ABSTRACT

Based on the date of RFT (Remote Field Technology) and FEM (finite element method), the failure behavior and residual strength of multiphase pipeline with corrosion defects exposed to internal pressure are studied. The mechanism of riser corrosion is discussed as well. From the FE results, a set of limit solutions are proposed to predict failure pressure of multiphase pipeline riser made of X60 steel with corrosion defects. The residual strength predicted by the FEM are compared with the results from various assessment methods. Consequently, it is concluded that FEM give more accurate predictions than the existing assessing methods with regard to the property of riser.

KEY WORDS: Riser; RFT; residual strength

INTRODUCTION

Risers, which are the arteries of the offshore oil and gas industry, have been widely used as one of the most economical ways of transmitting oil and gas from an inlet point, typically an offshore platform or floating production storage offloading, to an outlet point, typically the well or another offshore platform. Due to the harsh marine environment, the damage of pipeline is non-ignorable which may result in not only economical loss but also severe environmental pollution characterized by (MMS, 1995). Intensive researches have been conducted on the failure mechanism and safety evaluation of corroded offshore pipelines. For example, it was also noted that (Freire 2006) nine burst tests of API X60 pipeline with simulated external long corrosion defects subjected to internal pressure only. Several methods have been established for evaluating the residual strength of corroded pipelines. The majority of the methods available for the assessment of corrosion defects represent the longitudinal area of metal loss A on the basis of the maximum defect depth d and of the overall defect length L (Stephens and Francini 2000). According to the proposition of (Fu and Batte, 1999), the Level-1 method shall require simple material data and simple defect geometry data while the Level-2 method shall require simple material data and a detailed defect geometry data (the defect depth profile). Several common design codes that incorporate the Level-1 method are the DnV RP F101, Modified ASME B31G, Shell, PCORRC. It can be said that these codes were more or less originated from the original B31G criterion but later evolved using extensive series of full-scale tests results on corroded pipelines. The Level-3 method shall require detailed material data and a detailed defect geometry data. It is generally accepted that the nonlinear Finite Element Method (taking into account large strains and elastic-plastic material) together with an experimental validated failure criterion is the better choice for the Level-3 assessment method. Whether the Level-1 method such as B31G or the Level-3 method mainly refer to FEM is seldom used on the riser. Definitely there is several differences between riser and pipeline, it mainly reflects on that the riser has bigger radius-thickness ratio and subjected to both internal pressure and axial force.

RFT INSPECTION

The use of RFT to detect pipelines as part of pipeline integrity management has become almost routine in the offshore oil and gas industry. RFT is equally sensitive to internal and external wall loss, was therefore selected as the non destructive evaluation method of choice for the inspection of heavy wall steel pipeline. Remote Field Testing Tools work by measuring the “time of flight” (phase shift) and the signal strength (Amplitude) of a signal sent out by an exciter coil and detected by an array of receivers. The receivers are positioned circumferentially so that they essentially are sensitive to the many clock locations of the pipe circumference. RFT is a common method for assessing the integrity of pipelines. It provides a perspective of the geometrical scale of the defect which include the wall thickness of ferromagnetic pipes and the length of the defect and its spatial variation of that defect within any section of pipeline. It provides information of affiliation such as flange and girth weld along the pipe. Despite the costs of this technique and it is relatively low accuracy, the method gives pipeline operators much information about the whole pipeline. Measures were taken to ensure that the RFT tool would successfully pass through the riser without obstruction and to ensure it was feasible to perform the inspection in a safe manner several month ago. Industrial reports describing the results of RFT inspections typically describe the corrosion in pipelines as ‘defect’. These may include pitting and grooving corrosion as well as other forms. (Palmer, 2008)

The scope of work assumed by industry partner pertains to the data acquisition and results for the riser section of the multiphase pipeline on the BJT platform. This is a first RFT inspection of this risers. Risers were externally coated to prevent corrosion from seawater. We use the method which rely on the nitrogen to put down the RFT ILI (In-Line-Inspection) tool. Data downloading commenced immediately after putting it down. Immediately after the data download was finished a data quality check was performed and the data quality was deemed acceptable by comparison of the out-going run data (Launch Run) against the in-coming run data (Retrieve Run).

The basic information about the condition of the riser considered here