, this equalled the Worst Case Failure Design Intent (WCFDI).

2.2 Operational Setup

Vessel Configuration: The vessel was operating in a split bus configuration, a standard practice in DP operations to enhance electrical redundancy and reliability. This set-up involved two generators connected to separate switchboards (port and starboard).

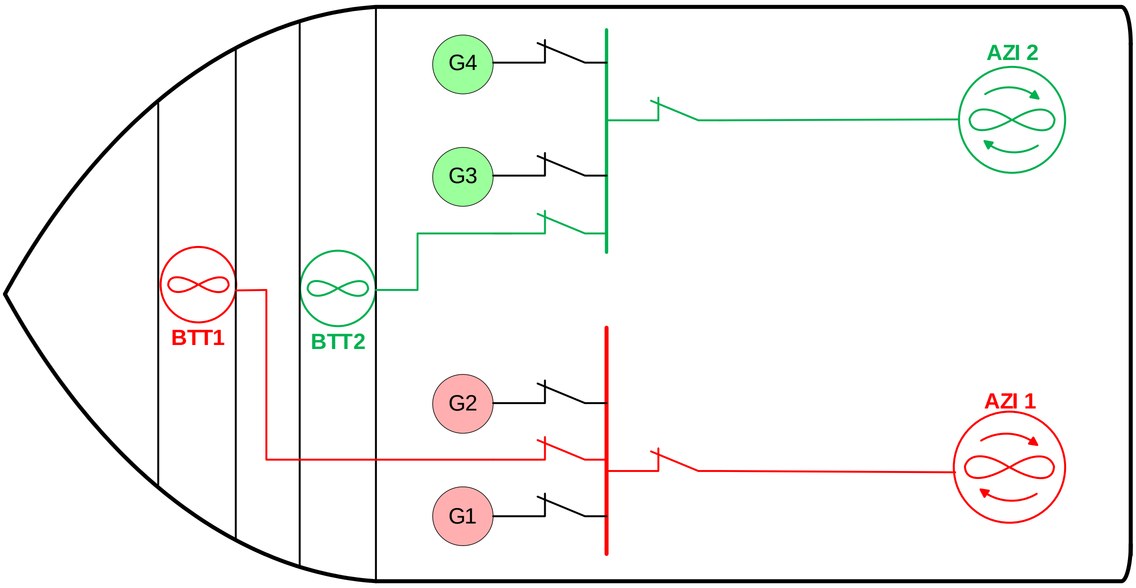

Figure 2-1 Power Configuration Prior to Event

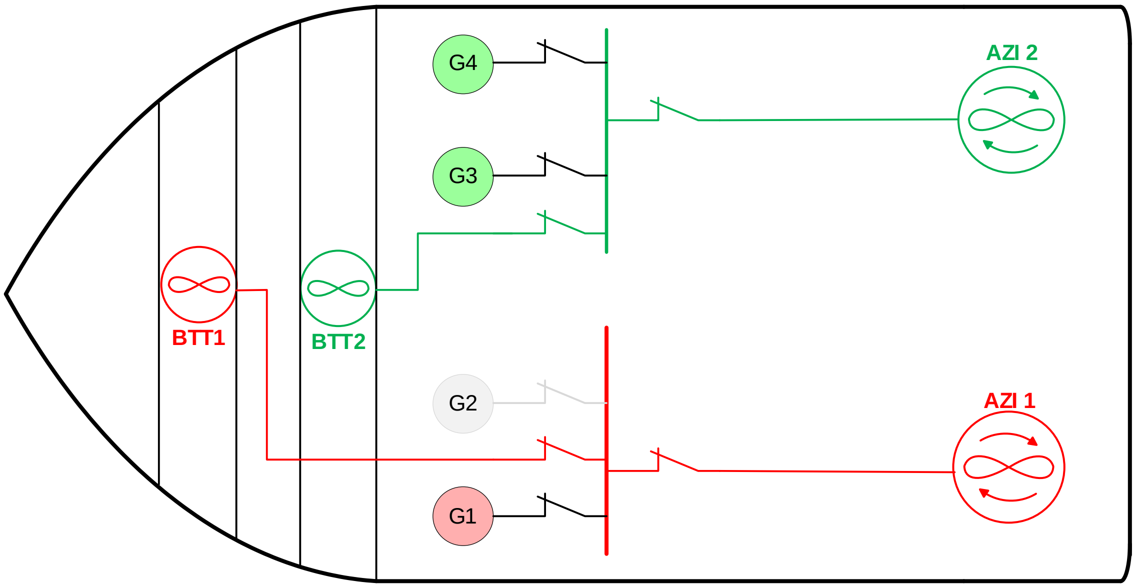

Figure 2-2 Power Configuration Following Initial Failure of G2

The primary operation involved ROV deployment for subsea tasks adjacent to the oil platform, classified as a Critical Activity Mode (CAM) due to the proximity to the platform and the nature of the operations.

2.3 Incident Overview

Initial Generator Failure: During operations, one of the generators connected to the port switchboard experienced a failure and subsequent trip. This incident posed a potential risk to the vessel's DP capability and, by extension, to the ROV operations and the nearby oil platform.

Immediate Response and System Resilience: The vessel's DP system demonstrated resilience through redundancy. The remaining generator on the port switchboard successfully accepted the additional load, ensuring no immediate impact on the vessel's station-keeping ability.

Procedural Response: Shift to Yellow Level: In accordance with the Activity Specific Operating Guidelines (ASOG), the vessel's operational status was changed to a 'yellow level'. This change in status indicated a heightened awareness and a move towards conservative operational measures.

