IMCA DP Station Keeping Bulletin 04/19

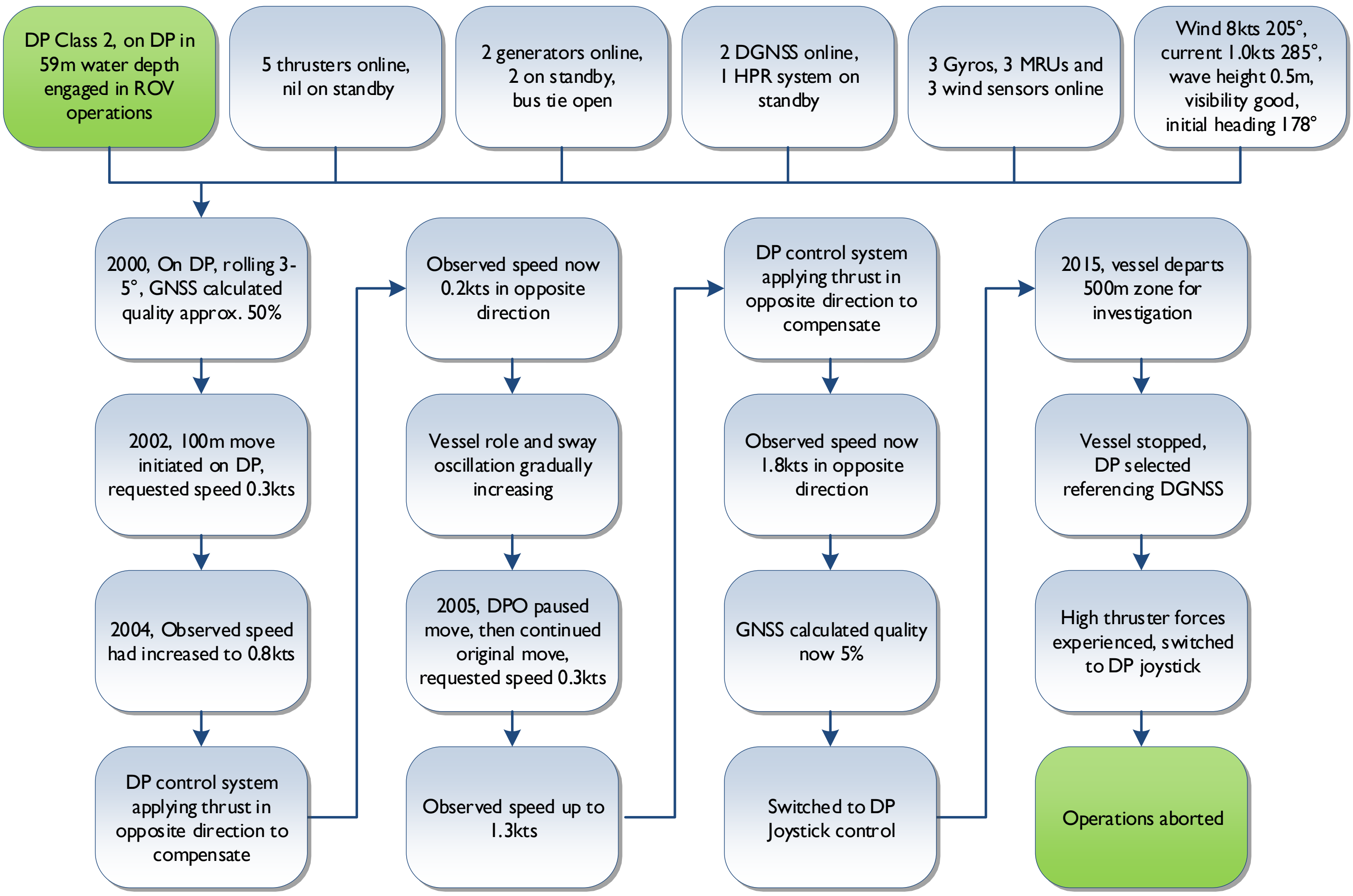
November 2019

The following case studies and observations have been compiled from information received by IMCA during 2019. To ensure anonymity all vessel, client and operational data has been removed from the narrative.

Vessel managers, DP operators and DP technical crew should consider if these case studies are relevant to their own vessel DP operation so that they can be used to assess and assist the safe operation of the vessel.

