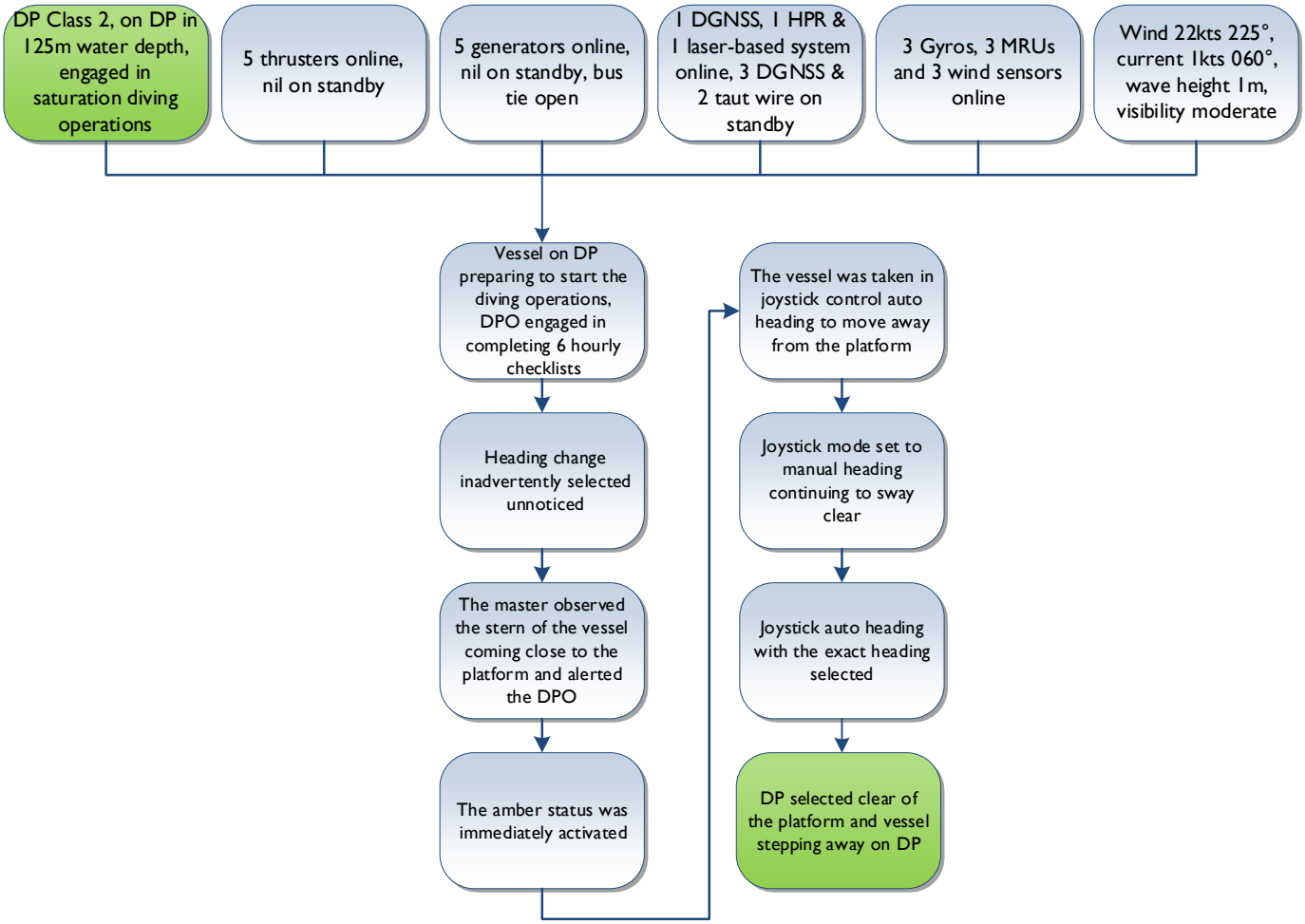
The following case studies and observations have been compiled from information received by IMCA. All vessel, client, and operational data has been removed from the narrative to ensure anonymity. Case studies are not intended as guidance on the safe conduct of operations, but rather to assist vessel managers, DP operators and DP technical crew in appropriately determining how to safely conduct their own operations. Any queries should be directed to IMCA Incident Reports at incidentreports@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.