ROV Recall: As a precaution, the ROV was ordered to return to its TMS, signalling a temporary halt to subsea operations.

Vessel Repositioning: The vessel commenced manoeuvres to move away from the oil platform, reducing the risk of any potential impact due to the compromised redundancy in its power generation and distribution system.

Secondary Incident: Port Redundant Group Blackout: In a subsequent development, the port redundant group experienced a complete blackout. This incident occurred before the vessel exited the 500m safety zone around the platform.

Worst Case Failure Design Intent (WCFDI): The partial blackout represented a scenario equivalent to the WCFDI, a critical threshold in DP operations. This scenario envisages the most severe failure the DP system is designed to withstand while maintaining position.

2.4 What Happened

After the generator failed, the vessel technical staff initiated the fault-finding process and, or so they believed, discovered the issue without delay. They attempted to reconnect the generator after incorrectly concluding that they had identified the problem – however, doing so resulted in a voltage spike on the main switchboard, which subsequently caused a complete blackout of that switchboard.

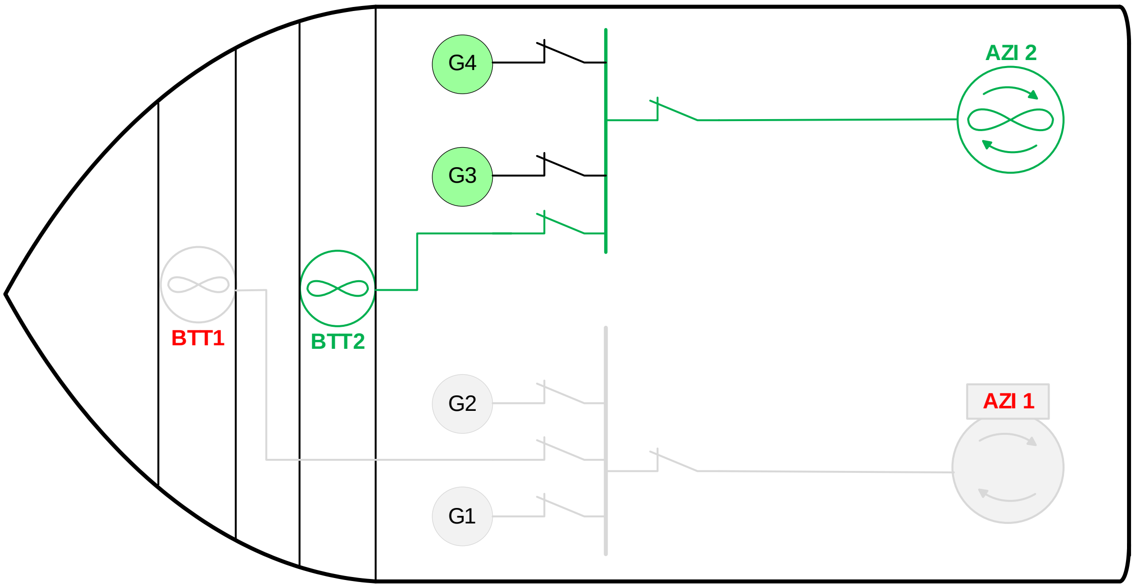

Figure 2-3 Power configuration after attempting to re-connect G2

2.5 Conclusion

This incident underscores the importance of robust DP system design and the efficacy of procedural responses in managing unexpected failures. Key takeaways include:

- The impact of attaining a Yellow alert status in the ASOG was defeated when the technical staff of the vessel bypassed the ASOG and re-established the generator connection. It was unequivocally stated by the ASOG that machinery should not be reinstated until the vessel was in a safe position or status, which effectively meant being outside the 500m zone.
- **System Resilience**: The ability of the remaining generator to assume additional load highlights the importance of designing DP systems with adequate redundancy and load-sharing capabilities, and, operating the DP system within its designed capability.
- **Need for Continuous Monitoring**: Continuous monitoring and regular maintenance of all critical systems, especially power generation and distribution in DP vessels, are essential to prevent such incidents.
- **Training and Preparedness**: Regular training and drills for vessel crews on managing such emergencies are crucial for ensuring safety during critical operations like ROV deployment near oil platforms.
- **Effective Emergency Protocols – ASOG**: The swift transition to a yellow alert level and the immediate recall of the ROV demonstrate the vessel crew's adherence to ASOG and their preparedness to respond to emergencies.

3 Read the Room – Port Side Azimuth Thruster Shutdown and Subsequent Partial Blackout on DP Vessel

3.1 Overview

This report provides a detailed technical analysis of a series of incidents involving the unexpected shutdown of a port side azimuth thruster and a subsequent partial blackout on a Dynamic Positioning (DP) vessel. The vessel was engaged in DP operations with a ROV and a crane deployed at working depth.

During the incident, Diesel Generators (DG) 2 and 4 were online, DG 1 was out of order, and DG 3 was on standby. The vessel was operating an open bus.

3.2 What happened

First Shutdown: The port side azimuth thruster unexpectedly shut down. A DC over-voltage alarm was observed on the local display of the Inverter Unit (INU) at the Port Side Variable Frequency Drive (VFD). After checking all Motor Drive Control (MDC) circuit boards, which were found operational with green LED indicators, the alarm was reset and cleared. The thruster was then restarted without active alarms.

Second Shutdown: A similar incident occurred again with the same thruster, followed by the same diagnostic and reset procedure. The thruster was reselected into the DP system, and operations were resumed.

Third Shutdown: The thruster experienced another shutdown with the same DC over-voltage alarm. The alarm was reset after standard checks.

Partial Blackout: During an attempt to restart the port side azimuth thruster, a partial blackout occurred on the Port Side Switchboard (PS SWB), powered by DG 2. Bow Thruster 1 and Azimuth Thruster 3 went offline. However, the vessel maintained station keeping with Bow Thruster 2 and Azimuth Thruster 4 remaining online. WCFDI was equalled.

The root cause was identified as a failure of the Insulated Gate Bipolar Transistor (IGBT) module on the port side azimuth thruster VFD. The IGBT module is critical for the VFD's operation, controlling the power flow to the thruster motors. The repeated DC over-voltage alarms suggest a malfunction in the VFD's ability to maintain the DC voltage, stemming from the damaged IGBT module. Although the report did not detail the reason for the generator tripping (causing the partial blackout) it is assumed that the failed IGBT being continually reset eventually resulted in power system fault causing the generator protection to trip.

3.3 Conclusion

The attempt to restart the thruster with a compromised VFD likely contributed to a power system fault, resulting in a partial blackout on the PS SWB. The specific interaction between the failed IGBT module and the generators protective systems requires further investigation.

Emergency response procedures should be assessed and updated to address potential power system instabilities, especially during critical DP operations.

Conduct crew training focused on response to power system anomalies and emergency station-keeping procedures. Vessel technical staff need to fully understand all the nuances of DP operations and be involved in the development of the ASOG in order to understand the guidance within such document.

It is unknown whether this vessel in this case was equipped with an ASOG; however, machinery that has malfunctioned must not be reinstated until the vessel has stabilised and the underlying cause has been adequately identified and resolved.