Any queries regarding this bulletin should be directed to Andy Goldsmith (andy.goldsmith@imca-int.com), IMCA Technical Adviser – Marine. Members and non-members alike are welcome to contact Andy if they have experienced DP events which can be securely analysed and then shared anonymously with the DP industry.

Unreliable Position Reference Systems Leads to DP Incident



Comments from the report

Only 2 DGNSS were online, with poor signal quality due to the location and environmental conditions. The end effect was that the deviation from the set point in surge and sway were increasing for each oscillation.

Considerations of the IMCA Marine DP Committee from the above event

- For DP2 operations, the use of only 2 DGNSS systems is insufficient; a minimum of 3 systems are to be used based on 2 principles.
- The importance of monitoring the position reference systems (PRS) screen cannot be overstated; this then ensures that all the PRS agree on the position of the vessel.

- It is evident that the selected PRS were not providing reliable position information and highlights the problems that can be experienced when at least one reliable PRS is not available.
- It was noted that the move was paused at 2005; this should have provided the opportunity to investigate and correct the situation rather than continue with the move.
- It is also worth considering that the erratic movement of the vessel could indicate that the DP system needs retuning.

Vessel Rotation Leads to Loss of Position – DP Incident

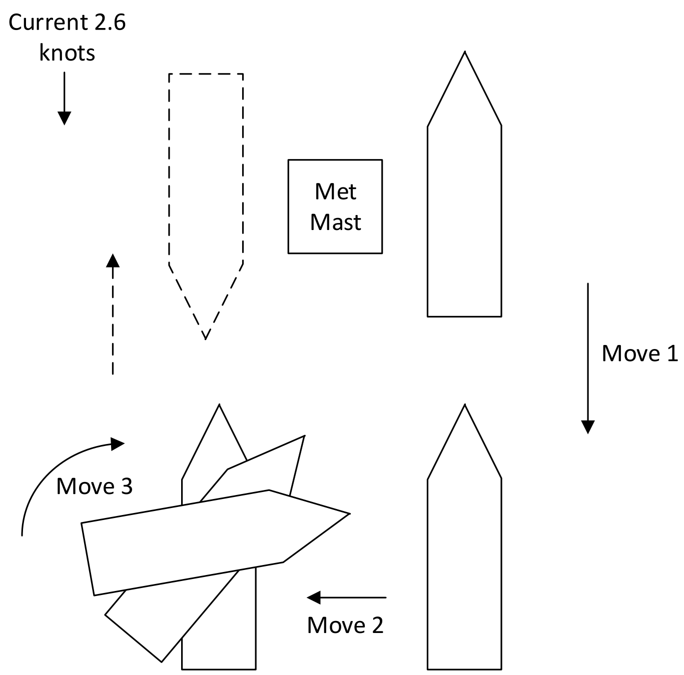
Case narrative

A DP2 ROV support vessel was working close to a metrological (met) mast within a wind farm. With ROV work completed, the project instructed the vessel to be relocated from the East to the West side of the mast for further ROV duties.

The current at the time of the event was around 2.6 knots, and this value was known to exceed the vessel's station keeping capability at angles approaching 90 degrees to the beam. As a result, the bridge team conducted an assessment of the risks and concluded that the move could be safely conducted away from the met mast structure in a drift off location making the turn using joystick control.

The vessel commenced relocating, moving astern on automatic DP control to clear the met mast to a safe position downstream (move 1). At that location, the vessel was then manoeuvred transversely to port on automatic DP control (move 2). At the end of this movement, the DPO commenced rotating the vessel through 180 degrees at a rate of turn of 40 degrees per minute using joystick control (move 3). In preparation for the vessel rotation, the DP operator did not change control to full joystick, electing instead to disable 'auto yaw' whilst leaving 'auto surge' and 'auto sway' enabled. Although not understood by the DPO at the time, this effectively meant that the DP system was still set to maintain a setpoint. Thruster loads began to increase as the beam of the vessel became perpendicular to the current. This resulted in the position set point alarm, DP overload alarm, thrust reduction alarms, and the loss of the starboard power system (50% of thrust capability), leading to a total loss of station keeping control.

The master of the vessel took manual control and manoeuvred the vessel away from the wind farm using the remaining thrusters, and eventually, when they had been restarted, the thrusters that had been lost.



