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Implementation of the New HISC Criteria and Other Challenges Faced for a North Sea Bundle Project

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Abstract

Duplex material has been an attractive choice for subsea in-field pipelines with aggressive fluid and sour service requirements. However, in last years there have been incidents where Duplex material under cathodic protection has failed. The main reason for these failures has been attributed to a combination of load/stress and hydrogen embrittlement. Another feature for duplex pipelines is the large uncertainties in loss of material strength for pipelines exposed to high temperature contents. DNV and NORSOK have based on the above failure criteria issued proposal for revised design guidelines considering corrosion resistant alloys.

This paper presents the challenges that were faced during implementing the new HISC criteria and the material de-rating effect in the bundle design. Other design challenges aspects that were met were local buckling and Euler buckling of the inner production duplex pipe and the interface loads between the bundle and the spools. This paper addresses the measures that were taken to fulfil the design criteria and some questions are raised about the conservatism found in the guidelines.

The paper also presents general description of the project summarising the interesting features with design, fabrication, launch, tow and installation of a 2.8 km long bundles deflected into a curved shape for final installation which involved off-bottom tow of the bundle over live crossings.

Introdution

This paper presents the challenges that were faced during implementing the new HISC criteria and the material de-rating effect in the bundle design. The bundle is a 2.8 km long pipe in pipe system with duplex inner pipe and Carbon Steel outer pipe terminated by bulkheads at each end. The bundle is routed between two platforms and is further tied in to the two platforms by duplex spools.

The challenges in general of using CRA material due to HISC and material de-rating are presented. Further how the issues were dealt with in the design is described.

Some of the challenging design aspects that were met were local buckling and Euler buckling of the inner production duplex pipe and the interface loads between the bundle and the spools. Other issues that are addressed are lateral bundle stability and seabed subsidence effects. The methodology and premises are presented for each design aspect together with the final results. The paper will also describe how they relate to and influence each other.

Further the paper presents a general description of the project summarising the interesting features with fabrication, launch, tow and installation. Furthermore, the paper covers the major issues found during the North Sea Bundle Project and how they successfully were dealt with.

Duplex Material and HISC Challenges

The choice of CRA material is dependent on the specific well-stream environment and mechanical properties required. The flow-line will internally be exposed to the well fluids, which will be corrosive mainly due to CO2. The H2S partial pressure might also influence the material selection. Hence, solid corrosion resistant alloys (CRA) or clad will be utilized when risk for corrosion attacks exists. On the Norwegian Continental Shelf (NCS) supermartensitic stainless steel (SMSS) which is 13% Cr. Steel, has been extensively used for flow lines, where Statoil in total is operating more than 400 km. Some brittle failures have been discovered in 13% Cr. steel, Duplex (22%Cr) and Super Duplex (25%Cr), where hydrogen from cathodic protection (CP) or welding consumables are one of many factors leading to the failures. The major oil companies have however confidence in these materials provided appropriate measures, e.g. high quality coatings to reduce the risk of exposing welds to seawater and CP, stringent fabrication requirements to reduce hydrogen contamination, and reduced load and strain utilization factors.

Both 22Cr and 25Cr duplex stainless steels have been extensively used for subsea equipment. These types of steels have been used as pipes, castings, forgings and small bore tubing. In general the experience is good but some significant failures have occurred. The main reason for these failures has been attributed to an unfortunate combination of load/stress and hydrogen embrittlement (HE) caused by ingress of

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