BLACK OUT ON A DP 2 CLASS VESSEL OPERATING WITH AN ASOG AND A SEGREGATED POWER PLANT

Target audience

- Vessel Management and Operations Teams on DP Vessels
- DP Technical Support Function of Vessel Owners/Contractors
- Vessel Designers, Electrical Vendors,
- FMEA Providers
- Classification Society DP Approval Authorities

What happened

A DP 2 vessel carrying out light subsea inspection repair maintenance activities had a black out and as a consequence had a loss of position (LOP) incident. The vessel was operating in open water and there were no consequences to people, assets or environment associated with this LOP incident.

A control power conductor broke off Diesel Generator 3 (DG3) and made contact with earth (vessel's hull through Engine Foundation). DG3 stopped due to loss of control power, a predictable consequence. What was not predicted as a consequence of such a failure was that the remaining three on line generators would also stop resulting in a black out and a loss of position. The vessel was being operated in accordance with the Activity Specific Operating Guideline and the power plant and auxiliary systems were segregated in line with the redundancy concept. Such a loss could have occurred only if there was a common link from DG3 to the other engines.

Why it happened

Independence, Segregation and Autonomy of redundant groups were compromised by introducing commonality through the 24 volt battery charger wiring. Isolation provided by the open busties was defeated.

Each engine had its own 24Vdc battery bank and charger but they were not referenced to the ship's hull.

Grounding/Earthing arrangements for generator control supplies, on the engines and within the main switchboard, were a mix of floating and hull referenced ground points as shown in Figure 1.

Investigation revealed a 30 ohm impedance from each engine to the hull indicating that the 24Vdc electrical control power systems were not fully floating as originally thought.

When the earth fault occurred, the commonality in the switchboard wiring allowed the voltage on the negative supply rail of the floating 24Vdc systems to be raised with respect to those parts of the control

system that were referenced to the vessel's hull causing a malfunction which stopped the engines of DGs 1,2 and 4. See Figure 2.

The 24Vdc battery charger output circuit breaker did not trip suggesting that the current was low and confirming the fault was not a short circuit.

The investigation revealed another potential fault propagation path which could have resulted in the same consequence. This failure mode was created by a common black start battery system spanning all redundant DP groups. See Figure 3. The full extent of the threat posed by this potential fault propagation path had not been captured in the DP system FMEA.

The owner operator also investigated all other vessels in its fleet, a sister ship was found to have same design issue with fault propagation paths.

Lessons learned

a. Potential fault propagation paths which introduce commonality across redundant DP groups must be identified in the DP FMEA.

b. Designs should eliminate avoidable cross connections across redundant DP equipment groups.

c. Unavoidable connections across redundant groups must be analyzed and immunity to common mode failures verified by testing.

d. A common grounding philosophy should be used for all control system power supplies.

e. Where possible, specifications for earthing and grounding of control systems should require earth (hull referenced) grounding as this reduced the potential for hidden failures and fault propagation by way of floating power supply lines.

Additional Notes

Designs with cross connections across redundant groups are vulnerable to larger failures with the potential to experience serious consequences

All avoidable cross connections across redundant groups should be avoided.

Designs where cross connections across redundant groups cannot be avoided should be subject to additional scrutiny and attributes of fault tolerance, fault resistance and fault ride through be validated by additional analysis and testing.

Other examples of cross connections or commonalities which introduce vulnerability to loss of position are, backup power supplies across redundant groups, data connections across redundant groups, common 24Vdc control power supplies to all redundant groups, lack of

differentiation in redundant equipment, typically sensors and position reference sensors, Errors in software/firmware compounded by commonality across redundant groups (eg lack of differentiation in gyro compass types).

Recommendations

It is recommended that owners of DP vessels disseminate this LFI to Vessel Management Teams on all DP Vessels and to their electrical contractors and vendors of DP FMEA;s and to their DP Technical Support Function.

It is recommended that Vessel Management Teams and DP Technical Support Functions review this LFI and provide positive confirmation through their respective organizations to the accountable DP Technical/Quality Focal that their vessels designs and documentation were reviewed against this LFI and subject vessels are not vulnerable to the potential for such an incident. Results of this investigation should be communicated back within a mutually agreed time (No of days TBD) from the date of receipt of this LFI. If vulnerabilities have been identified Vessel Management Teams and DP Technical Support Functions, are recommended to communicate through their own internal process, the remediation measures being undertaken along with timelines to be concluded within Timelines to be mutually agreed to between Vessel Management Teams and DP Technical Support Function and Client if necessary.