4 Thrust Incident Due to Dynamic Positioning System Mode Change on Construction Vessel

4.1 Overview

This case study examines an incident involving a Construction vessel that experienced an insufficient thrust alarm while holding Dynamic Positioning (DP) position during offshore installation crew transfer operations. The incident was caused by an unintended change in the Power Management System (PMS) mode, leading to a temporary loss of positioning.

The vessel was engaged in offshore construction and crew transfer alongside an installed jacket.

Initially, the vessel was operating in "Closed Bus" mode, utilising two generators. Wind was 190 degrees/15 knots; DP current was 205 degrees/2 knots, heading was 38 deg.

Mode Change and Insufficient Thrust Alarm: The vessel's PMS mode was inadvertently changed from "Closed" to "CAM Island," during the operation which leads to increasing the number of generators online from two to four. The incident report notes that this transition period (for unknown reasons) resulted in insufficient thrust being available, causing the vessel to drift and experience a position excursion of approximately 5 metres.

DPO Response: The Dynamic Positioning Operator (DPO) responded to the effect the mode change was having and promptly reverted the system back to "Closed". After assessing the situation, the DPO confirmed the vessel's stability and resumed operations.

4.2 What Happened

Human Interaction: Log file analysis revealed that the mode change was due to human interaction, not a system fault. The change from "Closed" to "CAM Island" was manually initiated.

System Response: The transition to "CAM Island" mode required time to bring additional generators online, during which the vessel lacked sufficient thrust to maintain its position against environmental forces.

4.3 Conclusion

Software Modification: In response to this incident, a software modification was implemented in the DP system. This modification introduces a pop-up confirmation dialog box before any mode selection is finalised. This measure aims to prevent accidental or unintended mode changes.

Crew Training and Awareness: Enhanced training and awareness programmes for the vessel's crew, particularly focusing on the implications of different DP modes and the importance of vigilant system monitoring.

Operational Protocols Review: A review of operational protocols and procedures, especially concerning manual intervention in the DP system and PMS, to ensure clear guidelines and checks are in place.

Considering this incident, the vessel should have been in 'CAM Island' mode rather than 'Closed' prior to this operation. The DPO ought to have transitioned to 'CAM Island' sooner. They should have halted the operation, relocated to a secure location, and then switched to 'CAM Island' before resuming activities once they realised that they were in the incorrect mode. It is not clear from the incident report that suitable ASOG were in place and that the DP system set-up procedures (and field entry checks) prior to starting the mission were followed.

This incident underscores the critical importance of precise control and monitoring of DP system modes during sensitive offshore operations. The swift action by the DPO mitigated the potential risks associated with the unintended mode change. The subsequent software modification and procedural reviews enhance the safety and reliability of DP operations, emphasising the need for continuous vigilance and robust system controls in dynamic maritime environments. It also highlights the importance of robust procedures around field entry and activity specific guidelines.

5 DP Drill Scenario

DP emergency drill scenarios are included to assist DP vessel management and DPOs / Engineers and ETOs to conduct DP drills onboard. The intent is that the template can be used on any DP vessel, so specific details regarding the technical outcome are not included. The benefit of using this template 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 set-ups including their failure modes.

Refer to IMCA M117 The training and experience of key DP personnel – Appendix 6

<table>
<tr><th>EXERCISE SCENARIO   LOSS OF SEAWATER COOLING PUMP REDUNDANCY</th></tr>
<tr><td>Objective
To identify risks and impacts of this occurrence, possibilities to reduce that risk and suitable actions to be taken if such an occurrence happened.</td></tr>
<tr><td>Method
With the vessel in full auto DP control; power plant configured according to the vessel's DP operations manual (and respective decision support tool); all other vessel equipment and systems set up in accordance with applicable DP checklists:
1) Vessel in a safe location. Simulated location and activities agreed and communicated to all participants.
2) Simulate the loss of port side duty seawater pump and observe the starting of the standby pump.
3) Check that appropriate alarms are generated and that DP equipment temperatures and functions are unaffected.
4) Repeat test, however with the standby pump isolated to observe the effects on the equipment of the offline redundancy failing or being under repair.
5) Check the vessel DP crew's ability to manage the situation in a controlled manner.
6) Discuss the results and determine how the risk of losing seawater cooling could be mitigated / managed.</td></tr>
<tr><td>Prior to executing, discuss the expected results
♦ Is the methodology appropriate to gain the best outcome of the exercise?
♦ Who will be involved with the exercise and what roles will individuals have?
♦ What equipment will be impacted / lost?
♦ What are the risks of the exercise?
♦ Is the exercise scenario appropriately documented?
♦ What will be the communication channels during the exercise?
♦ Who will observe and accurately record exercise data including the DP system configuration pre-exercise?
♦ What is the anticipated loss of position?
♦ Are any secondary failures expected? – for example, mission equipment</td></tr>
<tr><td>Observations During Exercise
1) Is the DP emergency drill procedure being followed?
2) Is the equipment performing / reacting as expected?
3) Are those individuals directly involved in the exercise reacting appropriately given their assigned duties?
4) Are those individuals indirectly involved reacting in an appropriate manner?
5) Is the degree of participation and diligence as expected?</td></tr>
</table>

