

Risk-Based Inspection Planning Applied to 14 Steel Jacket Structures

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ABSTRACT

This paper presents the methodology for developing and applying a risk-based inspection (RBI) strategy for 14 steel jacket structures located in Bass Strait, Australia. The platforms range in age from 10 to 30 years and are situated in water-depths between 46 and 96 m. The RBI methodology was developed to improve the prediction of the structures' condition and provide a consistent basis for continued improvement. This methodology produces targeted inspection work-scopes for each platform that, coupled with the implementation of appropriate inspection techniques, ensure that the integrity of the platforms can be managed with greater confidence and at lower cost.

INTRODUCTION

For more than 30 years Esso Australia Ltd., with 50:50 joint venturer BHP, has been producing oil and gas from Bass Strait, an area off the South East Coast of Australia with one of the harshest environments in the world. Since early 1969 Bass Strait has been Australia's premier oil and gas production area, transforming Australia's oil supply situation from one of almost complete dependency on imports to one of substantial self-sufficiency.

With 14 steel jacket structures, the underwater inspection, repair and maintenance activities have consumed a significant proportion of the overall operating budget.

In the mid 1990s Esso decided to improve the effectiveness and efficiency of inspection by implementing a risk-based approach. The problem faced was to develop a practical risk-based inspection planning strategy capable of maintaining effective safeguards against structural deterioration at a minimal cost.

In 1997 Esso contracted QCL International to assist in developing and tailoring such a strategy to the Bass Strait fields and to apply this risk-based approach to the jacket structures. The methodology developed is based largely on QCL's Questar technique (Descamps, Woolley and Baker, 1995, 1996), but has been adapted and improved in order to meet Esso's needs and objectives. A first version of this methodology was applied to 2 jacket structures in 1997. The methodology was further refined in 1998 following third-party validation (DnV) and more suggestions from Esso. The final methodology has now been applied to all Bass Strait steel jacket structures, with optimised inspection programs being developed. The ongoing implementation of these programs has proven successful in that inspection results indicate that the scope of the programs is targeting critical areas of the structures, and with this the knowledge and confidence in the integrity of the structures are improved.

ROLE OF UNDERWATER INSPECTION

Failure of a jacket structure may be defined as total or partial collapse, permanent tilt or excessive deflection (that could lead to riser failure, for instance). The plausible mechanisms of jacket failure are detailed in the fault tree shown on Fig. 1.

Safety management practices such as the ship exclusion zone or emergency response drills address the risk of immediate failure of the structure (left branch in Fig. 1). The probability of collapse of the intact structure under extreme environmental conditions can be determined from a pushover analysis of the intact case. This probability is the minimum probability of platform collapse (once the platform starts deteriorating, the probability of platform collapse will increase) and thus represents the lowest threshold of the probability of platform collapse.

The proposed risk-based inspection planning methodology aims to manage the time-dependent probability of combined local weakening of the jacket and appurtenances, followed by high loading conditions (middle branch in Fig. 1). The probability of individual component failure is assessed, one by one, as well as the resulting conditional probability of platform collapse and appurtenance failure. The upper threshold of the overall probability of platform collapse is determined from a pushover analysis of the damaged case with the worst credible weakening of the jacket. Regular inspection of fatigue-sensitive components and CP (Cathodic Potential) surveys will manage the risk of pure progressive failure (right branch in Fig. 1) and will help to ensure that no multiple member failure through pure progressive fatigue and/or corrosion deterioration will stay undetected. With regular inspection, the combined probability of multiple critical members failing is extremely low. In these conditions the worst realistic weakening scenario is assumed to be single member failure. For completeness, the effect of multiple member failure in terms of reduction of platform's strength is the subject of a sensitivity study being carried out.

Fig. 2 gives a typical representation of the time-dependent probability of failure of intact and damaged structures, with upper and lower threshold values.

Underwater inspection is primarily concerned with preventing the gradual failure of the structure and its appurtenances by

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