1 Simultaneous activities on the bridge caused a DP Incident



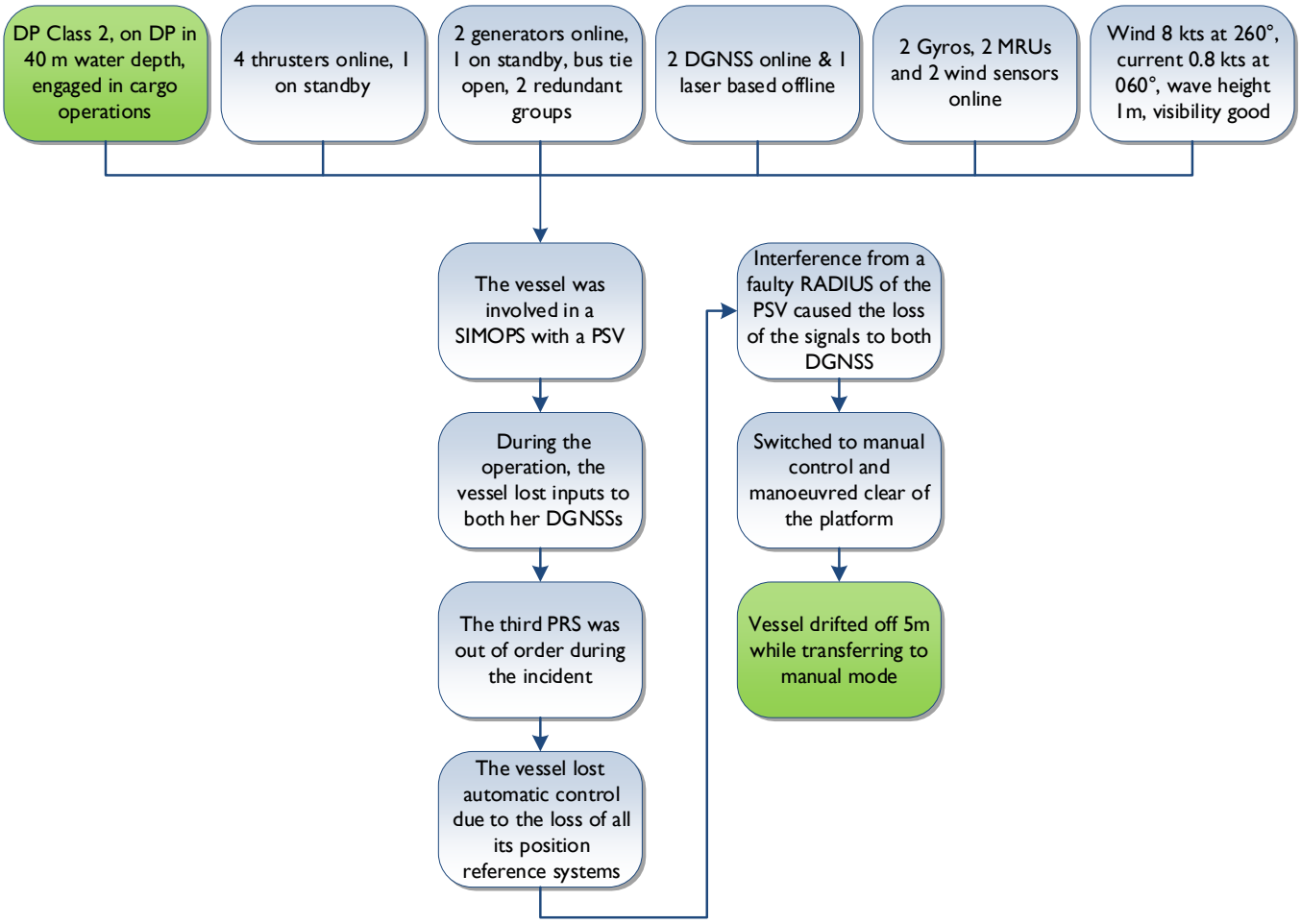
Comments from the report:

The DPO, though experienced, was new to the vessel and the DP system. He had undergone familiarisation of the system but misinterpreted 30° heading increment as being a 30° / min rate of turn. As the 6-hourly checklists were being completed, the vessel was making moves and deploying references. Multiple operations were initiated just prior to watch handover which could have been delayed by a few more minutes.

Considerations of the IMCA Marine DP Committee from the above event:

- Bridge resource management was not properly exercised. In principle, the second DPO should fill out the checklists and the DPO at the desk should concentrate on vessel position keeping only;
- The familiarisation process should be reviewed to be more robust to ensure new DPOs are completely familiar with the desk and functions;
- Reference should be made to IMCA M 117 "The training and experience of key DP Personnel;
- It should be noted that a 30^{o} per minute rate of turn was considered to be far too high whilst engaged in diving operations.

