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.

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1 Thorough preparation is key

1.1 Overview

With 4 of 8 diesel generators running and connected to a closed ring bus, and 7 of the 8 thrusters selected to DP, a DP equipment class 3 MODU was set up in Green mode whilst on standby. The weather at the time was poor, with wind speeds of 43 knots and 2.2 knots of current. The rig was positioned in a drift-off position, with the nearest vessel approximately 1.9NM away.

1.2 What happened?

Generators 1, 3, 5 & 7 were operating at approx. 45% when the DPO initiated a 10-degree heading change to provide better protection of the rig against the weather.

During the heading change, the rig was struck by a large wave, which resulted in an instant load spike and generator fault alarm on all running generators.

The power management system initiated automatic start of the first standby generator 'DG 6'. DG 6 started, paralleled and the breaker closed on to the ring, before the power management system opened the breakers and shut down DG's 1, 3, 5 & 7.

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Auto starts were initiated for the three remaining stand-by engines, but before they could synchronise and connect, DG6 ramped to 100% and tripped on overload. The MODU blacked out, and the blackout recovery system was initiated.

Due to the standby generators already going through the start-up & synchronise process at the time of the blackout, the vessel was able to restore power within 12 seconds, the MODU recorded a 7m shift in position.

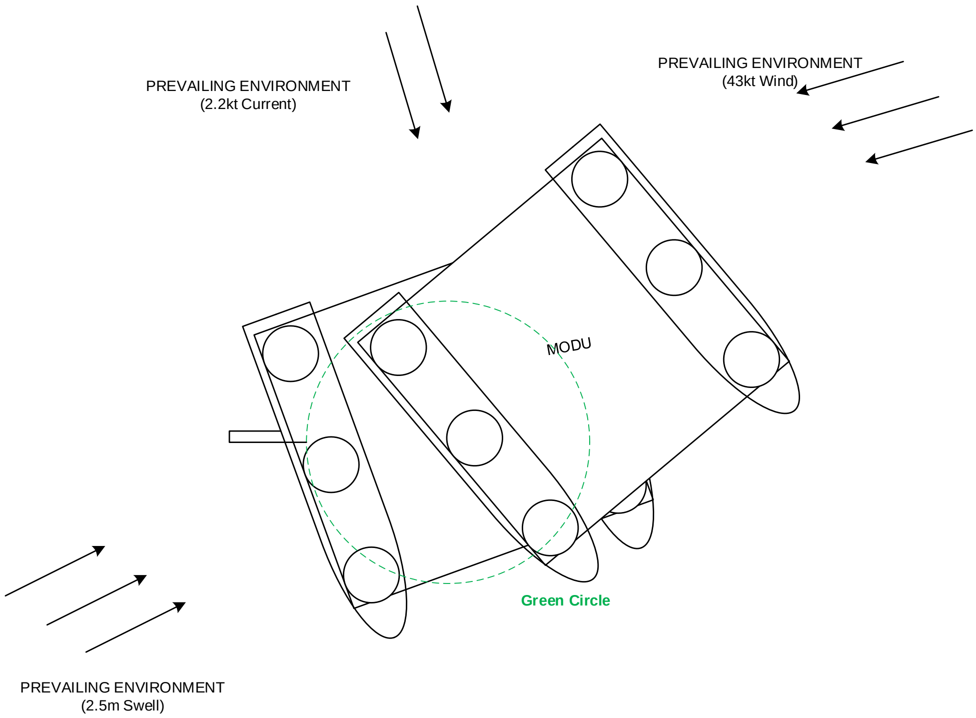

Figure 1 – Forced Out the Green Circle

1.3 Findings

Following investigation, the following was found:

- The DP system automatically switched temporarily to high precision control mode, as designed to when a position or heading change is made in Green Mode.
- The system was set to high gain.
- The large wave during the heading move forced the vessel out of the green area.
- The sudden power load increase initiated the auto-start system, as required.
- The system was set to Droop mode, and it was later identified that the droop curve limits were too tight to cater for the large load step changes of the generators.
- The power management system disconnected multiple generators when the first standby generator connected.

1.4 Conclusion

It was reported that following visits from the manufacturers of the DP and PMS systems, the software was upgraded, and extensive testing was carried out in both droop and isochronous modes, including scenarios of load step changes and blackout recovery.

