

These flashes summarise key safety matters and incidents, allowing wider dissemination of lessons learned from them. The information below has been provided in good faith by members and should be reviewed individually by recipients, who will determine its relevance to their own operations.

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A number of other organisations issue safety flashes and similar documents which may be of interest to IMCA members. Where these are particularly relevant, these may be summarised or highlighted here. Links to known relevant websites are provided at www.imca-int.com/links. Additional links should be submitted to webmaster@imca-int.com

Dynamic Positioning (DP) Blackout Incident

We have received the following information from a member regarding a DP blackout incident on one of its vessels. This safety flash outlines the incident, the learnings from the incident and the member's recommendations.

1 Operational Status

At the time of the incident, the member's vessel was engaged in routine saturation diving operations and all the systems were operating normally. The weather was good, well within the limits for safe diving operations. There was a 21 knot wind from the south east and a 0.5m swell running. The dive teams had just completed an on-bottom hand over. An ROV was also at depth with a minor entanglement in some soft line.

2 The Incident

At 02:55 hrs power from Board A to the Starboard bell was lost. Board B was selected. Numerous Starboard bell alarms activated. Some seconds later at 02:56 hrs, the vessel suffered a brief but complete loss of electrical power to all ship's systems, an event known in the industry as a 'black ship' condition.

All vessel systems that were powered from the vessel's power management system (PMS) were lost due to the power failure. Some systems that should have been protected by uninterruptable power supplies (UPSs) also failed.

Some two minutes later as power and power management was returning, an azimuth thruster was restarted by the DPO. A further two minutes elapsed before a tunnel thruster started. With propulsion now available fore and aft, station keeping capability returned. At 03:07 hrs, control of the vessel was regained and by 03:11 hrs, all services had been restored, all generators were on line, all thrusters running and selected to DP. The divers were successfully returned to the bells and recovered to the surface.

By a combination of the efforts of the ship's crew and the automatic functions of the PMS, power was quickly and progressively restored to the vessel's systems.

Initial alarms on the Bridge included loss of power management and loss of propulsion followed quickly by loss of power. The loss of power in turn caused loss of communications, lighting, clocks, positioning systems and steering. Alarms for 'dive warning' and 'abort dive' were activated in sequence by the DPO.

During the period between the blackout and regaining control of the vessel, the vessel had moved some 190m from its original position at the work site.

3 Conclusions as to Cause

The immediate causes of the incident have been identified as technical in nature. Management system failures were also found to have contributed to the incident.

1.13.1 Technical

The technical failures that triggered the events that blacked out the vessel have been identified as:

- ◆ Erroneous signals were issued from the PLC that manages the power distribution onboard the vessel. The erroneous signals were the result of physical degradation of the PLC's backplane through which all signals to and from the unit pass. This physical degradation definitely included loose contacts, dry joints and possibly also cracked and broken tracks in the circuit board itself. All of these physical substandard conditions can be attributed to ageing of the backplane.
- ◆ Terminal resistors on the printed circuit boards within the PLC had been snipped but not fully removed. It is likely that the attempted isolation of these resistors was done at the time the vessel was commissioned. With the natural vibration of the ship, these resistors were intermittently contacting the remainder of the circuit boards of which they were originally a part. The effect of this was to corrupt the data stored in the system that tells the system the status of the machinery on the vessel.
- ◆ Wiring within the PLC unit was incorrect resulting in reverse polarity in the series of communications cables. The effect of this would have been to stress the electronic components within the system though no evidence was found that this stressing had caused failure in any components. The reversed polarity could also have caused corruption of the telegram signals between boards contributing to the corruption of data.

It was found that US1 detected a self-fault and initiated a change over. US2 took over from US1 as the master PLC. US1 shut down as it was receiving inconsistent data and interpreted this as a fault within itself. This occurred as a result of the corrupted signals issued from the faulty backplane. US2 took over as it was designed to do.