2 Inadequate Position Reference Systems Caused DP Incident



Comments from the report:

It is mentioned in the report that task appropriate mode (TAM) and activity specific operating guidelines (ASOG) were in use, with the limitation identified for 2 DGNSS subject to common mode failure.

Considerations of the IMCA Marine DP Committee from the above event:

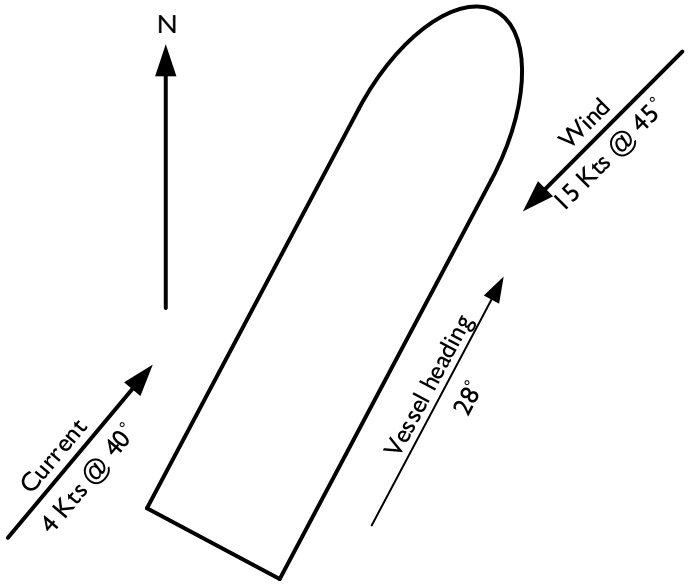
- Use of only 2 DGNSS was contrary to the MSc.1 / Circ. 1580 requirements. This meant the vessel was not set up in accordance with DP class 2 requirements of 3 position reference systems based on at least two different principles;
- Vessel sensors selection did not appear to comply with DP class 2 requirements, though this non-compliance was not a factor in the incident;
- Task appropriate mode was in place, indicating that a loss of position was acceptable. However, the incident indicates that an adequate risk assessment was not done and TAM and ASOG were not thoroughly reviewed prior to their approvals;
- When the vessel lost its automatic DP control due to the loss of all its PRSs, the position could have been maintained for a period of time using the DP mathematical model;
- The report states that interference from a faulty laser-based system on the PSV caused the loss of signals to both the DGNSSs. However, this could have been caused by interference of the differential correction signal receivers caused by shielding or reflection;
- Information on radio interference is provided in IMCA M 252 *Guidance on Position Reference Systems and Sensors for DP Operations*, Section 4.6 Operational Consideration Summary.

3 Lack of Experience in Dealing with Environmental Conditions Caused Loss of Position

Case narrative:

A DP 2 vessel with two redundant groups and operating in open bus mode, was involved in drilling operations in water depths of approximately 38 metres. The vessel was performing cone penetration testing (CPT) at a location with a drilling depth up to 90 metres. There were six thrusters and four generators available onboard and all were selected to DP. The available position reference systems (PRS) onboard were three DGNSS, one taut wire and one HPR, out of which only two DGNSS were selected to DP.

Also, out of the available four wind sensors, three of them were selected into DP, along with three gyros and three motion reference systems. The visibility was reported to be good with wind speed of fifteen knots at 045˚, current speed of four knots at 040˚and swells of 2 metres height with a duration of ten seconds at 220˚ were recorded during the operation. At the time of the incident, the vessel was drilling at a depth of 54 metres.



The vessel was encountering strong currents from the stern, as expected, and experienced by the DPO's during the earlier spring tides. For this reason, the vessel receives location specific current modelling from a remote centre during its operations. These models display peak marine current's direction and speed at any given time. During these strong currents, it is prudent to change the vessel heading regularly to follow the currents direction and to keep them at the stern.

The Event

At 20:00 hrs the senior DPO took over the watch at the DP desk and at 20:10 noticed the current was changing direction and intensity. The vessel heading was changed from 020˚ to 024˚ to keep the current at the stern. After the heading change, the loading on the vessel's thrusters were observed to be within normal operating limits and the vessel maintained its position. At 20:45, the SDPO noticed another change in the direction and speed of the current, and further observed that the load was increasing on all thrusters. The drilling control was advised of the need to make a further heading change as the CPT operation was ongoing.