The incident highlights the importance of performance testing of the power generation system and in all applicable load sharing modes (i.e. droop and isochronous). Testing during commissioning and DP trials, of the overall power and propulsion systems must include sufficient testing of generator load acceptance and rejection, blackout protection, DP & PMS thrust limitation, standby start of generators etc.

The incident report did not specify the verified and validated load sharing mode or the defined CAM configuration.

2 There – but not really there

2.1 Overview

This DP event occurred on a DP equipment class two supply vessel whilst carrying out cargo operations on the starboard side alongside the asset and working at the lee side in the drift-off position. The supply vessel was operating with two DGNSS, one radar based and one laser-based reference system accepted into the DP system.

2.2 What happened?

The vessel was operating in poor weather conditions and experiencing wind and waves on the starboard bow, with a heavy swell of 3.2m and around 28 knots average wind. The vessel had been experiencing position excursions of around 3-5m quite frequently and also heading was dropping around 3-5 degrees when losing position.

As the vessel was working on the drift-off (lee-side), the Master and DPOs considered this acceptable.

At 10:08, when the vessels position and heading deteriorated with around 2 meters and 2 degrees excursion, out-of-limit warnings were generated. Over the following couple of seconds, one by one, prediction error alarms for each of the reference systems were generated but not fully realised by the DPO.

The vessel commenced drifting aft and losing its heading due to the wind and waves. The DPO was monitoring the operator station and awaiting the thrusters to react and start thrusting to return to position; however, the vessel continued moving further away from position. On the operator station, the DPO reported that the reference systems were still appearing to be online, though the weighting was not clarified.

When the vessel's speed began increasing away from the asset, the DPO disengaged sway and surge to take control on DP joystick, at which point, a position dropout alarm was triggered due to no reference systems accepted into the system. The DPO manoeuvred the vessel away from the asset on the DP joystick and out of the 500m zone.

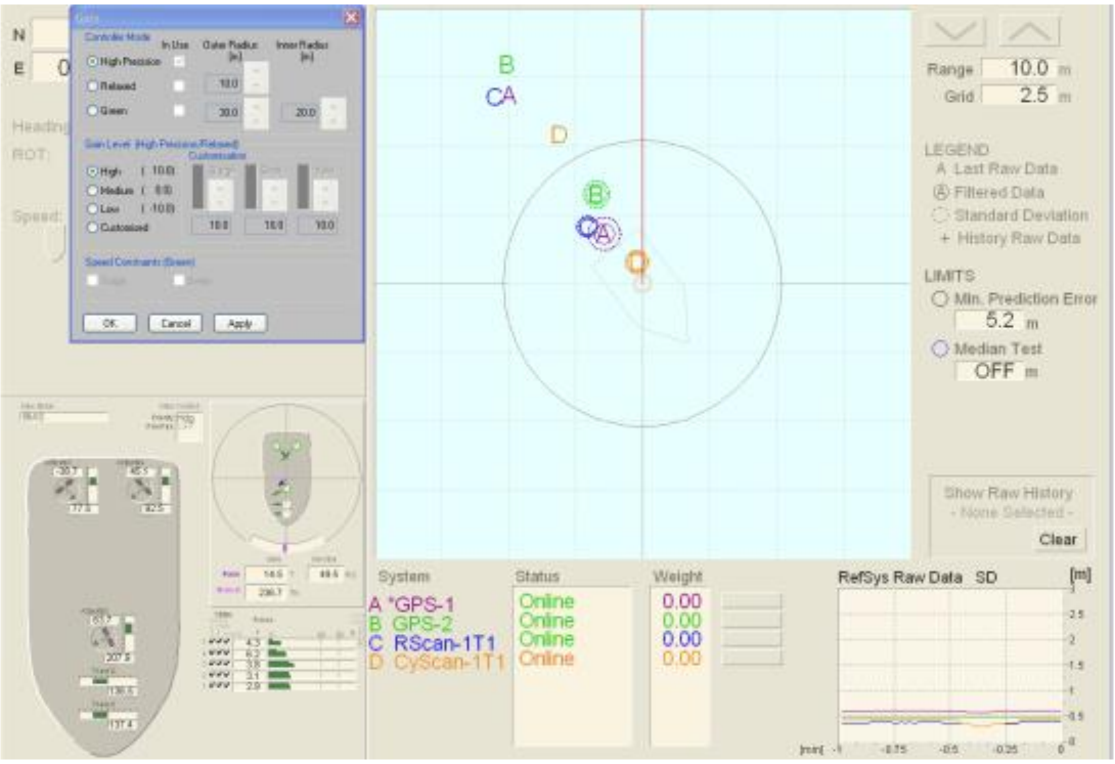

Figure 2 – Screenshot to show difference exceeding 5m

2.3 Findings

Investigation of the event concluded that:

