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.

The following case studies have been chosen in order to create discussion points for all Key DP personnel. The events have already taken place but, what could have been done differently? Hindsight is a wonderful thing, but these cases allow us to stop, think and positively learn lessons that can be carried into future DP operations.

The IMCA DP Committee has contributed to each of the studies adding their knowledge and experience.

1 Case Study – Maintenance – Not a good Idea During DP Ops

1.1 Overview of Event

An Offshore Supply Vessel (OSV) was conducting an ROV survey in open water, the bustie was closed creating a single power grid, as per Task Appropriate Mode (TAM) configuration.

The OSV was in Auto DP using 2 Position Reference Systems (PRS's) selected into DP Control all with automatic weighting, the PRS's selected were:

- x2 DGNSS

The power plant was set up as below with 2 generators (G2 & G3) connected.

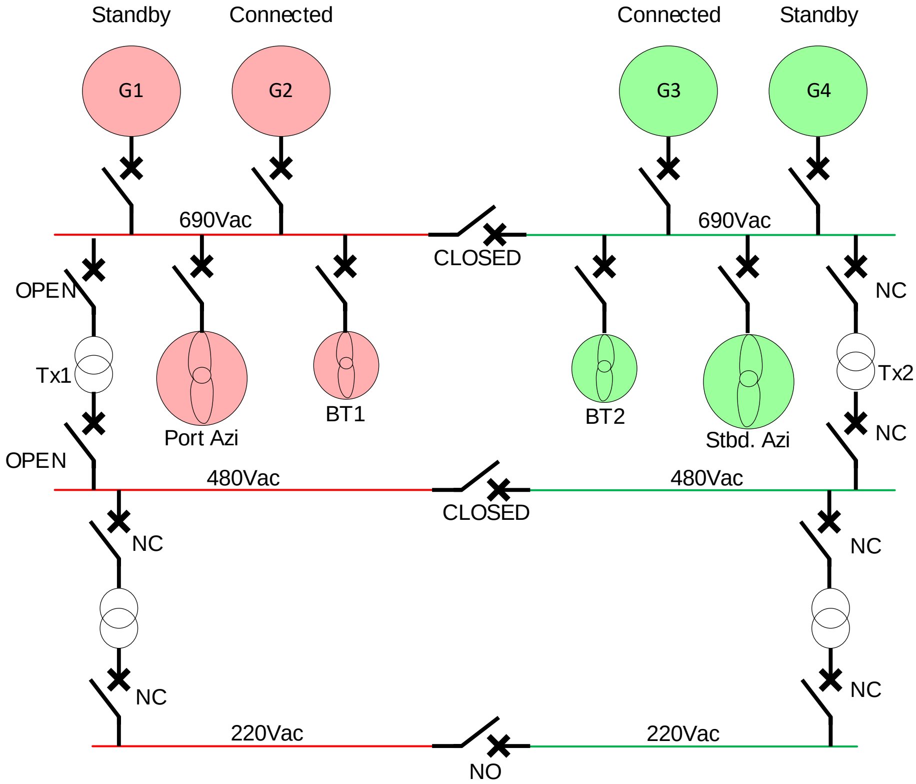

Figure 1 – 1 Configuration for maintenance on Tx1

During routine maintenance on Tx1 the 480Vac bustie was closed, and the two feeder breakers for Tx1 were opened to allow Tx1 to be isolated.

G2 & G3 were connected to the 690Vac switchboard.

Upon completion of the maintenance it was noted that the 690Vac feeder to Tx1 would not close. Troubleshooting determined that a Port 690Vac switchboard 'REF' protection relay was faulty and needed to be exchanged.

The vessel continued conducting DP operations.

It was decided to exchange the 'REF' relay. After remounting the replacement relay and in the process of terminating the new relay, an unknown live wire inadvertently contacted a surface and grounded. This grounding caused the remaining 690Vac circuit breakers on the Port bus to trip and open, since they were connected via "daisy chain" configuration by design for protection purposes. This then caused the bus tie to open as per design in order to protect the Starboard power bus. Port Azi and BT1 failed as a result.

The bus tie opened upon sensing low voltage on the Port bus. No loss of Position was experienced.