Further information on the lessons learned or support to the business if required can be obtained by contacting MTS DP Committee (Insert Contact)

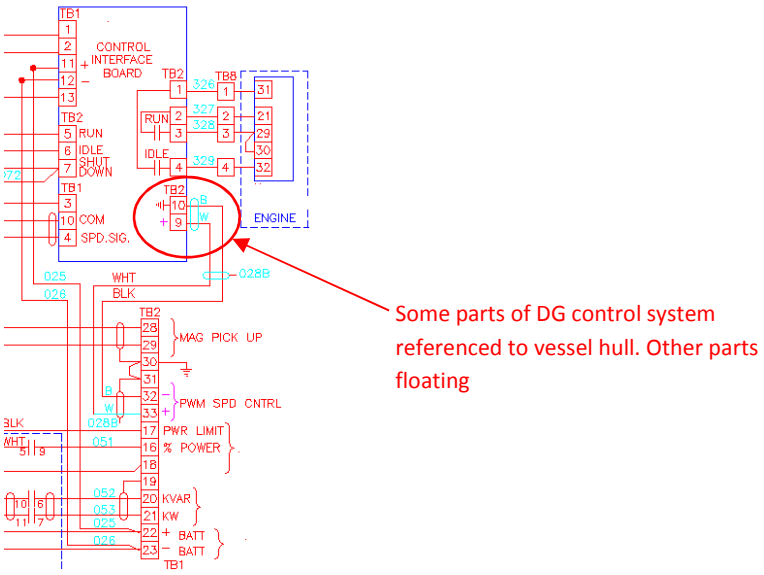


FIGURE 1

MTS DP COMMITTEE THANKS THE SUBMITTER OF THIS LFI ON BEHALF OF THE DP COMMUNITY. LFI's ARE PUBLISHED ON THE MTS DP COMMITTEE WEBSITE TO PROMULGATE LEARNINGS FROM INCIDENTS WITH A VIEW TO ENABLE PROACTIVE MANAGEMENT OF SUCH VULNERABILITIES AND MINIMIZE POTENTIAL FOR DP LOSS OF POSITION INCIDENTS.

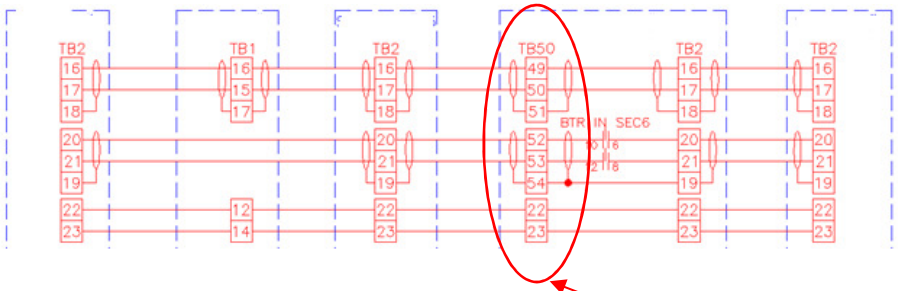
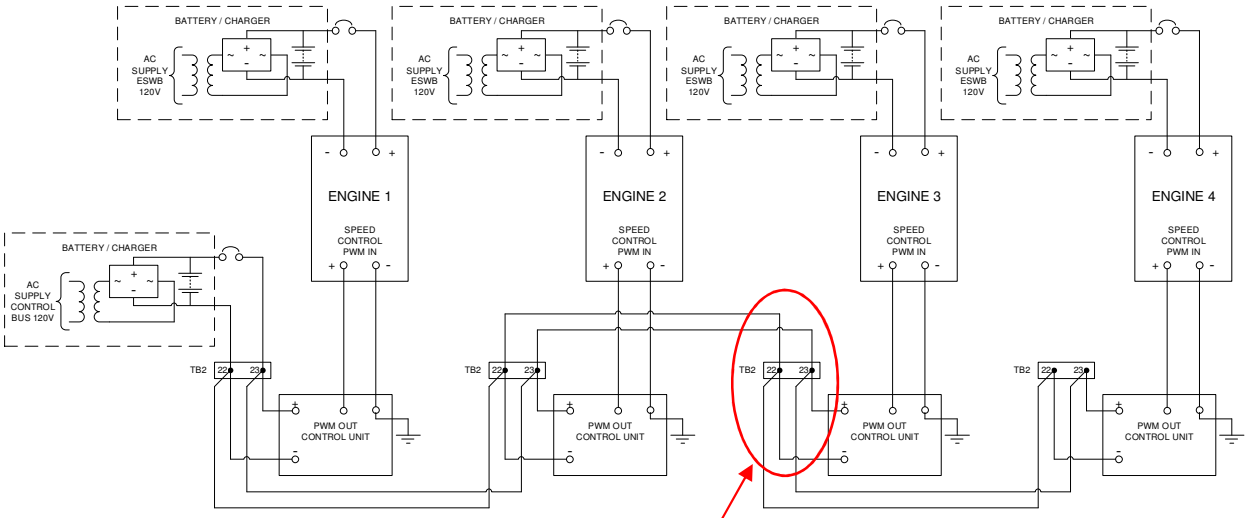


FIGURE 2

Several potential fault propagation paths created by control wiring between generators and redundant DP equipment groups



Potential fault propagation path introduced by common black start battery supply

FIGURE 3

MTS DP COMMITTEE THANKS THE SUBMITTER OF THIS LFI ON BEHALF OF THE DP COMMUNITY. LFI's ARE PUBLISHED ON THE MTS DP COMMITTEE WEBSITE TO PROMULGATE LEARNINGS FROM INCIDENTS WITH A VIEW TO ENABLE PROACTIVE MANAGEMENT OF SUCH VULNERABILITIES AND MINIMIZE POTENTIAL FOR DP LOSS OF POSITION INCIDENTS.