EXERCISE SCENARIO	LOSS OF SEAWATER COOLING PUMP REDUNDANCY

6) What is the actual loss of position?
7) What is the duration from commencement to concluding a safe outcome for the vessel?
8) Was the communication effective during the drill?

Actual results witnessed:

EXAMPLE:

The vessel maintained accurate station keeping with remaining online equipment.

The DP system reacted well maintaining station keeping as did the crew's reaction and response to the failure….

Discussion Points (Post exercise):

- Human Factors
  - What are the potential risks due to "multi-tasking" during DP operations that may directly lead to the scenario outlined during this drill? (Examples include managing / monitoring deck operations, radio traffic, etc.)
  - What are the potential risks due to distractions in the workspace (i.e., Bridge, Engine Room) that may directly lead to the scenario outlined during this drill? (Examples include routine maintenance procedures, social media, personnel interactions, etc.)
  - Discuss the alternative actions/reactions that may occur in response to a similar scenario. Are there multiple paths to a successful resolution or is there a preferred solution? Why?
  - Following a review of the simulated exercise and the vessel and crew's reaction, what different operator (Bridge and/or ECR) reaction(s) might be warranted if faced with a similar situation during operation?
- Review of DPO and other key DP personnel reaction
  - What potential gaps in the existing DP Familiarisation program have been highlighted as a result of the exercise?
  - What changes/revisions should be considered for the training and familiarisation procedures?
- Review the applicable checklists (ASOG CAM/TAM/DP operations manual/bridge and engine room checklists/FMEA/DP Annual Trials programmes/etc.)
  - What additional necessary actions and considerations should be addressed?
  - What potential changes should be made to make the checklists more appropriate?
  - What additional necessary operating conditions and parameters should be considered?
  - What potential changes should be considered to make Decision Support Tools more applicable to the vessel and her equipment?
  - How would these changes improve/affect the vessel's capabilities and limitations?

Conclusion

Based on the results of the exercise and related discussions before and after, any suggestions for follow up including any corrective actions deemed appropriate should be accurately detailed and managed to close out.
Handling of seawater system failures in the correct manner requires knowledge of:

1) the DP-specific equipment being supplied by the seawater system
2) how the DP system reacts to multiple failures and alarms and
3) the human intervention required if necessary to ensure station keeping. Items to consider include:
   a) awareness of the seawater system segregation (following the redundant groups)
   b) appreciation of the temperature effects on DP equipment from seawater system failures

EXERCISE SCENARIO	LOSS OF SEAWATER COOLING PUMP REDUNDANCY
	c) DP system reaction to multiple failures d) what to look for on the operator stations e) what event and alarms indicate seawater system failures (duty and standby equipment) f) methods of fault finding and investigation g) appropriateness of communication h) training requirements

6 News in Brief from the DP Committee

- M190 *Code of practice for developing and conducting DP annual trials programmes* and M191 *Code of practice for DP annual trials for mobile offshore drilling units*, published June 2023
- M117 *Code of practice for the training and experience of key DP personnel*, published June 2023
- M263 *Recommended Practice for shallow water DP operations*, published October 2023

6.1 Station Keeping Events STATS

The information below is a snapshot of the DP Station Keeping Events to date for 2023.

