Complex Lifting Operations: Innovative Design & Techniques

Rigid Spool Bundles Installation for Johan Castberg Project (Equinor)

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Senior Installation Engineer

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Presenter & Company Briefing

Presenter Briefing

Who am I?

Romain Fouchard

Senior Installation Engineer with 15 years of experience in the offshore installation sector for the Oil & Gas, renewables and marine industries. I have been involved in various international projects involving subsea construction, offshore lifting operations, vessel mobilisations and all associated aspects such as project planning, quality & safety and management.

Ocean Installer at a Glance

Ocean Installer is a marine construction company within the SURF, mooring, renewables and carbon capture segments

Background
Established and reputable global offshore installation company
Established in 2011 by HitecVision (~100% ownership)
Headquartered in Stavanger, Norway, and with offices in Oslo, Houston, Aberdeen and Dubai
Approx. 240 employees, primarily engineers
Strong commercial company culture with high focus on safety
Firm contract backlog of NOK 1,3 + 6bn (Q4-2022)

Project Capabilities

Full Range EPCI Service Provider

FEED Studies → Detailed Design and Engineering → Procurement and Fabrication → Installation Engineering → Subsea Installation and Pre-Commissioning

EPC of Subsea Products

- Structures (riser bases, manifolds, PLEM, templates, XMT, SSIV)
- Flexible and umbilical risers and static lines
- Spool pieces and tie-in
- Flying leads
- Cable Protection covers
- Global MOU with Baker Hughes