- Due to only one line of DP alarms being visible at a time on the operator station screen, the DPO did not visually see the reference prediction error alarms activated. When many alarms activate in a short period, the second DP operator station must be used to show the full alarm list.
- Multiple rapid alarms had been accepted, and the alarm drop-down had not been expanded to check entirely those activated. If they had, it would have been realised that the 'No reference system' alarm had been activated and that the system was using the estimated position only.
- From analysis of the DP system history, it was seen that the vessel was hit by a wave train. The wave train's effect is that the position reference systems' measure position is moving away from the estimated position.

Figure 3 – History Analysis

- The wave train hit the vessels, and this 'unknown external force' pushed the vessel rapidly out of position, causing deviation between the measured position (reference systems) and the estimated position (model position). The deviation exceeded the prediction error limits of 5m and caused all reference systems to be rejected.
- The DP software version onboard the vessel had a known weakness regarding position drop out of the DP reference systems during rapid movements caused by wave trains/ several waves in a row.

2.4 Conclusion

Following analysis of the event from the DP manufacturer, the cause was identified. The vessel was able to continue DP operations, with limitations, until the DP software could be upgraded to a higher version that had implemented improvements to handle the model error.

In cases like the one described above, if all reference systems are rejected, there are three potential actions to be taken.

- Enter joystick mode to control the vessel and regain position.
- Re-calibrate all reference systems.
- Wait 30 seconds for position dropout to be reported, and the reference system will automatically calibrate.

With the vessel's movement in this case study, the vessel crew made a valid choice of entering joystick mode to regain position.

3 Equipment Class 3, even if you operate as 'Class 2

3.1 Overview

This case study examines a DP incident on an equipment class 3 multi-purpose vessel while operating in good conditions. The vessel was set up according to their class-approved FMEA in a 'DP 2 configuration' with open bus ties, four of the six generators running online, and equally spilt across two bus sections. The FPSO they were due to attend had a holdback Tug connected to allow more control during operations.

3.2 What happened?

The vessel was 100m from the FPSO and approaching when a failure alarm was initiated for Main Engine 1. This rapidly escalated to losing the port switchboard followed by the starboard switchboard almost simultaneously.

In its blacked-out condition, the vessel proceeded to drift away from the asset due to the correct procedures being followed and being set up in a drift-off position.

The vessels Bridge department immediately contacted the FPSO to warn of the emergency, and the FPSO lowered the starboard side Yokohama's in case of impact between the vessels.

The anchors and towing lines were prepared as the engine department proceeded to fault find and regain power to the vessel. The Tug was called to disconnect from the FPSO and standby for towing, if necessary.

The engineers discovered water in the fuel system, within the settling and service tanks on both port and starboard sides. and were required to drain the water from both systems. After two hours, the engines were finally restarted, and the vessel returned under control, having lost 2nm position.

