Qualification of an innovative electrofusion welded connector for polymer lined subsea pipelines

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AGENDA

• Industry challenge and our solution
• Introduction to LinerBridge®
• Construction and installation
• Qualification of new technology
• Critical qualification activities
• First deployment and further developments
• Summary
The industry challenge

- **51%** of all pipeline failures are a result of internal corrosion

- **7 years** is typical life expectancy of an unlined carbon steel water injection pipeline*

- Traditional corrosion allowances now driving pipeline wall thickness up to 2 inches.

* Failure of water injection lines Joint Industry Project, by AEA Technology, July 1997:
  - 23 water injection lines included in study, only one had survived 15 years
  - Eight flowlines had already failed, with average corrosion rate of 1.7mm/year
Our solution – the Integrated Liner System

- **Polymer lining** - to provide a 50 year internal corrosion barrier

- **Connectors** - LinerBridge® to join pipeline stalks together to provide a continuous end to end polymer corrosion barrier

- **InsuLine™ sleeves** - to provide heat protection should high temperature field joint coatings be specified

- **End terminations** - Flanged or PLET’s installed onshore or offshore using LinerBridge®
Introduction to LinerBridge®

- Removes Corrosion Resistant Alloys from subsea pipeline infrastructure
- Reduces pipeline fabrication complexity, cost and schedule
- Facilitates installation of pre-fabricated end terminations
- Enables polymer lining for S-Lay and J-Lay
Qualification of new technology

- Det Norske Veritas (DNV GL) Recommended Practice A-203
- Systematic, risk based approach to qualification of new technology
- Sound engineering practices to ensure product is suitable for intended use
- Focus on the novel aspects of the technology
- Technology Readiness Level (TRL) 5
Critical qualification activities

**Critical product functions and test activities included:**

- Installation environment
- Offshore installation – ability to be reeled
- Withstand pipeline operating conditions
- Design life considerations
- Carbon steel welding process
Installation environment

**Product performance specification**

Installation can be completed between the temperatures of 5°C and 40°C

**Test activities**

- Installations completed at each boundary condition
- Installations completed on 8” and 16” connectors
- Connectors destructively tested
Offshore installation - ability to be reeled

Product performance specification

Connector must maintain its integrity during the offshore installation process

Test activities

• Simulated Reeling Trials (SRT) – 7.5m former
• Installations completed on 10” and 16” connectors
• Post SRT, test spools hydrostatically tested
• Connectors destructively tested
Pipeline operating conditions

Product performance specification

Connector must maintain its integrity at operating pressures and temperatures

Test activities

- Hydrostatic testing to 380bar(g)
- High temperature cyclic pressure testing
- Collapse testing
- Connectors destructively tested
Design life considerations

**Product performance specification**

Polymer liner system materials provide appropriate mechanical properties at end of life.

**Test activities**

- Virgin materials testing
- Ultrasonic inspection
- Accelerated age testing
- Post aged - materials testing
- Temperature cycling

\[
\frac{1}{t_f} = \sum_{i=1}^{i=n} \left( \frac{t_i}{t_{tot}} \right) / t_{fi} (T_i, s_i) \quad \text{Miner’s Rule}
\]
Carbon steel welding

**Product performance specification**

Connector facilitates the use of manual carbon steel welding processes.

**Test activities**

- Thermocouple installation
- Temperature monitoring during carbon steel welding processes
- Full penetration repair
- Visual inspection of connector body
LinerBridge® – First deployment and further developments

- First use in a commercial project – Equinor Snorre

- DNV certificate amendment – increased operational pressure (445bar)

- DNV certificate amendment – LinerBridge® use for offshore cut to length operations

- LinerBridge® selected for use in two further 2019 projects
Summary

• LinerBridge® provides clear technical and commercial advantages

• Flangeless polymer connector suitable for the complete pipeline system

• Future connector developments

• Qualification of New Technology – DNV GL RP A203 (TRL 5)

• First commercial project commenced, others scheduled for 2019
THANK YOU

We look forward to discussing your needs and exploring where we can best support you.

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