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COST CONSEQUENCE-BASED RELIABLITY ANALYSIS OF BURSTING FAILURE IN SUBSEA PIPELINES

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ABSTRACT

The uncertainty in material and fabrication (i.e., construction) quality result in major concerns in reliability and durability of pipelines and has a remarkable impact on the balance between CAPEX and OPEX of pipelines in a Risk-based integrity management approach. This research investigates the impacts of uncertainties in fabrication procedure quality and accuracy on the failure risk of a pipeline during a 40 years period of operation.

Keywords: pipeline, bursting, reliability-sensitivity analysis, Monte Carlo simulation.

INTRODUCTION

Subsea pipelines are known as a principle contributor to petroleum fluids transfer in offshore oil and gas industry. Although subsea pipelines are cost-effective and environmental-friendly means of transferring production, they are still subjected to high risk of failure and are known as potentially high risk facilities. High risk facilities are defined as facilities with high probability of failure and high consequence of failure (Muhlbauer, 2004; Crawley *et al*., 2003). Since they are major structures with costs that run in the hundreds of millions, Failure occurrence can result in severe economic consequences and safety and health hazard. (Miran, 2016; Alijaroudi, 2015). Failure of offshore pipelines usually takes place as a result of degradation in the pipes. Degradation depends on numerous physical and environmental factors such as uncertainty in values/ homogeneity of materials properties, uncertainty in external and internal loads, fabrication quality (geometric parameters), and temperature fluctuations (Shafiee, 2015). To address this issue, a risk-based approach (considering structural uncertainties) is used for evaluation of pipelines and maintenance scheduling. The objective of this paper is to investigate the influence of structural uncertainties caused by construction process on estimation of the failure risk of subsea pipeline. These uncertainties are modeled in limit state formulations that are normally used to design the pipelines.

RESULTS AND CONCLUSIONS

Results indicate that the accuracy in the construction parameters including wall thickness, material properties, and line pipe diameter, significantly affect the probability of failure (POF) of the pipeline. With improving construction quality by 33% (allowing less variability in construction parameters) a reduction of more than 99 percent of POF is being observed as shown briefly in Table 1. The degraded structure has been modeled with decreasing pipeline wall thickness according to approved corrosion pattern. As shown in Figure 1, the POF (%)-Time (year) curve illustrate exact time for failure occurrence for three different fabricators in which their fabrication tolerances are in DNV-OS-F101 allowable range.

Table 1 - Pipeline probability of failure and sensitivity

Standard Diviation	POF(%)	POF sensitivity to (t) (%)	POF sensitivity to (D) (%)	POF sensitivity to (SMYS) (%)
Fabrication quality 1	5.9e-2	-3.35e-3	7.66e-05	-6.17e-05
Fabrication quality 2	2.6e-3	-1.77e-4	5.41e-06	-3.55e-06
Fabrication quality 3	7e-5	-5.21e-06	2.21e-07	-1.08e-07

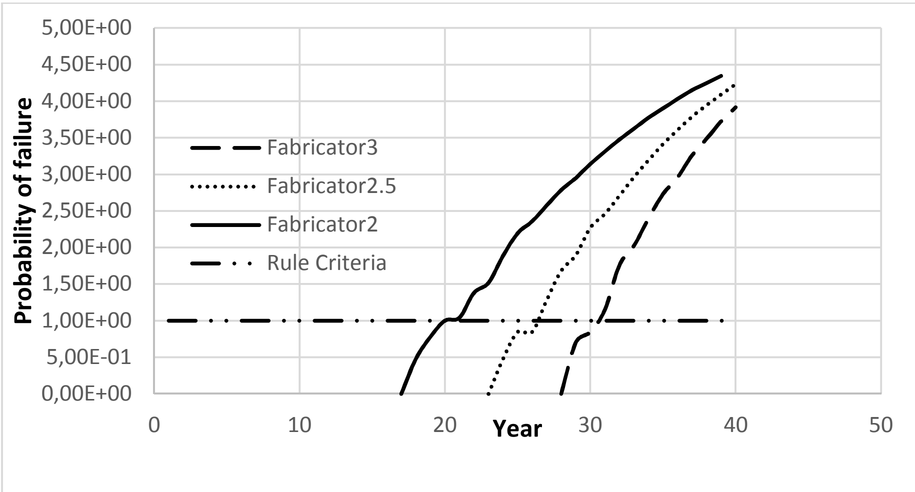

Fig. 1 - Failure occurrence time

Sensitivity analysis shows that wall thickness has the greatest effect on the POF. Significant minimum Yield stress (SMYS) and diameter are respectively in second and third degree of importance.

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