Fatigue Design for Risers in Sour Service via Full Scale Testing

PUBLISHABLE SUMMARY

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Background

Steel catenary risers (SCRs) are commonly used within deepwater oil and gas developments, and fatigue performance is often a critical factor in overall design. Resonance fatigue testing of full scale girth welds has become standard industry practice to demonstrate adequate performance. However, these tests alone take no account of aggressive service environments such as sour production fluids. In these instances qualification testing is usually a two-stage process involving resonance fatigue testing to demonstrate the required performance in air, and strip fatigue testing (in air and in a sour environment) to determine a fatigue life reduction factor that is then applied to the base design curve. This approach accounts for both size effects (i.e. the difference between strip and full scale testing) and environmental effects individually, and has been adopted on many projects. However, the validity of the approach has not been demonstrated. There is therefore a need to give better understanding of the sour performance of girth welded riser pipe by full scale experiment. This project will develop validated design guidance and improve confidence in risers for sour service.

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Objectives

- Develop validated riser fatigue design guidance based on direct qualification of a sour service design curve.
- Characterise the sour corrosion fatigue behaviour of risers, by testing full scale girth welds in a sour environment.
- Examine the validity of the current two-stage design process.

Project Outcome

- Validated guidance for design of risers, based on a full scale sour service riser fatigue design curve.
- Full scale test data for C-Mn girth welds in a typical sour service operating environment.

Progress reports with details of experimental procedures and test data issued every six months, prior to Sponsor Group meetings, and a final report detailing the main results.

Benefits

- Elimination of excessive conservatism providing significant cost savings and greater design flexibility.
- Greater confidence in likely material behaviour in service resulting from a more direct means of quantifying material performance.
- Improved understanding of fatigue in sour environments leading to enhanced safety by reducing the risk of corrosion fatigue related failure.

Participants

The Sponsor Group comprised:

- Chevron Energy Technology Company
- ExxonMobil Upstream Research Company
- PETROBRAS - Petroleo Brasileiro SA
- SAIPEM S.P.A
- Serimax
- Subsea 7
- Tenaris - Tubos de Acero de Mexico SA
- TOTAL

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Scope of Work

The pipe material used in this project is 323.9mm OD x 20.8mm WT seamless Grade API 5L PSL-2 X65QS, supplied by Tenaris. Test welds are all single-sided with unbacked roots made by GMAW STT and GMAW fill, all in the 5G welding position. The welds have been manufactured by Serimax.

Phase 1 of the project involved the design and manufacture of a rotating bending fatigue test machine capable of testing full scale pipe welds with an internal sour environment. This is now complete

The fatigue testing being conducted as part of Phase 1 involves testing of:

- Twelve full scale joints in air using the resonance technique (complete)
- Six full scale joints in sour environment (in progress)
- Six small scale strip tests in air and six small scale strip tests in sour environment (complete)

The sour environment used is 1psi (7kPa) partial pressure of H_2S in CO_2 with a pH of 5.0 at a temperature of 25^{o}C. This testing is currently in progress.

Phase 2 involves testing a second set of twelve full scale joints and six small scale strip tests in environment. The effect of specimen orientation and internal surface cleaning prior to test are being studied. The sour environment for Phase 2 is the same as that used in Phase 1.

.Price and Duration

The project had a duration of 5 years and a budget of £1,200,000. There were 8 Sponsors each making a contribution of £150,000. The fee for companies wishing to access the results by buying-back into the project is £150,000

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi.co.uk/services/research-and-consultancy/joint-industry-projects/

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