1.2 What can be concluded?

- That the vessel was configured in such a way that a single failure would exceed the WCFDI.
- The event occurred as a result of the decision to replace a critical switchboard component while remaining on DP.

1.3 Additional Comments

- This was recorded as a Human Factor triggered event.
- The power system was configured as per a TAM presumably with the knowledge and understanding of all stakeholders that the vessel could lose position. The TAM may have been agreed, but it's unlikely that the increased risk caused by conducting maintenance would have been.
- It was not clear if an ASOG was in place and if it was being followed. While operating in TAM will allow for a lesser fault tolerance, the system integrity has been further compounded by vessel maintenance activities.
- It is not clear whether the closed bus configuration had been fully analysed in the FMEA. If so then the analysis appears to have missed the failure mode associated with common power supply. If not considered within the FMEA then the decision to operate closed bus had additional risk of unknown failures.
- The event highlights the risk of undertaking maintenance / repair of components critical to the integrity of the DP system (in this case the main switchboard). It also highlights the importance of management of change procedures.
- This case study highlights the dangers of working on a live switchboard and also highlights the risks of not ensuring appropriate isolation of electrical components. This event could easily have resulted in personal injury.

1.4 Guidance that would be relevant

The following IMCA Guidance would be relevant to this case study:

- IMCA M220 – *Guidance on operational planning*

2 Case Study – Importance of Units

2.1 Overview

Upon completion of DP field arrival trials, the vessel began sub-sea operations. One ROV was deployed and the crane was in use subsea. The vessel set the two stern thrusters AZI1 and AZI2 to bias, in addition the bow drop-down thruster AZI3 was set to bias mode.

Biasing was set at 0.5t with a turn factor of 50%. The vessel lost position due to stern thrusters oscillating thrust against each other, ramping up to over the 50% turn factor causing them to kick into variable mode.

An all stop was called and the crane and ROV's were recovered to deck. The stern thrusters continually circled around their azimuths, unable to meet their set points. The stern thrusters continued to increase their thrust up to 100% causing the bow thrusters to ramp up as well. The excess thrust increased the demand on the available generators on each side of the bus (open bus), starting the 2 remaining standby generators. Vessel heading was lost by 5 degrees, and the position up to 10m.

The DPO then disengaged the sway axis to allow the thrusters to settle down. Control of Sway was kept by joystick command. Once stable, the DPO put the thrusters back into biasing and reengaged the sway axis. The vessel then stabilised and kept position until the ROV and Crane were back on deck.