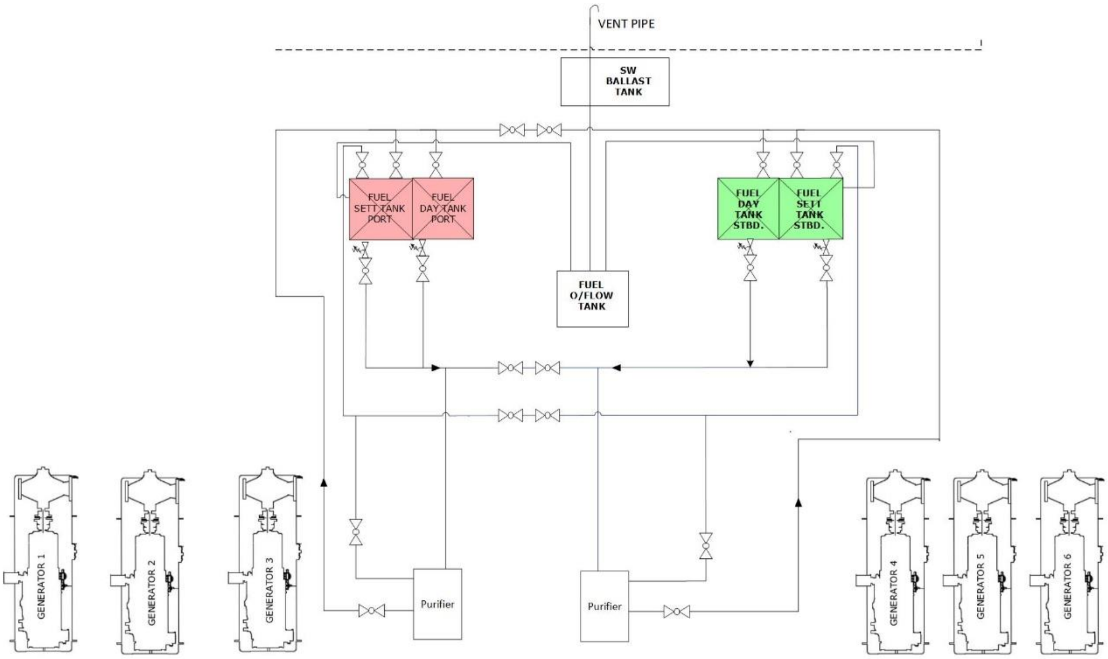

Figure 4 – Simplified Example Fuel System

3.3 Findings

Investigation of the event uncovered a few areas to consider:

- The water ingress to the FO overflow Tank was traced back to the FO overflow tank vent pipework.
- The FO overflow tank vent pipe was traced and found to pass through a water ballast tank, which at the time was full.

- Upon emptying the water ballast tank, the leaking stopped, and when the vent pipe was safely inspected, it was found with several holes from years of corrosion.
- The FO overflow tank was set up to the port and starboard settling tanks simultaneously.
- FO operation procedures were reviewed, and concluded that there was room for improvement in regard to the storage, transfer and treatment onboard.
- During the incident, both port and starboard FO purifiers were operating; however, no alarms were activated.
- An investigation of purifier settings revealed that the water monitoring function was inactive in a factory setting. The Purifier controller was still in default factory settings, which did not match the vessel's separator type onboard. The controller settings were updated per the manufacturer's instructions to match the actual purifiers onboard. All functions and alarms, including water content alarm, were verified.

3.4 Considerations

Though the vessel was operating in a configuration they referred to as 'DP 2 mode' the vessel is constructed following the classification for DP equipment class 3. Therefore, a loss of a static component, i.e. a pipe, should not result in a loss that could exceed the worst-case failure design intent.

The main cause for this incident was clear: power failure led to the loss of thrusters and subsequent position, but what about secondary failure, the failure mode that started it all?

- Would you have called it a mechanical or human factor?
- Was it the hole in the vent pipe? But if the vent pipe hadn't run through a water ballast tank, the hole wouldn't have caused such an issue.
- Was it that the pipe should have been picked up at the design/construction stage, and could the FMEA have picked this potential failure out?
- Was it the incorrect set-up of the FO overflow tank valves, for if they'd been set up differently, only one redundancy group would have been affected, no matter that the water was there?
- Was it the FO procedures being followed onboard?
- Was it that the purifiers were in the default factory setting? Had the settings been different, would the water content have been identified before the water affected the engine's combustion cycle?

So, was this mechanical, or was it a human factor?

4 Line of sight

4.1 Overview

This case study covers events onboard a DP equipment class 2 vessel whilst holding position in a turbine field, with three position reference systems selected into DP – DGPS, HPR and Fanbeam.

4.2 What happened?

The vessel was holding position when a crane movement blocked the path from the Fanbeam to the reflector on the turbine.

The DP system registered the drop in reference system, with appropriate alarms and held position on the two remaining reference systems. However, when the crane moved away from the path of the Fanbeam, the Fanbeam reacquired a connection, and a 4.5m move was experienced.

The SDPO changed over to joystick control and pulled safely out of the field to carry out troubleshooting.

4.3 Findings

Troubleshooting of the event concluded that:

- Once the path was clear, the Fanbeam reacquired connection with a different reflector, which had a similar range, bearing and signal level as the original reflector.
- As the wrong reflector was acquired, the DP system repositioned the vessel according to the position of the secondary Fanbeam reflector.
- The vessel recreated the scenario, and the same outcome was experienced with each repeat. Without deselecting the Fanbeam from DP, after the signal loss, the Fanbeam reacquired the wrong reflector, and the vessel experienced a position move.
- During an alternative scenario, when the Fanbeam lost connection, the DPOs deselected the Fanbeam from the DP desk. Only when the Fanbeam became available and stable did they reselect the Fanbeam back into DP, and the position remained stable.
- Once the crane covers the line of sight between the Fanbeam and reflector and a prediction error is generated, the DPO should deselect it from DP.