At 20:54 the DP consequence analysis advised that the load was higher than one of the two redundancy groups could tolerate post worst-case failure. Ten seconds later, power consumption was within limits again. The SDPO advised the drilling control of a further heading change which was confirmed at 20:56, and the heading was changed from 024˚ to 028˚. At 21:00 the DP consequence analysis warning indicated that the power online was in excess of the capacity of one redundant group, post worst-case failure. This alarm lasted for one and a half minutes. After

completion of the heading change and at 21:05, the loading on the vessel's thrusters were observed to be within normal operating limits and the vessel maintained its position. The SDPO handed over the watch to the DPO.

At 21:15 the DPO alerted the SDPO that the load on thrusters T3 and T4 were increasing. The SDPO, immediately attended the DP desk, noticing that thrusters T3 and T4 loads were increasing and that the vessel was struggling to maintain its position. At 21:19 the heading was changed by 2˚ to 030˚. At 21:21 the DP system indicated high loads on T3 and T4 followed by a consequence analysis "Off -Position" warning alarm. Simultaneously, there were speed feedback faults on both T3 and T4. At 21:22 a DP yellow alert was given to the drill operators as the vessel excursions overshot the ten percent of the water depth limitation.

The drillers immediately stopped their drilling operation, lifted the drilling equipment, and hoisted it back at the moonpool. The heading was changed to 040˚ where the current was at the vessel's stern. At 21:25 the vessel settled down and could maintain position. At this time, the drilling assembly was inspected, and the pipe and the bottom hole assembly were observed to be in good condition. After a complete inspection, it was confirmed that there was no damage to the drilling equipment. Distance of uncontrolled movement during the event was nine metres and the duration of the event was recorded to be six minutes.

The lessons

- It needs to be fully understood that the current indicated was the "DP current" and not a "measured current". A DP current value could be affected by other disturbing factors and needs to be relied on with care with regard to magnitude as well as direction.
- It was mentioned in the report that the current strength was above the thresholds specified in the vessel ASOG. It is essential the ASOG is continually reviewed to ensure it covers all possible hazards during a specific operation.
- IMCA M 220 Guidance on Operational Activity Planning, discusses the importance of various documentations such as CAM, TAM and ASOG. DP and emergency response drills discussed in the document, highlight the importance that all DP personnel must know what actions to take and what to expect when operating parameters are exceeded.
- It is concluded in the report that current must be included as a factor in the vessel's manual of permitted operations. The effect of the stern thrusters, running at near full power and throwing the wash against the hull, will be reduced due to thruster-hull interaction. The vessel DP capability plots should be consulted.
- It needs to be highlighted that only two position reference systems of the same kind were being used. Therefore, with regard to position reference systems, the vessel was not set up according to DP class 2 requirements. A minimum of three position reference systems with one being of different type are required in a DP class 2 or 3 operation.
- The contents of the ASOG for this operation was not disclosed. However, it was stated in the report that immediately after the yellow alert, drilling operations stopped, and the drilling equipment lifted and hoisted up in the moonpool. It is not clear whether these actions were precautionary measures or mandates arising from the ASOG. In this instance a Yellow alert was indicated to the drill operators, if a loss of position was occurring a Red light should have been given to the drill operators.
- It is not clear in the report as to why the speed feedbacks on both T3 and T4 became faulty. One possibility was that the speed feedback discrepancies of T3 and T4 could have been caused by the strong current inflow and thrusters running at near or above full speed.

This case study demonstrates the importance of fully understanding the vessels capability and normal operating limits, and also ensuring that this level of detail is clear within the ASOG. The case study also highlights the significance of training in emergency situations for key DP personnel.

4 DP Emergency 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.

EXERCISE SCENARIO	**LOSS OF MAIN DP SYSTEM UPS**

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.

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 main DP system UPS by isolating all outputs simultaneously.
3. Check the vessel ability to maintain position using remaining online equipment.
4. Check the vessel DP crew ability to manage the situation in a controlled manner.
5. Discuss the results and determine how the risk of losing the UPS could be mitigated.

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 there any secondary failures expected, for example, mission equipment?

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?
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.

EXERCISE SCENARIO	LOSS OF MAIN DP SYSTEM UPS

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 UPS failures in the correct manner requires knowledge of the DP specific equipment being supplied by the particular UPS, how the DP system reacts to multiple failures and alarms and the human intervention required, if necessary, to ensure station keeping. Items to consider include:

a. Awareness of the UPS DP supplies segregation (following the redundant groups)
b. Appreciation that internal UPS failures can prevent bypass facilities operating in some designs
c. DP system reaction to multiple failures
d. What to look for on the operator stations
e. What event and alarms indicate UPS failures
f. Methods of fault finding and investigation
g. Appropriateness of communication
h. Training requirements

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