Siri Caisson Permanent Support
- A Unique Challenge

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Alan Cassie, Subsea 7 Project Manager
Agenda

- Project Overview
- Challenges
- Outcome
- Lessons Learnt
Project Overview

- Platform Status
- Design Concept
- Design Basis
DONG Siri Permanent Support Project

- Siri Platform operated by Danish Oil and Natural Gas (DONG)
- DONG Siri platform located in North Sea – Danish Sector (approx. 220km from coast)
- Water depth: 60-65m approx.
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Project Overview – Platform Status

- Innovative low cost design
- Topsides supported by three unbraced legs (denoted North, South and West)
- Main oil storage tank forms gravity base structure for the platform
- Support structure for the well caisson (Sponson) forms part of the overall gravity base structure
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Project Overview Temporary Solution - Jacking Beam

- A temporary support was required ASAP
- Jacking beam installed under Sponson
- Installed and jacked-up during winter 2009/10
- 4 x 300 Te jacks take load of caisson

Beam interfaces with lip of caisson underneath sponson
Siri Caisson Permanent Support Design Concept Selection

• Following installation of the Jacking System, Subsea 7 supported concept selection and FEED engineering for a permanent solution

• Key considerations:
  - Reduce platform natural sway period to circa 3 seconds, to reduce dynamic response/loading
  - Remove/reduce environmental loading on the caisson
  - Minimise production downtime
  - Design life of 12 years
  - Minimise additional weight.

• On concept selection Subsea 7 were then appointed as the EPIC contractor and had full responsibility for the design, fabrication and installation of a permanent support for the Siri platform and caisson.
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Project Overview - Design Concept / Specification

- **Clamps**
  - Nominal weights 150 tonne
  - Split half shell with castellation
  - Height 6.4 m
  - 56 M90 bolts per clamp

- **Cable Stays**
  - 169 Cohestrand
  - End anchorage c/w bearing plate
  - Cross-overs
  - Monitoring system

- **Platform Response**
  - Reduce platform period from 6.5 sec to 3 sec – with associated reduction in platform motion

- **Design Basis**
  - Design Life 13 years, with DFF of 10
  - Design Code ISO 199002
Project Challenges

- Design
- Clamp Fabrication
- Cable Stay Fabrication
- Installation
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Design Context

- Fast track design and fabrication
  - weight and dimensional growth of clamps and cables
  - difficult to finalise installation procedures with design not complete
- Cable stay technology unproven in subsea environment
  - programme of component testing performed
- Clamp and cable design feed-in to overall platform integrity analysis
- Introduction of design changes
  - water tight duct
  - crossover requirement
- DNV verification
  - verification of design and fabrication activities in parallel
  - lack of appropriate codes and standards for some elements
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Design and Fabrication

- Design considerations
  - code based requirements for ALS, FLS and ULS
  - missing cable, ship impact, VIV, natural frequency
  - integrity of platform during installation; additional mass added before platform stabilised
  - bearing plates unique to each clamp/cable, to counteract tolerances achieved during clamp fabrication
  - cathodic protection design
  - cable tensioning sequence - applying tension to one cable changes the tension in all cables
  - crossover wear
  - demanding and time consuming analysis effort
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Design for Installation

- Installation considerations
  - weight growth as design evolved
  - north leg riser in close proximity to north upper clamp
  - ensure castellation contact between clamp halves
  - design requirement to install upper clamps to with 0.15° of design heading
  - unknown handling characteristics of cable
  - eccentric loading of anchorage nut
  - polarising shim settings
  - alignment control on tensioning system
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Clamp Fabrication – Welding Engineering
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Cable Stay Fabrication and Assembly

- The 169 strand stay was a catalogue product, but had never been manufactured
- The application in a subsea context required significant changes to the design of the standard cable stay including:
  - Bend stiffeners
  - Telescopic joints
  - Fexjoints Large and Small
  - Anchorage sealing
  - Crossover
  - Filler
- All of the above required to be designed and tested as part of the verification process.
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Cable Stay Fabrication and Assembly

- Individual components manufactured in France, Italy, Norway and UK
- Cable stays assembled in Scotland - suitable covered facilities with quayside access, proximity to Aberdeen for ease of project over site.
Project Outcomes

- Installation Tolerances
- Cable Tensioning
- Platform Motion
- Platform Operation
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Project Outcomes

- Upper Clamps installed within tolerance
  - South 0.02 degrees
  - West 0.15 degrees
  - North 0.47 degrees

- Cable Stays installed and tensioned to 1250 tonnes, without damage to the thread or the water tight duct

- Platform natural period reduced from 6.5 seconds to circa 3 seconds, with corresponding reduction in platform motion
Lessons Learnt
Lessons Learnt

• Don’t underestimate the complexity and challenge associated with delivery of an innovative solution
• Don’t under estimate the ability of good engineers to overcome these challenges
• Sound design, robust procedures and comprehensive testing were key in achieving success.