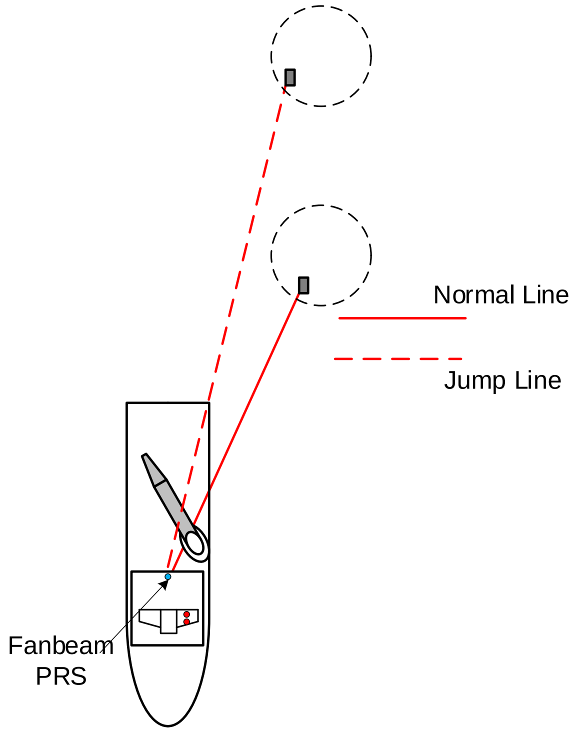

Figure 5 – Fanbeam Array

4.4 Conclusion

Knowing your ship has never been more critical, which is why procedures, training and drills are so necessary.

The issue here wasn't actually the loss of connection from the PRS, but how the system recovered. Being able to recognise, handle and pre-empt the next steps is imperative to a good outcome, so preparation is key!

The following IMCA Guidance would be relevant to these case studies:

- IMCA M117 – Code of practice for the training and experience of key DP personnel
- IMCA M166 – Code of practice on Failure Mode and Effects Analysis (FMEA)
- IMCA M220 – Guidance on operational planning
- IMCA M247 – Guidance to identify DP system components and their failure modes
- IMCA M252 – Guidance on position reference systems and sensors for DP operations

5 DP Drill Scenario

DP emergency drill scenarios are included to assist DP vessel management, DPOs / Engineers, and ETOs in conducting 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 essential that the crew are familiar with various DP system set-ups, including their failure modes.

Refer to IMCA M117 Code of practice for the training & experience of key DP personnel, Appendix 6

EXERCISE SCENARIO THRUSTER FULL THRUST FAILURE
Objective: To familiarise all vessel crew with what actions are required in order to recover the vessel into a controllable condition following a thruster failure to full thrust.
Method: This test can be undertaken when the vessel is in a safe open space with no risk of excessive position excursion causing an unsafe condition. If the vessel has CPP Main thrusters, carry out using CPP. 1. Settle vessel on auto DP 2. A second person to take the most powerful thruster into manual control 3. Ramp that thruster to 100% in a direction perpendicular (if azimuth thruster) to the Auto DP thrust. If carrying out for CPP, put CPP thrust in the opposite direction Observe effects
Observations During Drill: 1. Does the DP Control system compensate? 2. Is there an initial excursion? 3. What action would the DPO take? 4. Is the degree of participation and diligence of Key DP Personnel as expected?

EXERCISE SCENARIO	**THRUSTER FULL THRUST FAILURE**

Discussion Points (post-exercise)

Vessel

- How are the thrusters placed on the vessel where single skeg thrusters are fitted? What are the implications of this failure to full thrust.
- Can a forward retractable azimuth thruster counteract two bow tunnel thrusters?
- Powerful stern CPP Propellors - if one fails to full thrust, is position compromised?
- Where rudders are used for position control, consider if the prop fails to full thrust and the rudder still follows a DP Commend.

Human Factors

- What should the DPO's response be?
- What would be the worst-case scenario?
- 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?

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 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.

Correctly handling thruster system failures requires knowledge of the DP vessel control, how the DP system reacts to failures and alarms and the human intervention needed, if necessary, to ensure station keeping.

