Flexible Riser Cost Saving

The New Economic Reality

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Contents

Cost Saving – The New Economic Reality

Overview

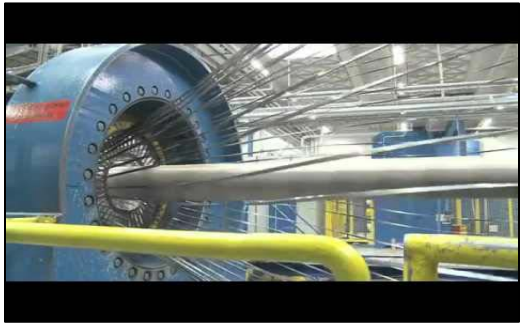
- Flexlife is a riser specialist based in Aberdeen and Houston, founded 2007
- Many staff have held key roles at flexible pipe OEMs, Installation Contractors and Riser Engineering Companies
- Revenue £8m (2015-6), 35 staff

o Flexible riser engineering, delivery management and integrity
o Complete range of patented flexible inspection and repair technologies

- Currently focused on projects with cost and FID gating issues..

Live case study (1) - Angola

- New FPSO development 1700m WD
- 7 x 7.5 inch ID flexible risers and flowlines (~ 47 km of flexible pipe)
- Max DP 9000 psi, max DT 100°C
- High value OEM tenders received : FID issues / sanction Q4 2015
- Flexlife joined the project team during the ITT phase



Live case study cost savings - Design

Pre-Flexlife:

- Common multi-service pipe design for Production, Gas Injection, Water Injection
- Worst case design criteria combined temperature, flow assurance, chemical compatibility, pressure
- Specified with PVDF liner, super-austenitic carcass, sour service wire, multiple insulation layers
- Resulting pipe structures pushed OEM qualification limits -> complex clarifications

Post-Flexlife review of field design requirements on a per-pipe basis:

• PVDF only required for production lines	~30%
• Insulation only required for production lines	~15%
• Sour service requirements removed for water injection	~15%
• Carcass material changed to duplex	~10%
• Total design savings	US $50-80 Mil

Live case study savings - Global Analysis

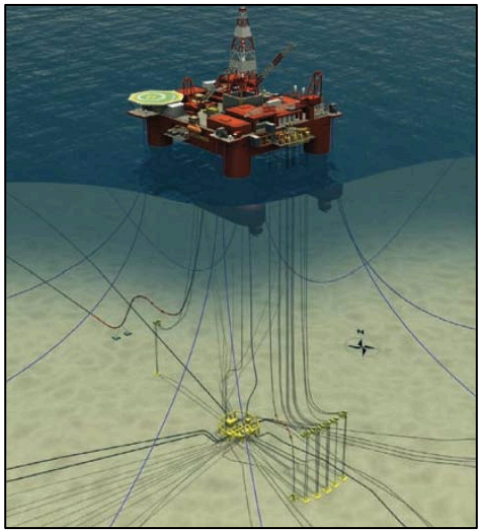
Pre-Flexlife:

- Riser configuration driven by umbilical clashing & compression configuration, no iterations
- Resulting hang-off angle for risers = 10°, free hanging catenary.
- Max top tension ~ 580 Te
- Max TDP tension >100 Te
- Substantial holdback suction piles unnoticed due to analysis issues

Flexlife Modifications:

- Decrease riser hang-off angle, greatly reducing tensions
- Modify turret layout to optimize between risers and umbilicals
- Re-run analysis with correct inputs and service specific pipe designs
- Relocate smaller holdback anchors at optimum locations

- Total analysis savings US $10M



Live case study savings – Installation

The knock-on effects on installation were considerable:

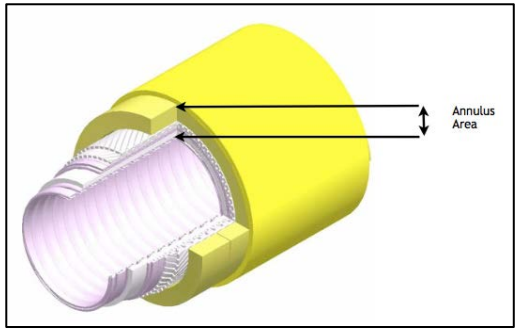
- Reduced number of reels / trips required based on decreased pipe diameter
- Reduced installation tensions allowing smaller vessels to install (previously only a few vessels that could install)
- Simplified pull-in to FPSO with reduced hang-off angles
- Reduced hold-back requirements = reduced fabrication costs, faster install

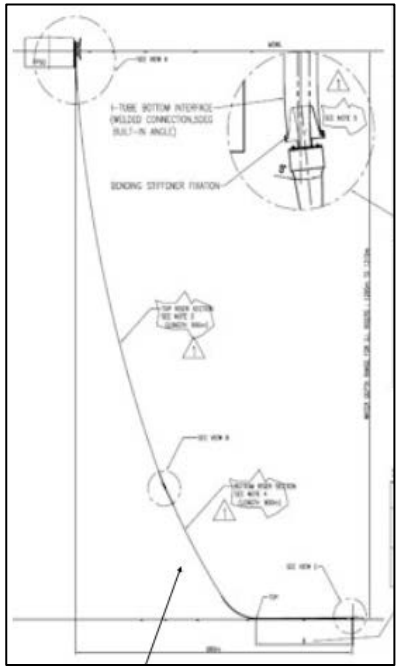
➢ Total installation savings US $25M

Live Case Study (2) – Malaysia – Riser Leak

- 2015 : ROV inspection reveals catastrophic sheath failure below BSR
- Signs of gas leakage into open water

