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FATIGUE LIFE EXTENSION OF OFFSHORE STRUCTURES

BY ULTRASONIC PEENING

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ABSTRACT

The service life of offshore installations is limited by its structural integrity. Furthermore the structural integrity is mainly governed by the fatigue resistance of critical welded details. In a FPSO installation these details are among others pallet stools weld joints to deck structure and bulkheads/web frames weld connections to longitudinal in ballast tanks. ultrasonic peening can improve the fatigue resistance of welded joints. Fatigue test results shows an increase of four times for high stress ranges and up to ten times for high cycle fatigue. For specimens which have already consumed half of their fatigue life the treatment resets the clock to zero, as a minimum value. Consequently ultrasonic peening treatment was applied to several offshore installations on fatigue sensitive weld connections with the objective to extend the service life of the these. Finite Element Analysis carried out by classification societies for these offshore structures demonstrated critical fatigue lives for several weld connections. These weld connections were then treated by ultrasonic peening with the objective to extend their fatigue lives and by doing that reach the targeted service life for the installation. The successful application of the ultrasonic peening treatment was a pioneering work which involved several partners.

A pilot project on a FPSO started in 2005 and the treated critical weld connections are still intact and show not sign of crack initiation despite the fact the calculations then showed shorter fatigue lives than the life span already consumed. As a result the same ultrasonic peening procedure has been proposed to be applied for other fatigue sensitive locations on the installation.

Offshore installations around the world are reaching their original design life. Most of the operators chose to extend the service life of their assets rather than scrape them and build new. The reasons for that are: improved oil recovering techniques, time required to get a new build installation on site, environment concerns, wiser management of energy and resources among others. Therefore the Life Extension of Offshore Installations is a subject of current interest for the upstream industry.

INTRODUCTION

The application of fatigue life improvement techniques on offshore installations is gaining popularity in the last years as showed on the f. ex. on the latest FPSO Forum [1]. Classification Societies have also been focusing more and more on these and one document dealing with it presents recommendations for weld toe profiling by machining and grinding, weld toe grinding, TIG-dressing and hammer peening [2]. The other important document in respect to execution of the improvement is the IIW Recommendations [3], which contains extensive reference data for various fatigue life improvements [4] and the quality assurance and control of their application. Specifically ultrasonic peening have been generally accepted for reconditioning of structures by ABS in the Notice No. 3 to its Guidance Notes [5].

Fatigue life improvement techniques can contribute to reduce maintenance cost by the avoidance of returning weld repairs. Furthermore life extension techniques are the only