Items to consider include:

- Awareness of the current thrust levels and directions
- DP system reaction to failures
- Appropriateness of communication
- Training requirements

6 News in Brief from the DP Committee

- M140 *Specification for DP capability plots* is being updated.
- M117 *Code of Practice The training and experience of key DP personnel* has been updated (M117 Rev. 3.2 Aug 24)

6.1 Station Keeping Events STATS

The information below is a snapshot of the DP Station Keeping Events to date for 2024.

How many in 2024	What type	Bus Configuration
♦ 138 reported to date	♦ 18 Observations ♦ 85 Undesired events ♦ 35 Incidents	♦ 118 Open ♦ 16 Closed ♦ 4 Unknown

Main Cause (Overall Effect)	Secondary Cause
♦ 1 Human	♦ 18 Human
♦ 18 Computer	♦ 17 Computer
♦ 54 Thruster/Propulsion	♦ 5 Thruster/Propulsion
♦ 38 Power	♦ 3 Power
♦ 9 Electrical	♦ 45 Electrical
♦ 2 External Factors	♦ 8 External Factors
♦ 9 Position References	♦ 6 Position References
♦ 1 Environmental	♦ 2 Environmental
♦ 3 Mechanical	♦ 26 Mechanical
♦ 3 Sensors	♦ 7 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, which was encouraging; however, 2023 showed an upturn. As we enter the final quarter of 2024, this year's figures are still down on last year's.

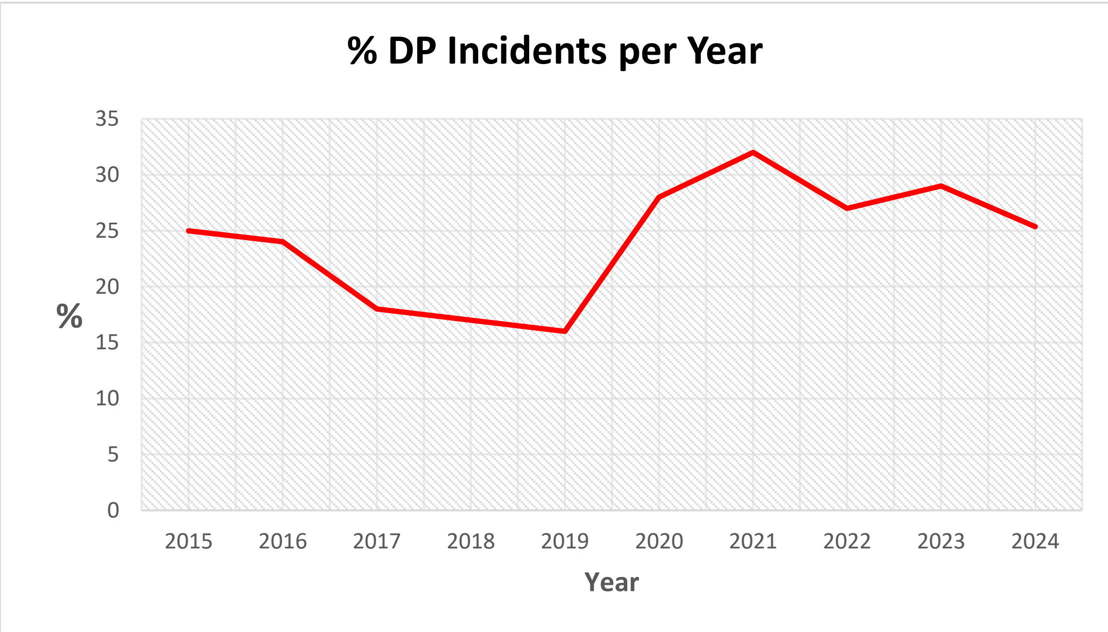

Figure 6 – Percentage of DP Event Reports received resulting in DP Incidents (loss of position/heading)

Dynamic Positioning Station Keeping Review – Incidents and Events Reported for 2023 can be downloaded from our website.

If an IMCA member company employs you, you can register using your company domain email address on the IMCA website. Once registered, you will be given direct access to the member's area, including all technical documents and other publications. This also applies to Bridge, ECR or Rank email addresses onboard vessels.

The IMCA DP reporting form is 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 maintained and measured through questions delivered through an application available on desktop and mobile devices. This will provide 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 content is delivered 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 an internet connection, a crucial factor for seagoing personnel.

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

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