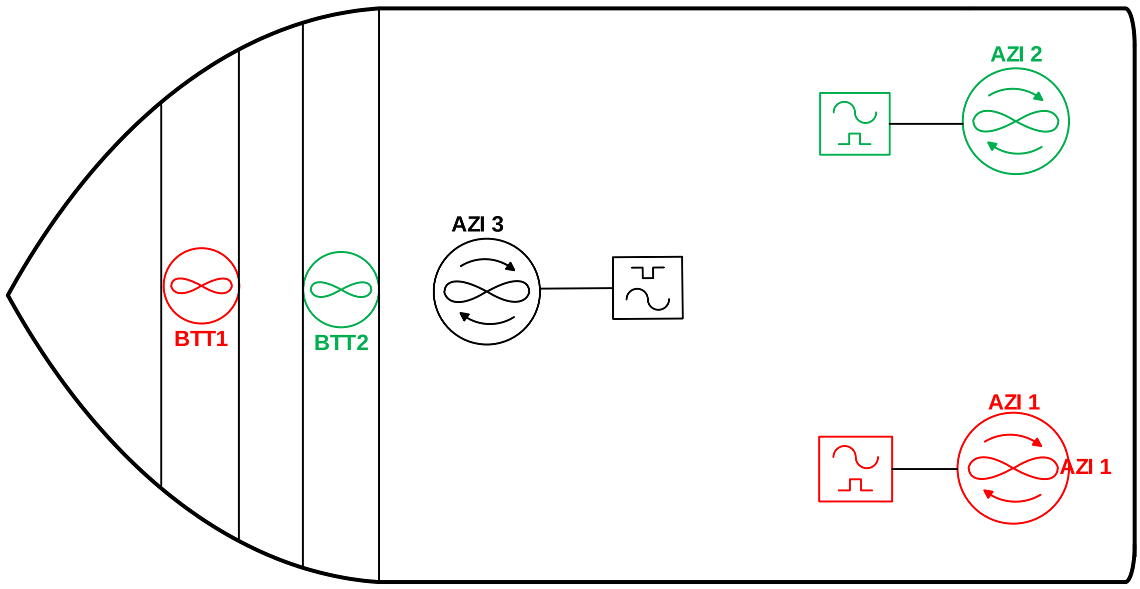

Figure 2 – 1 Thruster Setup

2.2 Events leading up to the incident

The vessel owner was requested by the charterer to use metres as distance units for DP Control, the DPO then changed all DP parameters from feet to metres to suit.

An on-coming DPO then changed offset values from their correct value in metres to feet believing that feet were the correct value for the DP Control System. However, the DP system was still selected to operate in metres.

As the vessel heading became less stable as environment increased the DGNSS positions were less accurate and the DP system became critically unstable.

2.3 What can be concluded?

- Poor management of change, logging of system settings, handovers, etc.
- Poor Communication.

2.4 Additional Comments

- It is unclear why the DPO did not deselect the bias mode when the thrusters began to ramp up.
- It is unclear what the environmental forces were in the lead up to the event. Bias mode is often chosen for light environmental conditions to prevent the azimuth thrusters 'hunting' however this mode is not generally suitable for higher environmental conditions.
- The event report did not mention the use of ASOG. An ASOG would have assisted in the decision making process whether in an increasing environmental situation or in which modes to operate in and when.
- The units of measurement can be changed for the HMI presentation within the DP controller. This is a selection available to the DPO. The DP controller accuracy and quality is not influenced by the units chosen. The variable settings for the DP controller are set during the tuning of the DP system by the OEM engineer and are not accessible for the DPO.

2.5 Guidance that would be relevant

The following IMCA Guidance would be relevant to this case study:

- IMCA M220 – *Guidance on operational planning*
- IMCA M252 – *Guidance on position reference systems and sensors for DP Operations*
- IMCA M242 – *Guidance on satellite-based positioning systems for offshore applications*

3 Case Study – Consequences of not following ASOG

3.1 Overview of event

An SOV was approaching a Platform for personnel transfer via use of onboard Personel Access Platform (PAP) and the Platform's gangway. When the distance was approximately 1 metre between the gangway and the PAP, there was a sudden rejection of the vessel's starboard azimuth thruster by the vessel's DP system without any warning. The 'ready' signal was lost to DP Control for the starboard Azimuth thruster. The vessel started to drift astern.

After a few seconds, the starboard azimuth thruster readiness indicator on the Vessel's DP Console showed 'ready'. The DPO on duty immediately re-selected the thruster back into operation. After the re-selection of the previously failed thruster, the vessel continued to drift astern with the stern starting to rotate slowly to starboard. As the PAP was very near to the gangway, it made contact with the gangway and incurred damage. During the drift, the gangway also snagged against the ship's structure at the ship's stern.

The DPO immediately tried to move the vessel away using the DP joystick but found response was slow. The Master, who was at the manual thruster console at that time, immediately instructed the OOW to switch the vessel to manual control. He then took over command using manual control and manouevered the vessel away to avoid further collision with the platform. During the manoeuvre, the gangway which was snagged with vessel's stern structure was dragged. It subsequently came detatched from it's securing point on the Platform and finally remained suspended off the platform by its rigging.

There was no injury to personnel reported.

