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## Upgrade of DP Failure Mode Effects Analysis

P. Fougere, Transocean, and A.A. Pallaoro, Petrobras

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### Abstract

Failure Mode Effects Analysis (FMEA) is the primary tool for Dynamic Positioning (DP) system reliability assessment and is required by the Classification Societies for DP-Class Notation. However, many DP vessels have experienced faults that either were not identified in their FMEAs or were more severe than their FMEAs indicated. This paper's authors, and others, have questioned why DP FMEAs have not been as effective as expected.

As a result, the paper will discuss:

- Post-FMEA experience of DP vessels;
- Conclusions of gap analysis between DP FMEA-expected results and actual experience;
- Specific steps to upgrade the quality of DP FMEAs on existing vessels. Upgraded FMEAs of three vessels are compared to previous FMEAs, demonstrating higher effectiveness with additional single-point failures identified;
- Ways that vessel personnel can utilize the FMEA to improve responses to unplanned events.

The summary conclusion shows that FMEA effectiveness is sensitive to several predictable factors.

### FMEA History

The U.S. military has employed FMEA techniques since the 1970s as a design aid to enhance equipment reliability. An early application of FMEAs in offshore drilling on the Transocean vessel *Discoverer Seven Seas* identified DP reliability improvements in 1985. By the early 1990s, FMEA techniques were in wider use in the marine industry. The UK trade organization Dynamic Position Vessel Owners Association (DPVOA) cited the FMEA technique in its 1991 "Guidelines for the Design and Operation of Dynamically Positioned Ves-

sels."<sup>1</sup> After the 1994 publication of International Maritime Organization (IMO) MSC CIRC 645<sup>2</sup> the Classification Societies, including ABS, DNV, and Lloyds Register of Shipping, subsequently included FMEAs in their DP Class Notation requirements as the primary means of identifying failure modes.

FMEAs were then widely employed to satisfy those requirements. For most vessels, physical trials were used to verify the FMEA. Once these vessels began their working lives, however, equipment failures sometimes resulted in effects more severe than those identified in the vessel's FMEA. Also, some failure modes experienced were not even identified in the FMEA. Evidence and recognition of such issues grew through the early 2000s and produced reaction by industry groups. For example, the International Marine Contractors Association (IMCA) attempted to address these developments in two papers titled: "Guidelines on Failure Modes and Effects Analysis (FMEAs)"<sup>3</sup> and "FMEA Management Guide."<sup>4</sup> Another important document was a study commissioned by the UK HSE (Health and Safety Executive) titled "Review of Methods for Demonstrating Redundancy in Dynamic Positioning Systems for the Offshore Industry."<sup>5</sup>

### Gap Analysis

Believing that FMEAs could deliver better results, we looked for the root causes of the disparity between the predicted and actual results and found the following:

- Failure by an owner to specify, or adequately specify, an FMEA's scope and depth, which often led to a shallow, ineffective FMEA.
- Failure of the FMEA vendor to perform sufficient analytical work. The default tended to be an experienced-based FMEA performed by one or two individuals who looked for familiar faults that identified only a worst-case fault for each system. The FMEA should have been done by competent specialists to

<sup>1</sup> "DPVOA 103/IMCA M 103: Guidelines for the Design and Operation of Dynamically Positioned Vessels," IMCA, London, (1991)

<sup>2</sup> "IMO MSC/Circ 645: Guidelines for vessels with Dynamic Positioning Systems," IMO, London, (1994)

<sup>3</sup> "IMCA M 166: Guidelines on Failure Modes and Effects Analyses (FMEAs)," IMCA, London, (2002)

<sup>4</sup> "IMCA M 178: FMEA Management Guide," IMCA, London, (2005)

<sup>5</sup> Spouge, John: "Review of Methods for Demonstrating Redundancy in Dynamic Positioning Systems for the Offshore Industry," paper presented at the 2003 IMCA Deepwater Marine Operations and Safety Conference, Houston, November 5 – 6.