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Methodology to Establish the Fitness for Continued Service of a Damaged Export Pipeline in 1000 m of Water

D. Raghu, Shell Global Solutions US, Houston, TX, Richard Swanson, RCS Engineering, Houston, TX, Chris Alexander, Stress Engineering Services, Houston, TX

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Abstract

Deepwater pipelines are critical arteries that transport gas and oil production from the Gulf of Mexico to onshore transportation hubs. The yearly hurricane season in the GoM has a serious impact on the reliability of this infrastructure, as evidenced by the severe damage experienced, and subsequent difficulty and delay returning to full service. The difficulty arises from the various challenges in damage, inspection and evaluation as well as the delay in analysis and procuring the repair hardware needed. Many of the damaged pipelines need extensive and time-consuming repairs depending on the severity and criticality. However, if sufficiently conservative and prudent analytical methodologies are used, many of the damaged lines can be inspected, analyzed and established to be fit for continued finite service. Employing a combination of repair and fitness for service analysis can effectively manage the risk of damaged deepwater lines, while in some cases, continuing operation.

In this paper, an approach is presented that can be used to analyze and establish the integrity of damaged lines. It reviews the various analysis methods available and integrates one or more of the methods to arrive at a unified approach. The approach is illustrated through an example of a 20" dented pipeline in 1000 m of water, where the fatigue life was estimated using FEA, simple dent fatigue equations and further validated using full scale testing. A decision tree that provides guidelines for deepwater pipeline damage evaluation and fitness for service is provided.

Introduction

The ability to reliably transport hydrocarbon products from the Gulf of Mexico outer continental shelf to refineries in the continental US is very critical to the continued supply of energy to the nation. The total hydrocarbon production, over 300 million STB of oil and 1100 million SCF gas constitute 30% of the US oil consumption and over 25% of the gas consumption[1]. In the Gulf of Mexico currently there are over 44,000 km of pipelines that transport oil and gas.

Over the last several years hurricanes, such as Rita and Katrina have had devastating effects on this pipeline infrastructure. In many cases the damage has been severe enough to require extensive replacements. Operators of the pipelines are faced with the increased challenge of inspecting and quickly assessing the damage to establish appropriate repair methods, or in certain cases replacement. Owing to the complexity of deep-water pipeline infrastructure, viz. difficulty to access and inspect and the complex designs required to carry out repairs, operators have to develop relatively elaborate and detailed protocols for inspection, analysis and repair.

Types of Sub-Sea Pipeline Damage & Failure Modes

Hurricane, such as Katrina or Rita, can cause significant damage to pipeline infrastructure as was evident in their aftermaths. Typically post-hurricane damage on pipelines can be classified into two categories (a) direct damage due to