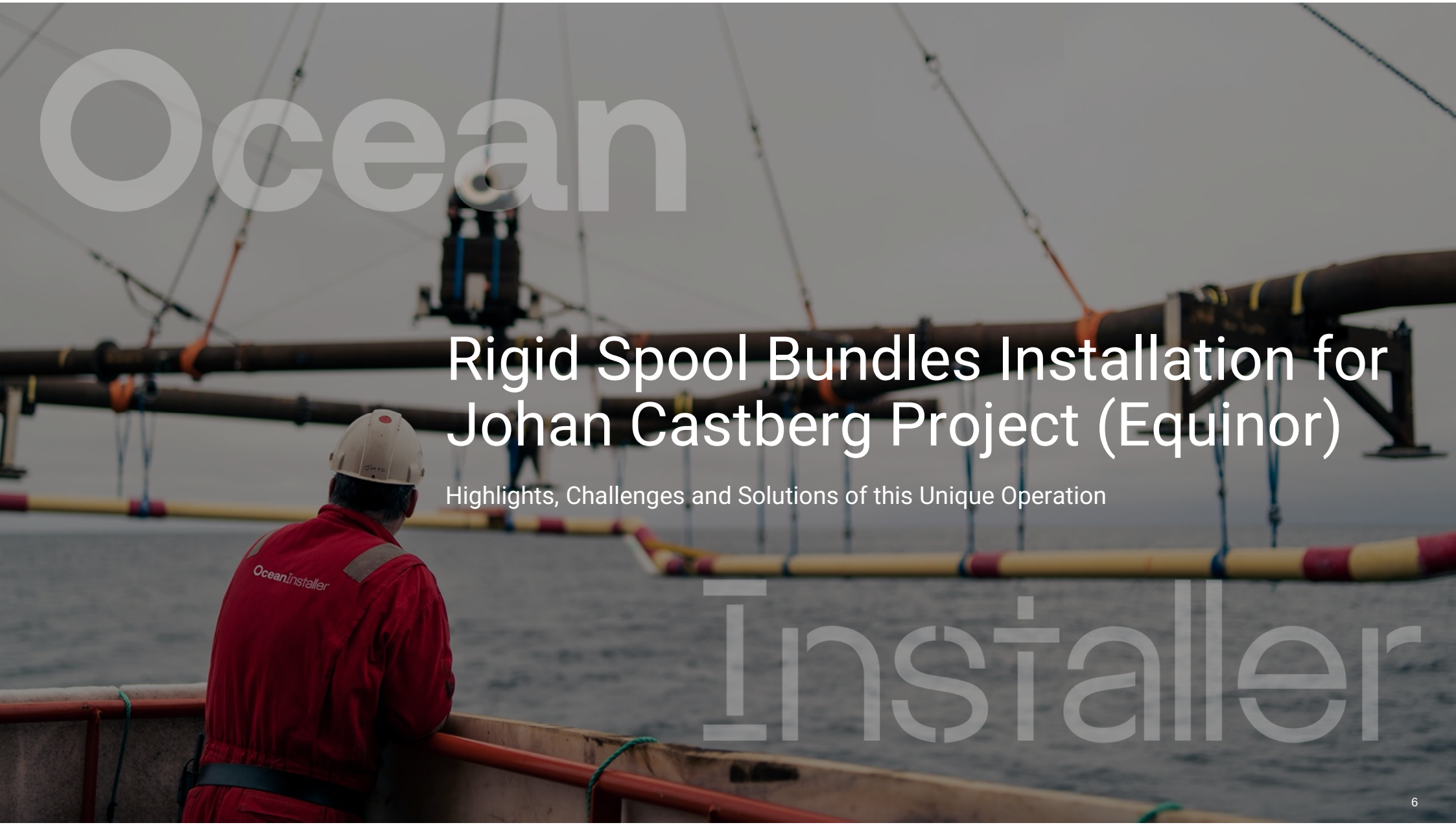
Design Engineering

- Flexible, umbilical and cable installation/recovery analysis
- Structure deployment and installation analysis
- Tie-in/pull-in analysis
- Lift & shift analysis
- In-place analysis
- Vessel motion analysis
- Seafastening and rigging design
- Materials, welding and fabrication
- Structural engineering

Operational Engineering

- Preparation for mobilisations
- Installation spread for mobilisations
- Loadout of products
- Transportation
- Installation of various subsea permanent assets
- Tie-in
- Platform topside pull-ins
- Decommissioning
- Construction follow-up

For information visit www.oceaninstaller.com or reach out to us during breaks.



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Highlights, Challenges and Solutions of this Unique Operation

Rigid Spool Bundles Installation

Rigid Spool Bundles Installation for Johan Castberg Project

Summary of Operations

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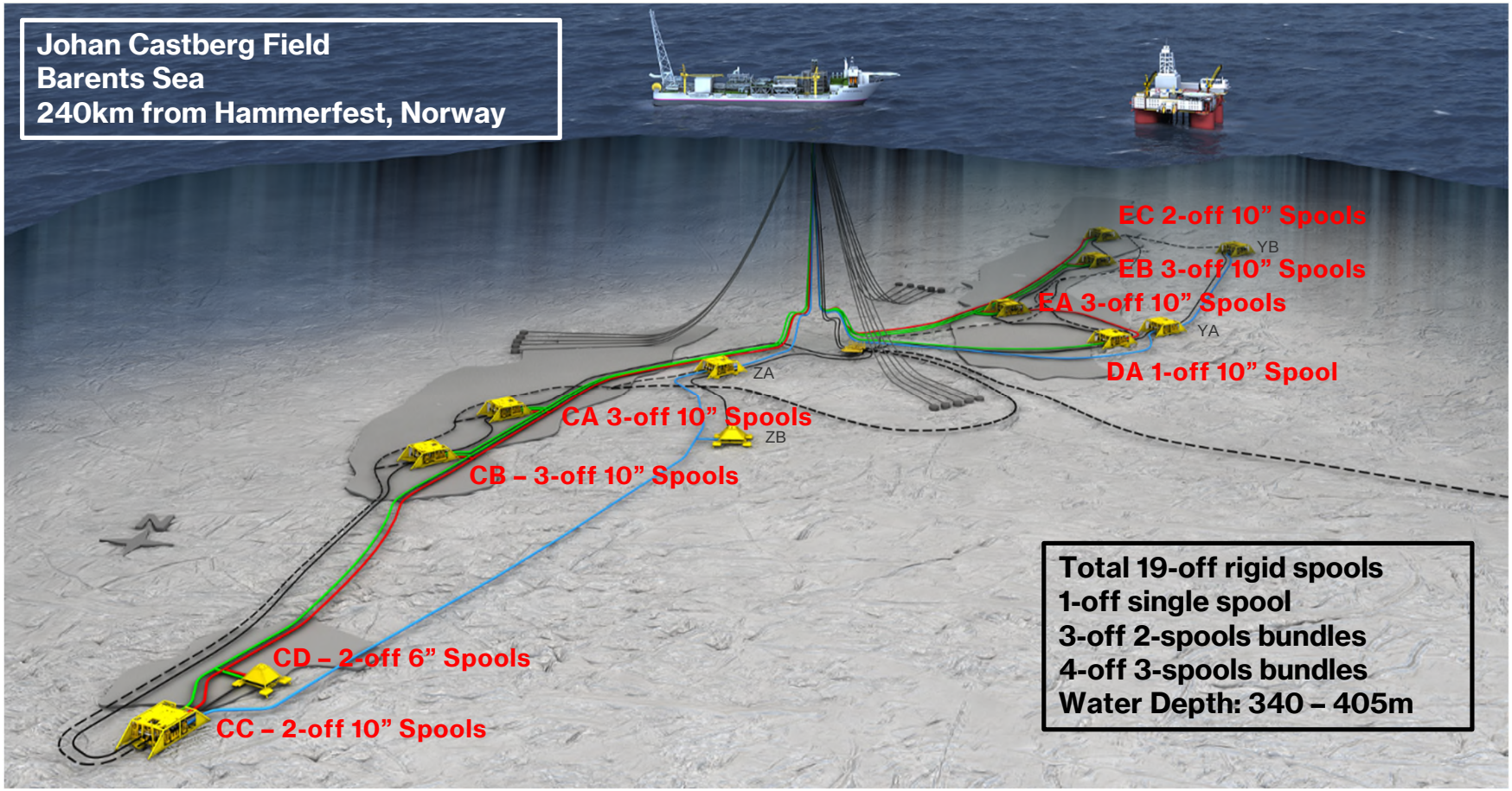
Field Layout