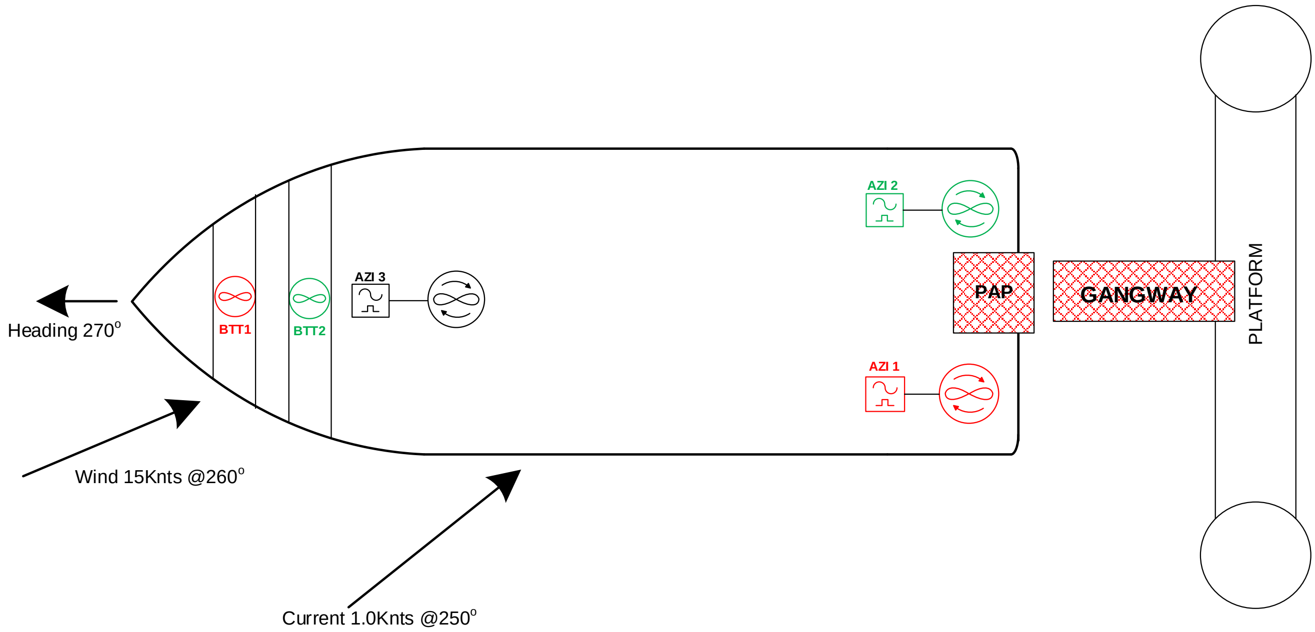

Figure 3 – 1 Overview

3.2 What Happened

While the vessel was manoeuvring into position to prepare for passenger transfer, the DP system reported an intermittent failure of one of two aft azimuth thrusters causing the starboard thruster to be incapacitated and de-select from DP Control, however the DP system still showed the thruster as ready, the operator re-selected the thruster back into DP Control.

The vessels DP system calculation was distorted by the inclusion of an unresponsive thruster and therefore could not stablise.

The vessel could not hold position with the remaining Bow and Port azimuth thrusters.

3.3 What can be concluded?

- The vessel operating outside its post WCF environmental conditions prior to the loss of the thruster
- The vessel was in a drift on position therefore situational awareness and possibly activity planning was inadequate given the environmental conditions being such that the vessel could not hold position with loss of one thruster.
- The ASOG was not followed as it stated that if the vessel status changes, then the re-selection of failed equipment is to be carried out only when it is in a safe position. The DPO shouldn't have reselected the thruster back into DP whilst alongside the platform. DP operations should have been safely stopped and vessel moved to safe location before the DP system was recovered.
- The DP event report did not conclude why the DP Joystick response was slow.

3.4 Guidance that would be relevant

The following IMCA Guidance would be relevant to this case study:

- IMCA M117 – *The Training and experience of key DP personnel*
- IMCA M220 – *Guidance on operational planning*

4 Relative PRS – A Reflection

4.1 Overview

A PSV was conducting cargo operations alongside an FPSO which was moving around its moored position. Selected into DP Control were two DGNSS absolute references and one Laser based relative reference, there were no other available relative references for the DPO to select. The DP Control system was selected to 'Follow Target' mode.

During a lift from the deck of the PSV, the vessel thrusters suddenly ramped up and the vessel started to move off position. The DPO switched the DP Control into Joystick manual heading control to stabilise the vessel and move out of the 500m Zone.