The Lessons

- The investigation noted that whilst the senior DPO was qualified and experienced, the individual was new to the vessel and vessel operator and was carrying out only the second DP watch on-board.
- At the time of the rotation (move 3), the DPO was alone at the DP desks as the junior DPO was undertaking other bridge activities; this contributed to the incorrect setup of the system prior to manoeuvre being unnoticed and/or unchallenged.
- The overall manoeuvre had been risk assessed with the control modes of operation for each step detailed. However, the selection to joystick mode for move 3 was incorrectly executed by leaving 'auto surge' and 'auto sway' functions active.
- The vessel crew received additional training on the use and effects of 'auto surge' and 'auto sway' in high current environments.
- A specific risk assessment procedure has been established for the use of manual and joystick control within windfarm limits where major heading changes are involved. This will include verification of the operational procedures (including system setup) by the master or second senior DPO.
- The investigation also recommended a full review of the vessel's DP operating manuals, risk assessments and close proximity procedures, to assess if any improvements could be made.

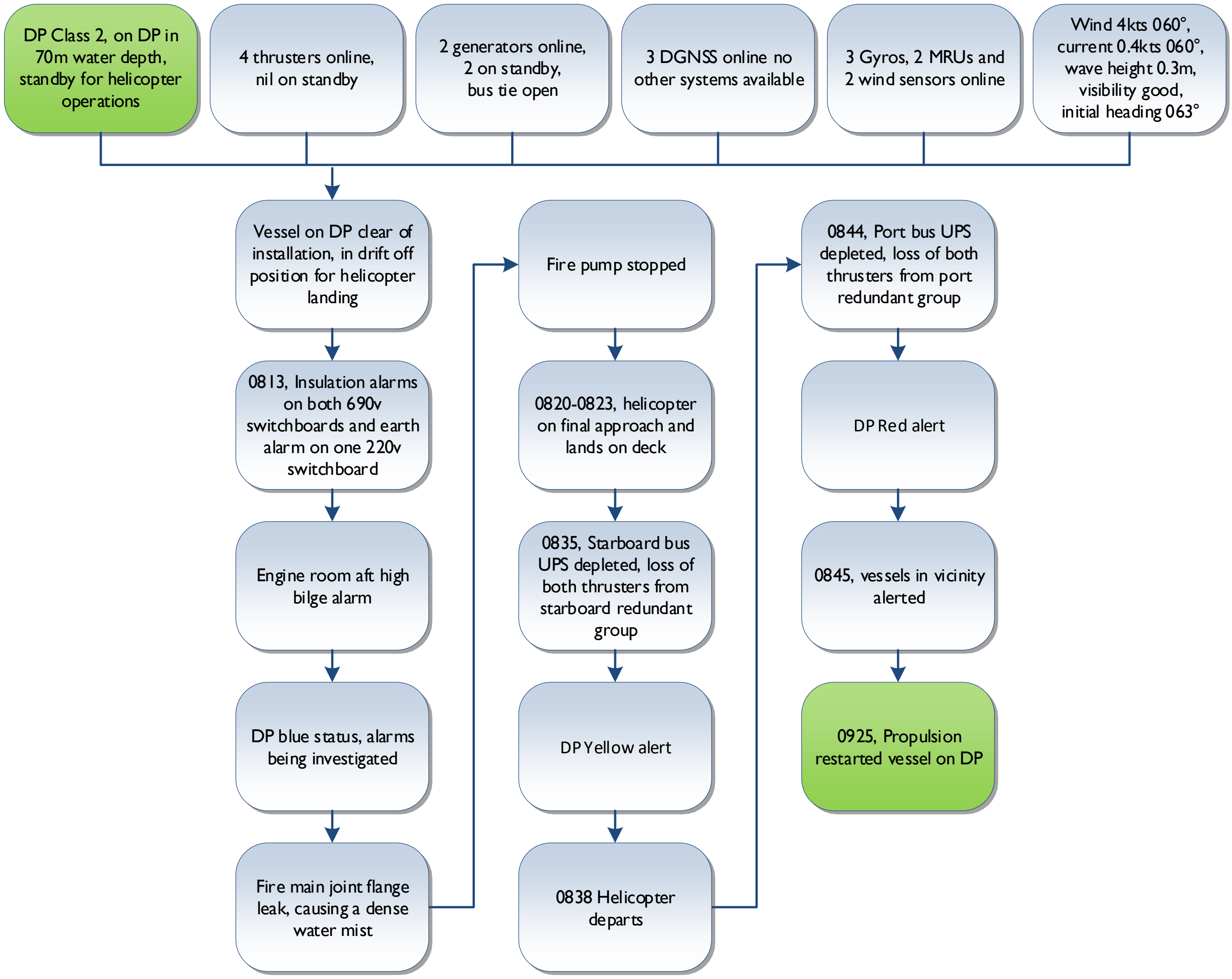
Considerations of the IMCA Marine DP Committee