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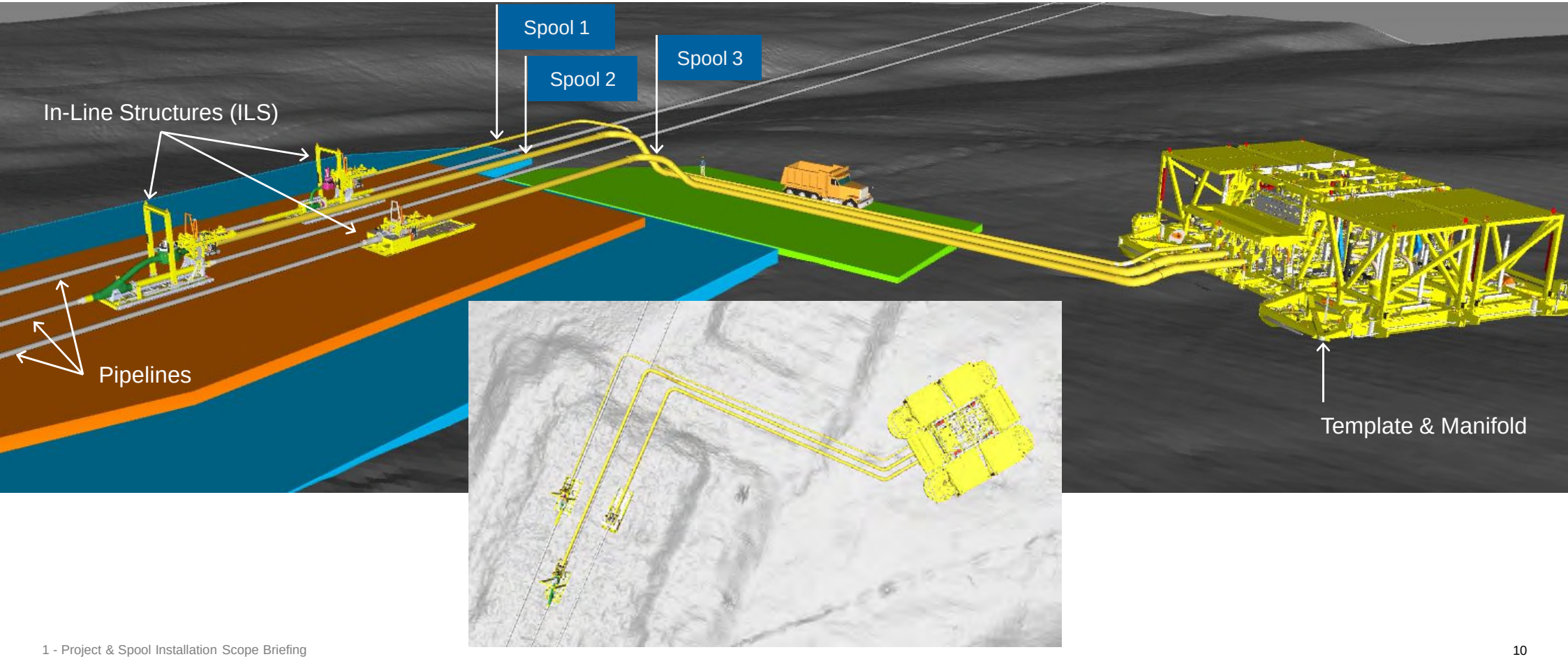
Typical Spools Configuration Subsea