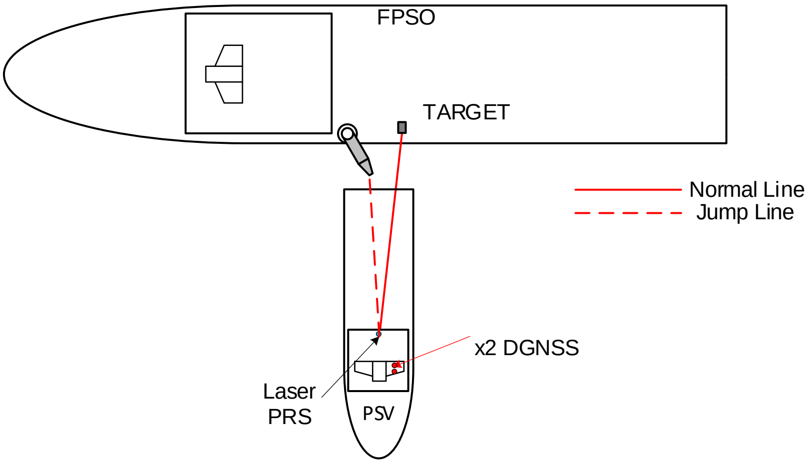

Figure 4 – 1 Position of Vessels

4.2 What happened?

The laser based relative position reference had switched to another target, in this instance the reflective tape on the crane hook. As there was only one relative reference available and selected this caused the DP Control to move the vessel off the original position.

4.3 What can be concluded?

The following can be concluded:

- There was no redundancy for relative position reference
- The Laser target appears to have been positioned in the wrong location. Targets should be located clear of crane operations and personnel with reflecting jackets moving around

4.4 Additional Comments

- If the DP control system was in Follow Target mode, the DGNSS should have been in "monitoring" and Relative PRS in "Mobile" configuration. The actual setup during the event in unclear.
- The DP event report did not discuss the use of any dicision support tools such as ASOG.
- IMCA M 252, Guidelines on position reference systems and sensors for DP operations, section 4.6, details specific operational considerations for laser position references including placement of the sensors and reflectors and the hazards to consider.

4.5 Guidance that would be relevant

The following IMCA Guidance would be relevant to this case study:

- IMCA M117 – *The Training and experience of key DP personnel*
- IMCA M220 – *Guidance on operational planning*
- 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 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 from 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 setups including their failure modes.

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

EXERCISE SCENARIO	**CONSEQUENCE ANALYSIS CLASS DP2 & DP3**
Objective: To familiarise all vessel crew on how the consequence analysis will warn the operator that there will be a loss of position following a failure once the alarm has been activated. Refer to IMCA Information Note - 1601 **DP Consequence Analysis – A Timely Reminder**	
Method: With the vessel on full auto DP, all thrusters online, generators online on each switchboards as required – ensure the consequence analyser is active. Position the vessel beam on to the environment such that more than the power of one generator is required to maintain position. (Part 3 may be weather dependent) Inhibit standby generators from auto-start and connection. (Make not standby) 1. Deselect thrusters at the forward end of the vessel leaving a single thruster until the alarm 'Consequence Analysis Drift Off Warning' is issued by the DP system. Wait for a minimum of 3-4 minutes – Remove the remaining forward thruster and observe the effects on vessel position and heading. Reinstate thrusters and stabilise DP position and heading. 2. Deselect thrusters at the aft end of the vessel leaving a single thruster until the alarm 'Consequence Analysis Drift Off Warning' is issued by the DP system. Wait for a minimum of 3-4 minutes – Remove the remaining aft thruster and observe the effects on vessel position and heading. Reinstate thrusters and stabilise DP position and heading. 3. Deselect all thrusters from a redundant group until the alarm 'Consequence Analysis Drift Off Warning' is issued by the DP system. (If more than one redundant group the remove thrusters from all but one redundant group) Wait for a minimum of 3-4 minutes – Observe the effects on vessel position and heading. Reinstate thrusters and stabilise DP position and heading. Repeat for all redundancy groups. 4. For vessels with multiple generators on a redundant Bus – Position the vessel beam on to the environment and shut (open breaker) down generators on any main bus until the alarm 'Consequence Analysis Drift Off Warning' is issued by the DP system, continue to shut down generators until drift off occurs note that DP gives priority to heading – reinstate generators	
Expected Results: 1. 'Consequence Analysis Drift Off Warning' is issued by the DP system – once all fwd. thrusters removed vessel position and heading is compromised. 2. 'Consequence Analysis Drift Off Warning' is issued by the DP system – once all aft thrusters removed vessel position and heading is compromised. 3. 'Consequence Analysis Drift Off Warning' is issued by the DP system 4. 'Consequence Analysis Drift Off Warning' is issued by the DP system	