Once US2 took over from US1, the combination of erroneous signals and corrupt data caused the software to open the Port 230V secondary breaker and then to take both generators off the 6kV board and open the 6kV bus tie more or less simultaneously. This action left the vessel without power resulting in the blackout.

1.23.2 Management Systems

3.2.1 Prior History

The investigation found that there was a significant history of unexplained starting and stopping of machinery onboard the vessel going back over many years though the significance of this history was not recognised either by offshore or onshore management.

In hindsight, it is clear that the previous events were significant in that they were indicating a fault condition that could, and ultimately did result in unsafe conditions. However, prior to the blackout and subsequent investigation, personnel operating the vessel believed that the FMEAs of the vessel's systems and the classification of the vessel confirmed that no single point failure could introduce unsafe conditions.

1.1.23.2.2 FMEA, Trials & Audits

The DP FMEA for the vessel has been reviewed as part of the investigation and was found to be inadequate. This had not been identified either internally or in the process of the many trials programmes and audits which the vessel has undergone since the FMEA was written in 1991.

1.1.33.2.3 Planned Maintenance

The investigation found that the UPSs onboard the vessel are not included in the planned maintenance system.

1.1.43.2.4 Training and Procedures

Until the incident, it had been universally considered that a blackout condition was not possible onboard the vessel due to the configuration of the PMS. Consequently, the crew had not trained to deal with such an event, no procedures were in place and no back-up power available. Given the very sudden and comprehensive nature of the blackout, the crew responded in a professional manner to the event, normalising the situation without injury or significant damage.

4 Recommendations

As a result of the incident and the findings of the investigation, the company involved has identified a number of recommendations which are set out below:

- i) The existing PMS, which was installed some years ago and is becoming obsolete should be replaced with a more modern system. The learning from this incident should be incorporated in the specification for the new system.

- ii) Planned maintenance routines should be revised to include the UPSs onboard. Pre-operational checks should include testing of relevant UPSs. The UPSs should be reconfigured so that power is supplied to the consumer through the UPS at all times. Primary and secondary monitoring should also be installed on all UPSs.
- iii) The scope of Dynamic Positioning FMEAs for other vessels in the fleet should be reviewed to ensure that all features affecting the redundancy capabilities of each vessel, including power management, are included in the analysis.
- iv) The scope of Diving System FMEAs for other vessels in the fleet should be reviewed to ensure that all features affecting the redundancy capabilities of the diving system, including power management are included in the analysis.
- v) The impact of ageing on critical components on other vessels in the fleet should be considered as part of FMEA (or FMECA) and maintenance/upgrade system requirements adjusted accordingly. The age profile of existing safety critical electronic systems should be mapped.
- vi) The adequacy of the annual DP trials protocol should be reviewed to ensure that they verify the effectiveness of the redundancy provisions associated with power management and its criticality in respect of station keeping in accordance with revised FMEAs.
- vii) A review should be undertaken to determine if the timing mechanisms of the various systems onboard can be synchronised. If this is practical, it should be implemented.
- viii) Diving emergency and contingency procedures to be reviewed as a result of this incident and familiarisation of personnel with emergency power options emphasised.
- ix) The PMS/DP failure/maintenance records on the other vessels in the fleet should be reviewed to identify if any have similar history that could now indicate common failure modes.
- x) Existing records of non-conformity (NCRs) should be reviewed to identify any trends that may suggest common fault modes in safety critical equipment. Consideration should be given to establishing a technical review panel to evaluate equipment related non-conformity reports.
- xi) Black box recording of fault detection and logging should be established for all key safety parameters. This would assist in identifying intermittent faults prior to incidents and the analysis of causal factors after incidents.
- xii) Policy in respect of supervision of work on safety critical systems should be reviewed with a view to improving control and addressing the potential for poor workmanship. This should include third party activities and should apply to new systems and change or modification of existing systems.