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Fatigue Life Extension Procedure for Offshore Structures by Ultrasonic Peening

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Abstract

The service life of a FPSO is limited by the structural integrity of the ship's hull. 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 stool brackets welds and longitudinal weld connections to web frames and to bulkheads in ballast tanks.

Ultrasonic Peening can improve the fatigue resistance of welded joints. Fatigue test results show a life extension of four times for high stress ranges and up to ten times for high cycle fatigue. For weld details which have already consumed half of their fatigue life ultrasonic peening treatment resets the clock to zero, as a minimum value.

Consequently ultrasonic peening treatment was applied on FPSO Triton on fatigue sensitive weld connections with the objective to extend the service life of this offshore installation.

The economical benefits due to reduced maintenance as a result of the ultrasonic peening treatment include:

- Avoidance of a long term plan for extensive hot work
- Avoidance of long and unscheduled operational disruptions
- Increased structural safety for the installation during the remaining service life

1. Introduction

The application of fatigue life improvement techniques is gaining popularity in the last years. Classification Societies have been focusing more and more on these and the latest document dealing with it [1] presents recommendations for weld toe profiling by machining and grinding, weld toe grinding, TIG-dressing and hammer peening. The other important document in respect to the execution of improvement techniques is the IIW Recommendations, which contains extensive reference data for various fatigue life improvement techniques and quality assurance and control of their application [2]. Besides these documents an evaluation of different fatigue life improvement techniques including their interaction with parent plate strength showed that ultrasonic peening is a promising method due to achieved improvement combined with its simple application [3]. As late as November 2009 ABS presented Notice No. 3 to its Guidance Notes where a general acceptance of ultrasonic peening for reconditioning of structures is stated [4].

Fatigue life improvement techniques can contribute to reduce maintenance cost by avoidance of recurring weld repairs. Furthermore life extension techniques are the only remedy when higher stresses and/or fatigue cracks occur in a structure with many years remaining service life. One of the most promising techniques currently used to extend the fatigue life of welded joints is ultrasonic peening. The technique consist of introducing a groove at the weld toe, "cleaning" the weld toe from possible crack sites as well as introducing compressive stresses during the same and solely working operation. The effect of "cleaning" the weld toe region as well as the introduction of a weld toe groove, which decreases the geometrical stress concentration, have undisputed benefits which are also easy to quantify.