Deep Water Installation of Steel Catenary Risers

Subsea Asia

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Grant Milne
Safety Moment – Abseiling for SCR Installation

- Used On Erha. SCR receptacles located above the waterline
- High standard of procedures
- Early involvement of the abseiling supervisor in the project
- Use of in-house abseiling department as well as subcontractors.
Agenda

Introduction
SCR Configurations
SCR Welding
Deepwater SCR Installation
SCR Hook-up
BC-10 Experience
Introduction to Steel Catenary Risers

• Steel Catenary Risers:
  - Economically attractive
  - Large diameters
  - High resistance to internal and external pressure
  - Simple and robust installation methods
  - Attractive for deepwater use

• Sensitive to dynamics and more vulnerable to fatigue when they are light in water

• Challenges:
  - Increasing top tensions due to larger diameters and deeper water
  - Increase of fatigue due to harsher environments, and increasing top tensions
SCR Configurations For Minimised Fatigue

- Three configurations to choose from are:
  - Free hanging SCR
  - Lazy wave SCR
  - Buoyancy supported riser

- Influenced by:
  - Water depth
  - Environmental conditions
  - Installation method
  - SCR size and design
  - Top tension
  - Fatigue allowances
  - Type of production platform
SCR Configurations – Free Hanging SCR

- Simple and easy installation
- Often installed VIV strakes
- Economically attractive
- Can be subject to high fatigue damage at top end and TDP
- Sometimes need hold-back anchors:
SCR Configurations – Lazy Wave SCR

- Addition of buoyancy modules
- Decreased top tension
- TDP is further away from production facility
- Lower Stress and Fatigue at the Top End and TDP by factors of between 2 and 5
- Completed for BC-10, 2009
SCR Configurations – Buoyancy Supported Risers

- De-couple FPSO motions from risers
- Effectively decreased top tension at FPSO or floating structure
- Easier SCR installation program:
  - De-coupled from FPSO
  - Completed without FPSO in field
- Suited to ultra deep water
- Guara Lula project – Brazil 2013/2014
Agenda

Introduction
SCR Configurations
**SCR Welding**
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SCR Welding for Improved Fatigue Performance

- Fatigue performance of weld is critical
- Close control of pipe end tolerances and joint misalignment
- High integrity weld procedures
- Flush grinding of weld caps for better fatigue performance
- Reel lay installation – onshore fabrication and testing
SCR Welding – Installation of Mechanically Lined Clad Pipe for Reel Lay

- Subsea7 has developed a methodology for the installation of mechanically lined pipe by reel lay.
- Qualification gained from DNV and the method will be used on Guara-Lula, 2013 for the SCR installation.
- Methodology adopts reeling on the lined pipe in a flooded condition with back pressure to mitigate any wrinkling of the CRA liner due to plastic bending.
- Method offers significant economic advantages due to the reduced cost from using metallurgically clad pipe which has been previously reeled.
SCR Fabrication – Prefabrication Onshore

- Vigra spool base in Norway
- Maximum stalk length of 1520m
- 1000m fabrication shed
SCR Fabrication – Prefabrication Onshore

- Pipeline stalks are fabricated first and then spooled onto reel lay vessel; Seven Navica

- SCRs can also be installed by offshore fabrication in S-Lay and J-Lay
Agenda

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- BC-10 Experience
Deepwater Installation Spread – Seven Borealis

Seven Borealis

- Size: 182m x 46m
- J-Lay: 937Te, 24”
- S-Lay: 600Te, 46”
- Crane: 5000Te
- 15° gimble capacity allows vessel to fully weathervane in order to minimise motions and SCR fatigue.

Suited for the installation of the biggest SCRs in ultra-deepwater environments
Deep Water Installation Spread – Sapura 3000

Sapura 3000

- Size: 151m x 38m
- J-lay: 400Te, 20”
- S-lay: 240Te, 60”
- Crane: 3000 sTe

Class leading heavy lift and pipelay vessel operating in water depths of up to 3000m
Deepwater Installation Spread – Seven Oceans

Seven Oceans

- Size: 157m x 28m
- Reel Lay: 3500Te
- Pipe Size: 6”-16”
- Crane: 350Te

Efficient reel lay vessel with SCR experience
Deepwater Installation Spread

Seven Seas

- Construction and flex-lay vessel with J-lay capabilities through the moonpool
- Top tension: 400Te
Deepwater Installation Spread – Weather Mitigation

- J-Lay: 15° gimble to allow 360° heading changes
- Larger vessels: smaller motions
- Reel lay: small installation window needed due to quick lay speeds
- Moonpool lay decreases vessel motions seen by SCR.
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SCR Hook-up – SCR Wet Store

- De-couple SCR fabrication and installation with FPSO delivery
- Tight corridors
- Additional vessel to recover and transfer SCR to FPSO
- Pull-in head and laydown tool installation
SCR Hook-up – Direct Transfer

- From pipelay vessel to FPSO
- Historically preferred method
- Deploy SCR on A&R winch from pipelay vessel and handover subsea to FPSO pull-in wire
SCR Hook-up – Riser Pull-in Equipment (RPE)

- Located on FPSO to complete final pull-in of SCR
- Up to 450Te has been completed, 600Te in the future
- Slides between riser receptacles
- De-mobilised off FPSO after hook-up.
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BC-10 Experience
Shell BC-10 Overview

- Brazil – Campos Basin
  - Harsh environmental conditions
- 1190-1940m WD
- 2009
- Reel lay – Seven Oceans
  - Ubu spool base
- Lazy Wave SCR
  - Improved fatigue life
  - Reduced top tension and reduced loads on FPSO turret
  - FPSO motions affect the SCR less.
- 3 SCR’s were wet stored and 2 were directly transferred.
Shell BC-10 – Buoyancy Modules

- Installed after the initiation of the PLET.
- Installed under lay spread on Seven Oceans.
- Half shells of buoyancy were heavy and large.
- Operation completed without incident.
- Fatigue performance for SCR are very good.
Shell BC-10 – Flexjoint Weld

- SCR hung off in worktable.
- Flexjoint lifted into lay spread by vessel crane.
- Flexjoint section manually welded onto SCR.
- J-lay methodology
Conclusion

- **Selection of the best SCR configuration**
  - Lazy Wave for decreased top tension and lower fatigue
  - Free hanging for simplicity
  - Buoyancy supported riser for ultra deep water

- **Selection of a vessel to minimise installation fatigue loads**
  - Reel lay for minimal installation time
  - J-lay for high top tension and 360° heading changes
  - S-lay

- **Wet-store or direct transfer**
  - De-couple installation schedule from FPSO delivery

- **Pull-in and landing of SCR into receptacle on floating structure**