How many in 2023

- Total 136 Reported to date

What type

- 47 Observation
- 84 Undesired Event
- 45 Incident

Bus Configuration

- 103 Open
- 33 Closed

Main Cause (Overall Effect)

- 2 Human
- 27 Computer
- 55 Thruster/Propulsion
- 38 Power
- 0 Electrical
- 0 External Factors
- 14 Position References
- 0 Environmental
- 0 Mechanical
- 0 Sensors

Secondary (Root) Cause

- 22 Human
- 16 Computer
- 0 Thruster/Propulsion
- 0 Power
- 41 Electrical
- 3 External Factors
- 9 Position References
- 14 Environmental
- 27 Mechanical
- 4 Sensors

The percentage of DP incidents (loss of position/heading) reported per year has increased since 2019, a year before the pandemic, which is a concerning trend. The 2022 figures showed that the percentage of incidents had decreased, and this was encouraging. However, so far this year we are seeing a sharp increase to date. See the graph below:

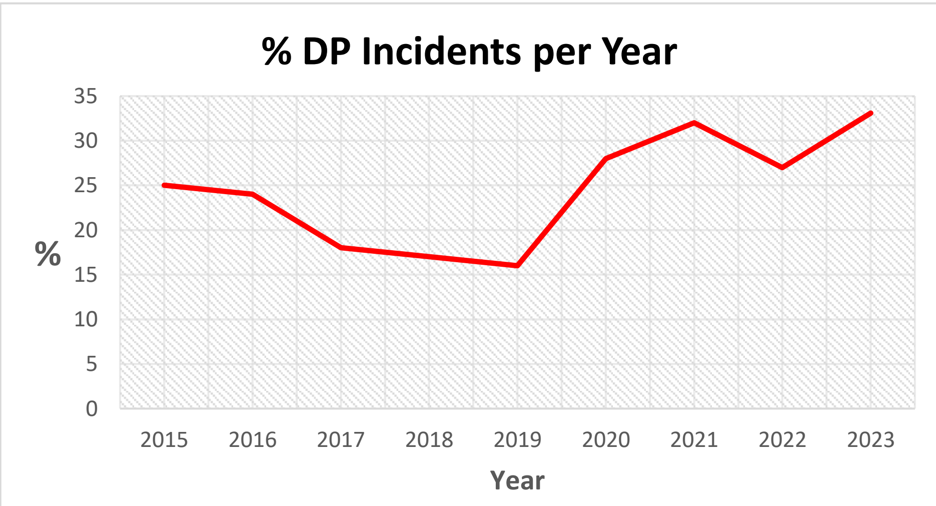

Figure 6-1 Percentage of DP Event Reports received resulting in DP Incidents (Loss of Position/Heading)

Dynamic Positioning Station Keeping Review – Incidents and Events Reported for 2022 can be downloaded from our website. The Incident and Event report for 2023 will be published February 2024.

If you are employed by an IMCA member company, you can register on the website using your company domain email address. Once registered, you will be given direct access to the members area including all guidance and publications. This also applies to Bridge, ECR or Rank email addresses onboard vessels.

The IMCA DP reporting form available here. You may want to consider using this form for your vessels. Please forward reports to dpreports@imca-int.com.

6.2 Continuous Professional Development (CPD)

Following the announcement from the Nautical Institute (NI) about the new requirements for revalidating the DPOs Certificate, a Key DP Personnel continuing professional development (CPD) learning programme has been developed by IMCA and the Nautical Institute to provide valuable CPD learning to DPOs who perform a safety critical role onboard offshore DP vessels.

The learning programme is accessible to all Key DP Personnel to ensure that their technical knowledge of the latest industry practices is up to date and measured though questions delivered through an application available on desktop and on mobile devices. This will ensure professional currency with the latest IMCA / industry guidance, DP safety bulletins, DP exercise and training drills, and help prevent knowledge and skill fade in the various DP related roles on vessels,

The content has been designed for use on mobile devices. The delivery of the content is through the EdApp application software which is a mobile device learning management software. The application is available across a wide range of operating systems, for example, IoS and Android, and the app functionality provides offline capability meaning the content remains available without internet connection, an important factor for seagoing personnel.

Registration and payment for the app is undertaken via the NI Alexis Platform which is accessible by all Key DP Personnel who wish to purchase the CPD programme.

Find out more @ https://www.imca-int.com/certification/dp/cpd/.