Current Performance and Future Practices in FPSO Hull Condition Assessments

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ABSTRACT

The aim of this paper is to show the benefits of enhancing classic Risk Based Inspection (without fatigue monitoring data) with an Advisory Hull Monitoring System (AHMS) to monitor and justify lifetime consumption to provide thorough grounds for operational, inspection, repair and maintenance decisions whilst demonstrating regulatory compliance.

KEY WORDS: FPSO Inspection; Advisory Hull Monitoring System (AHMS); Non-Destructive Testing (NDT); Risk Based Inspection (RBI); Structural Health Monitoring (SHM); Condition Based Maintenance (CBM).

INTRODUCTION

Floating Production Storage and Offloading units (FPSOs) are being recognized as one of the most economical systems to exploit marginal and (ultra) deep-water area’s (Paik and Tayamballi, 2007). With the increasing of the size, complexity and economic interests of these units, emphasis lies on the optimization of design, construction and operation in order to achieve high levels of functional integrity in terms of Safety, Health and Environmental (SHE) factors, and lifecycle capital (CAPEX) and operational (OPEX) expenditures.

FPSO structures pose some difficulties in contrast to traditional fixed offshore structures and trading tankers, as the units have a very large displacement volume and are continuously operated under (benign) site-specific environmental conditions, endure high levels of loading and offloading cycles, are equipped with mooring systems and can experience dynamic impacts from sloshing, green water, wave slamming and shuttle tanker collision and generally lack the ability to dry-dock. In order to safeguard structural integrity and fatigue lifetime consumption, calculations are required to detect and predict structural deterioration before a possibly catastrophic, polluting and/or expensive failure can result (Tammer and Kaminski, 2013).

Current FPSO design, construction and maintenance practices rely on traditional structural inspection methods as a primary instrument to identify and mitigate system anomalies and unanticipated defects. Logically, during the service life of a unit a small Probability of Failure is inevitable due to the complexity of the design, construction and operational characteristics, as well as from the economic principle of reasonableness. This Probability of Failure is usually managed through periodical inspections of specific details and is combined with the Consequence of Failure to provide a risk profile and inspection scheme to prevent incidents and maintain a specific safety level. Conversely, unnecessary, disruptive and costly inspection and maintenance could lead to high costs, downtime, subsequent damage and inherent Safety, Health and Environmental issues and should be prevented as much as possible. Hence, an optimum exists, which should be approximated as well as possible.

Risk Based Inspection (RBI) can be depicted as an emerging methodology, playing an inevitable role in determining this optimum with respect to fatigue degradation of FPSO hulls. The methodology focuses on more directed inspection effort to the most critical risk profiles through a generalisation principle. This further strengthens the case for correct inspection results, as these form one of the constitutes for the (future) integrity management and inspection plans. However, inspection (activities) intrinsically include fundamental limitations. In general, inspection performance relies on the available resources, skills, methods and inspection frequency, which pose challenges. It is argued that the use of Structural Health Monitoring can provide for a damage detection- and characterization strategy to overcome (most of) these issues.

Risk Based Inspection

In order to operationalize residual fatigue life-calculations and performance- and compliance based inspection regimes, the quantification and qualification of risks and the affiliated thresholds is essential. Traditionally, design data, historical records, input from ‘comparable’ assets, expert judgment, Non-Destructive Evaluation/Testing (NDE/NDT), (limited) probabilistic modelling and industry and legal standards are used to determine (initial) regimes. After gaining experience from the initial and subsequent inspections, degradation patterns for probabilistic models can be constructed. These models are able to produce estimations and predictions about asset degradation and structural integrity at a specific time in the future. By linking this understanding of degradation propagation with the classification of the inherent risks of this process and the consequences of failure, a more specific assessment and risk ranking can be made as an alternative for standard (prescribed) practices - which could be unsuitable for a specific asset design and/or operational context (over- or under stringent). Hence, the practice which is referred to as Risk Based Inspection (Tammer and Kaminski, 2013).