The investigation did not conclude any findings related to the vessel losing power to 50% of its thrusters. There should be no conditions where the DP system can command thrust load such that online equipment is overloaded, leading to power failure. Therefore, questions remain unanswered regarding the setup of the thrust limitation system (blackout preventions) within the DP and power management systems (PMS), and/or the power systems ability to operate at near or full load. Such factors should be analysed within the vessel's DP FMEA and analysis confirmed through FMEA proving trials and subsequent DP Annual Trials Programmes.

This case study demonstrates the importance of good understanding of the DP system modes of operation, specifically when using a combination of automatic and manual control. The same operation could have been performed in manual or joystick control realising that the vessel would drift with the current.

The case study also highlights the need for planning and risk assessment of the operation. This will ensure that there are enough personnel on the bridge and those operating the equipment are fully aware of its functionality.

Pipe Leak Leads to Loss of All Thrusters – DP Incident



Comments from the report

Whilst pressurising the fire main for helicopter operations, a gasket failure occurred on the pipework valve under the engine room floor in front of transformers 690V/440V T3 and T4. The spray created a water fog and favourable atmosphere for an electric arc on T3 and T4 transformers, leading to a loss of 440v and 230v on vessel power plant. Upon depletion of the UPS batteries, the thrusters were lost.

A detailed investigation was undertaken with many findings including adding ingress protection at the transformers, adding isolation valves in the piping and modifying procedures. One supplementary finding related to the UPS systems, as both failed before 30 minutes. Investigation revealed that the load on the UPS's was greater than when they were tested alongside during annual DP trials.

Considerations of the IMCA Marine DP Committee from the above event

- It was questioned whether the DP alarm should have been yellow rather than blue and it is assumed that, for some reason, the alarms generated at 0813 were not interpreted correctly.
- There was concern that a fire main was passing through a transformer space. It was considered that if the vessel had been equipment class 3, it would have been subject to an assessment of the space so the danger of such an occurrence happening would have been noted.
- UPS battery endurance tests (30min check) should be performed with all UPS consumers connected and in use.

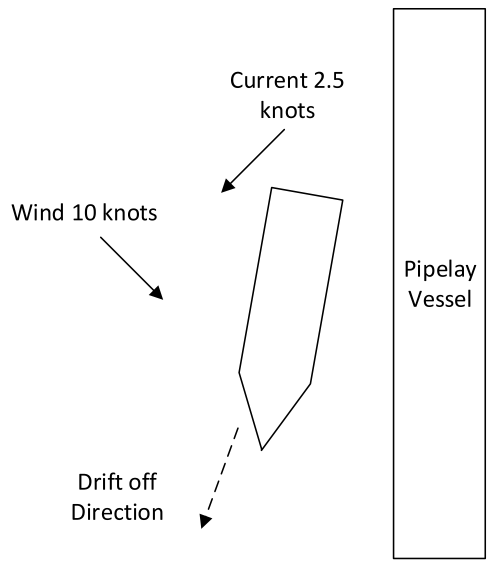
Steering Motor Failure Leads to Loss of Both Aft Thrusters – DP Incident

Case narrative

A DP2 cargo vessel was working close to a pipelaying vessel conducting cargo operations in a drift off position. The current at the time of the event was 2.5 knots which, in conjunction with 10 knots of wind, resulted in an external force of 30 tons acting on the port quarter.