EXERCISE SCENARIO	CONSEQUENCE ANALYSIS CLASS DP2 & DP3

Observations and Discussion Points (Post exercise):

Vessel

- Are all effects understood?
- Once the Consequence Analysis Alarm has been activated what would be the effect of a failure of the remaining thruster?
- Is it desirable to keep working when the Consequence Analysis alarm is being activated? – Should the DPO be ignoring and cancelling the alarm?
- Is the consequence Analysis alarm considered within your vessels ASOG and decision support tools?
- What is being observed in the ECR with regards the power plant – is the power plant under stress?

Human Factors

- Are all effects understood with regards Human intervention?
- What should be the response of the DPO?
- 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 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 essential DP systems in the correct manner requires knowledge of the Key DP Personnel and how the DP system reacts to human intervention.

Items to consider include:

- Appropriateness of communication.
- Training requirements.

6 News in Brief

DP Conference 2022

IMCA held its first DP Conference for some years which took up many hours of planning and logistical organisation by the Secretariat. However, this was more than worth it as the event was proven to be a success with the feedback being extremely positive and the engagement throughout the event being excellent. This has undoubtedly motivated us to ensure that the 2023 DP conference (May 9th/10th 2023) will be just as enjoyable and valuable for the IMCA membership and other DP industry interested parties. Thanks to all delegates and sponsors for making this happen.

Station Keeping Events STATS:

The information below is a snapshot of the DP Station Keeping events to date for 2022.

How many in 2022

- Total 91 Reported to date

What type

- 18 Observation
- 49 Undesired Event
- 24 Incident

Bus Configuration

- 76 Open
- 15 Closed

Main Cause (Overall Effect)

- 0 Human
- 41 Thruster/Propulsion
- 4 Position References
- 16 Power
- 1 Electrical
- 1 Environmental
- 5 Sensors
- 23 Computer
- 0 Mechanical

Secondary (Root) Cause

- 17 Human
- 0 Thruster/Propulsion
- 3 Position References
- 0 Power
- 23 Electrical
- 5 Environmental
- 5 Sensors
- 21 Computer
- 15 Mechanical

Figure 6 – 1 Event Stats

The percentage of DP Incidents per year of reporting has increased from 2019, a year before the pandemic hit, this is a worrying trend. See graph below;

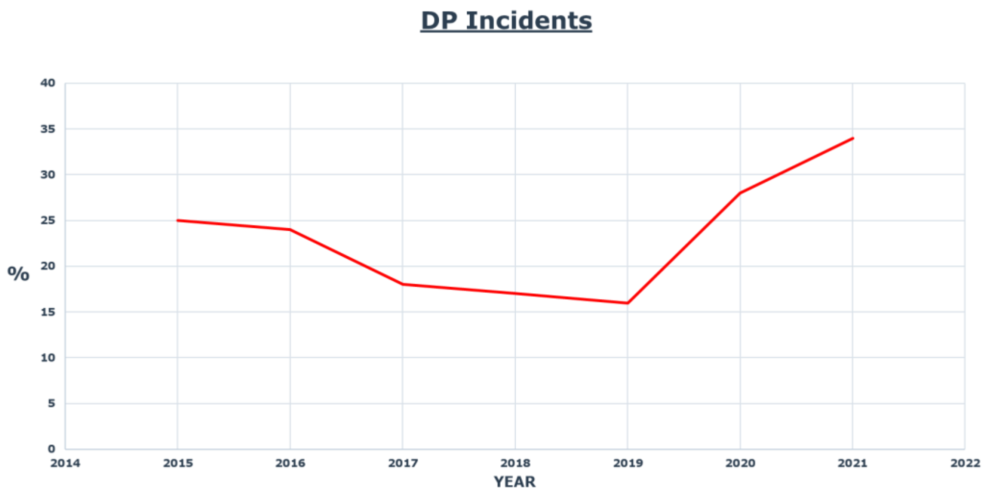

Figure 6 – 2 Percentage of DP Incidents per year of Reporting

Dynamic Positioning Station Keeping Review – Incidents and Events Reported for 2021 can be downloaded here.

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.

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