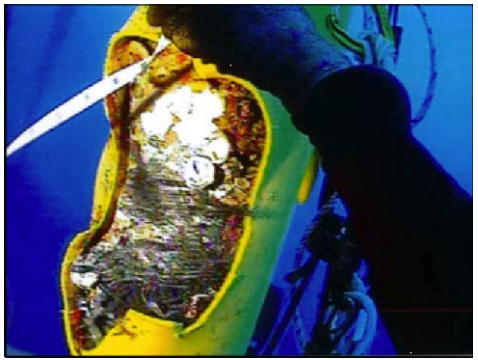
- Failure of subsea vent ports, leading to gas buildup, no annulus test
- Catastrophic sheath failure below BSR

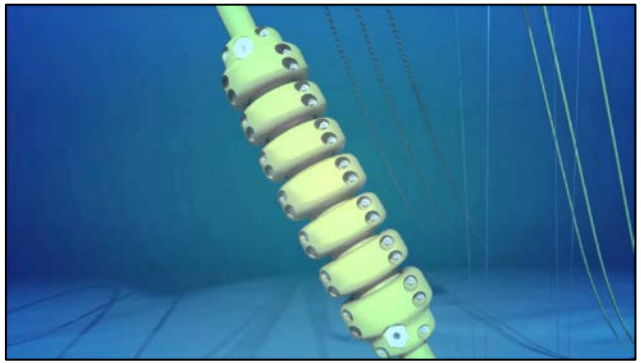


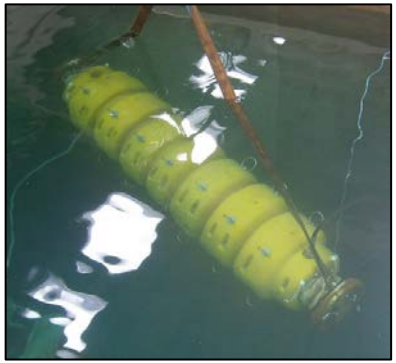


Riser repair : Armadillo

- Unique sheath repair product installed as a permanent dynamic riser solution
- Encapsulates and seals sheath rupture using injected gel
- Prevents ongoing water flow and corrosion of armour wire
- Incorporates patented secondary vent ports
- Annulus test @ 2.5 bar proves sheath integrity to 25m WD
- Flexlife recalculates design life of flooded riser

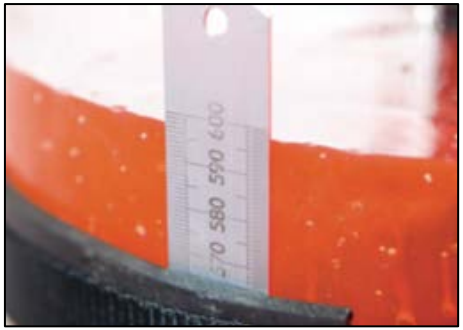






Riser repair : FlexGel

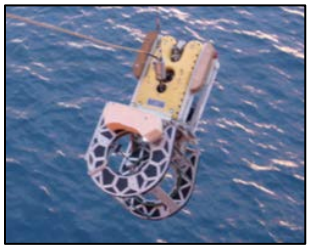
- Used within a confined area, such as Armadillo, J-tube, I-tube, or Caisson
- Prevents further corrosion by excavating oxygenated water from risk area
- Pumps as liquid and sets as rubber – suitable for dynamic risers
- Predetermined density minimizes quantities
- Environmentally friendly, CEFAS registered
- Compatible with PA11

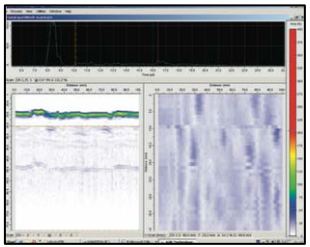
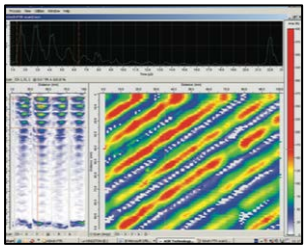
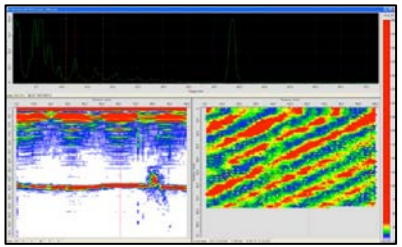


Case study (3) – Ultrasonic Scanning

- In 2013 Flexlife ultrasonic service (NEPTUNE) was employed on a deepwater Angola field
- Imagery suggested dropped object from host FPSO
- The operator required detailed understanding of damage

- Neptune gives 100% accuracy regarding annulus status via ROV deployment
- Over 140 risers scanned to date
- 2013 results demonstrated ‘no urgent remedial repair required’
- Regular scanning clearly and consistently confirms riser status to operator



Summary

- ✓ Go the extra mile at design stage, question each specification line
- ✓ Consider feasibility of ‘repair over replacement’ – testing services are available

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