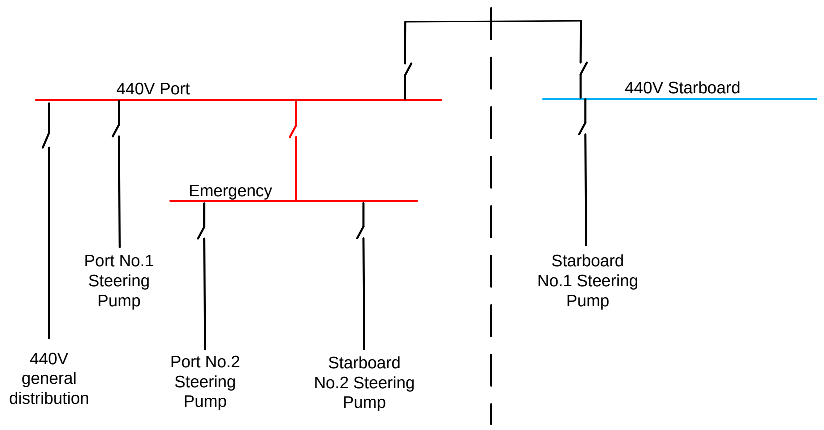
The port azimuth thruster failed as a result of failure of both steering motors. One of the two starboard azimuth thruster steering motors also failed; however, the thruster remained available due to the remaining healthy steering motor. Cargo operations were immediately ceased, and attempts were made to restart the port thruster unsuccessfully. During these attempts, the starboard thruster tripped due to a 'low hydraulic pressure' alarm.

With no aft thrusters available, the vessel drifted for around 200m before power was regained to one of the starboard steering pumps allowing the thruster to restart. The vessel was subsequently manoeuvred outside the 500M zone for failure investigation.



At the time of the event, the vessel was being operated on automatic DP2 mode, with 4 generators and 4 thrusters online. The main 690V, 440V and 220V switchboards were being operated with open bus tie; each side of the main switchboard powering one forward and one aft thruster as per the proven redundancy concept.

The supplies for port and starboard steering pumps were arranged in the same manner. Each pump was driven by electric motor controlled by variable speed drive (VSD). Steering pump no.1 for each thruster was supplied directly from the respective port or starboard main switchboard and steering pump no.2 for each thruster supplied from the emergency switchboard. The emergency switchboard was connected to the port main bus bar.



The investigation revealed a gradual but significant earth fault within a consumer supplied by the Port 440V general distribution panel. The Earth fault was caused by a trapped cable within a motor connection box. The cable had been trapped between the lid and body of the box during a recent maintenance inspection.

This earth fault had been detected by the sophisticated protection systems of the VSDs controlling the steering pumps on the port and emergency switchboards, but not the starboard switchboard as the bus tie was open. The VSDs tripped causing the three steering pumps to fail. Note that the VSDs are unable to differentiate whether an earth fault is upstream or downstream, therefore they will typically trip assuming that the earth fault relates to the equipment they control.

The remaining starboard steering pump tripped due to a low hydraulic pressure alarm. The cause identified in the investigation report as a faulty seal. Although there is no direct connection between this failure and the earth fault causing the other steering pumps to trip, the seal damage may have been exacerbated by the demand caused by the loss of the other starboard steering pump.

The Lessons

- The investigation report highlighted that the crew had properly set the vessel in DP2 mode and positioned the vessel in a drift off location. Despite their best efforts, they could not have positively affected the outcome of this failure.
- The earth fault, although caused by an unrelated consumer, caused the VSDs in question to trip. The investigation report highlighted that other VSDs of the same type did not trip therefore the VSD manufacturer was in the process of investigating the protection parameters of all VSDs on-board to determine any potential setting adjustments.
- The earth fault was caused by a trapped wire following equipment maintenance. The level of earth fault appeared to get progressively worse over time; however, this seemed to go unnoticed until the event occurred. The investigation report did not detail whether or not there was suitable switchboard earth fault monitoring installed. Nonetheless, this event clearly highlights the risks of inadequate earth fault monitoring and indeed procedures to be followed when such earth faults are measured/develop.
- The seal that failed on the starboard steering pump was found to be a known defective product. The investigation revealed that sister vessels had experienced the same seal failure and as such the investigation report highlighted the need to take a fleet wide approach to replacing the seals and ensuring critical spares were available on-board.
- Although there is no discussion regarding the DP system FMEA in the investigation report, the FMEA should have considered that there was the potential for cross connections and failure of port and emergency switchboards simultaneously. There should then have been FMEA proving trials confirming the outcome of such failures. This testing would have revealed that there was potential for loss of 3 out of 4 of the aft steering pumps.

Considerations of the IMCA Marine DP Committee

This case study demonstrates the challenge that exists when there is a classification rule requirement to install secondary equipment and supplies from the emergency switchboard, and the subsequent risks that the DP system design is then exposed to from a common mode/single point failure/cross connection perspective.

Such factors should be analysed within the vessel's DP FMEA. Analysis should then be confirmed through FMEA proving trials and subsequent DP Annual Trials Programmes with any necessary mitigating measures (technically or procedurally) put in place.