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1 Project & Spool Installation Scope Briefing

2 Spreader Bar Design and Modularity

3 Lift Rigging Design and Disconnection System

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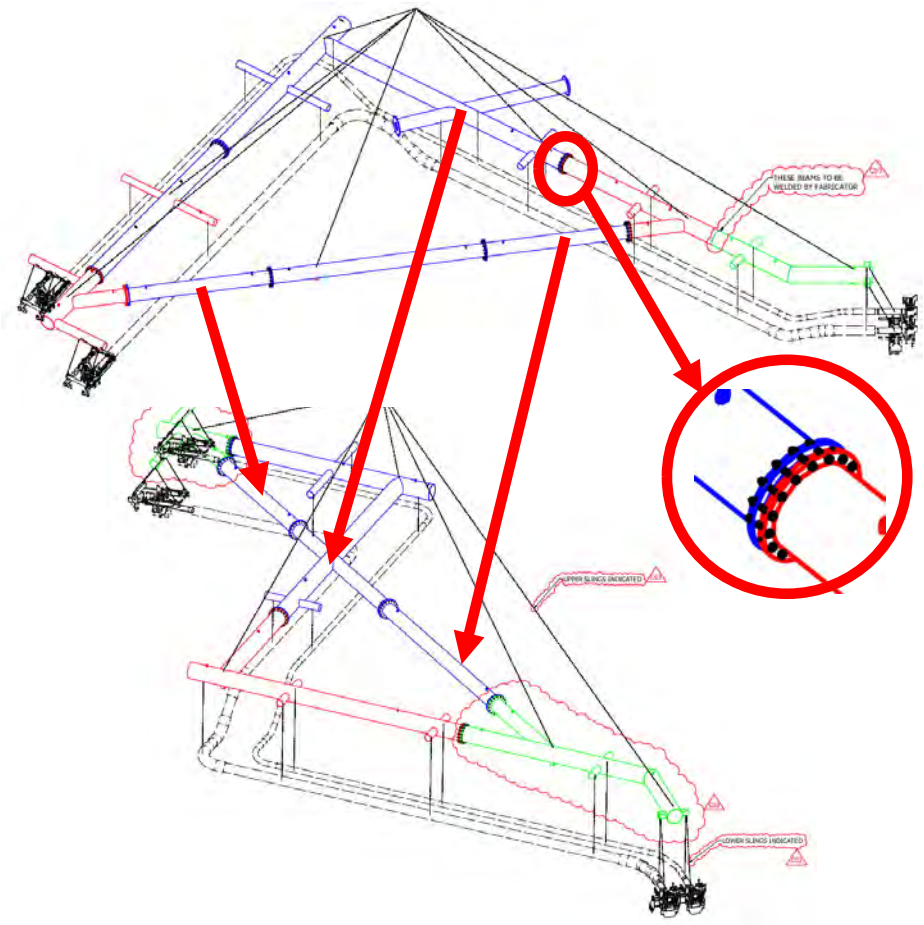
Spreader Bar Design and Modularity

- Spool – Very delicate and sensitive piece of equipment
- Installed between 2 preinstalled mating structures
- Designed in 2 phases – Pre-metrology and Post-metrology
- Need very good planning & engineering for installation
- One of most important aspect – Spreader bar design
- Modular design adopted (Parts connected with bolted flange connection)
  - Possibility to recover in parts – If recovery as whole difficult due to weather condition
  - Reusability of parts - 4 modular sets used for 7 lifts
  - More than 120Te of steel saved
  - Easier transport and storage
  - Flexibility in selection of fabricator (cost efficiency)



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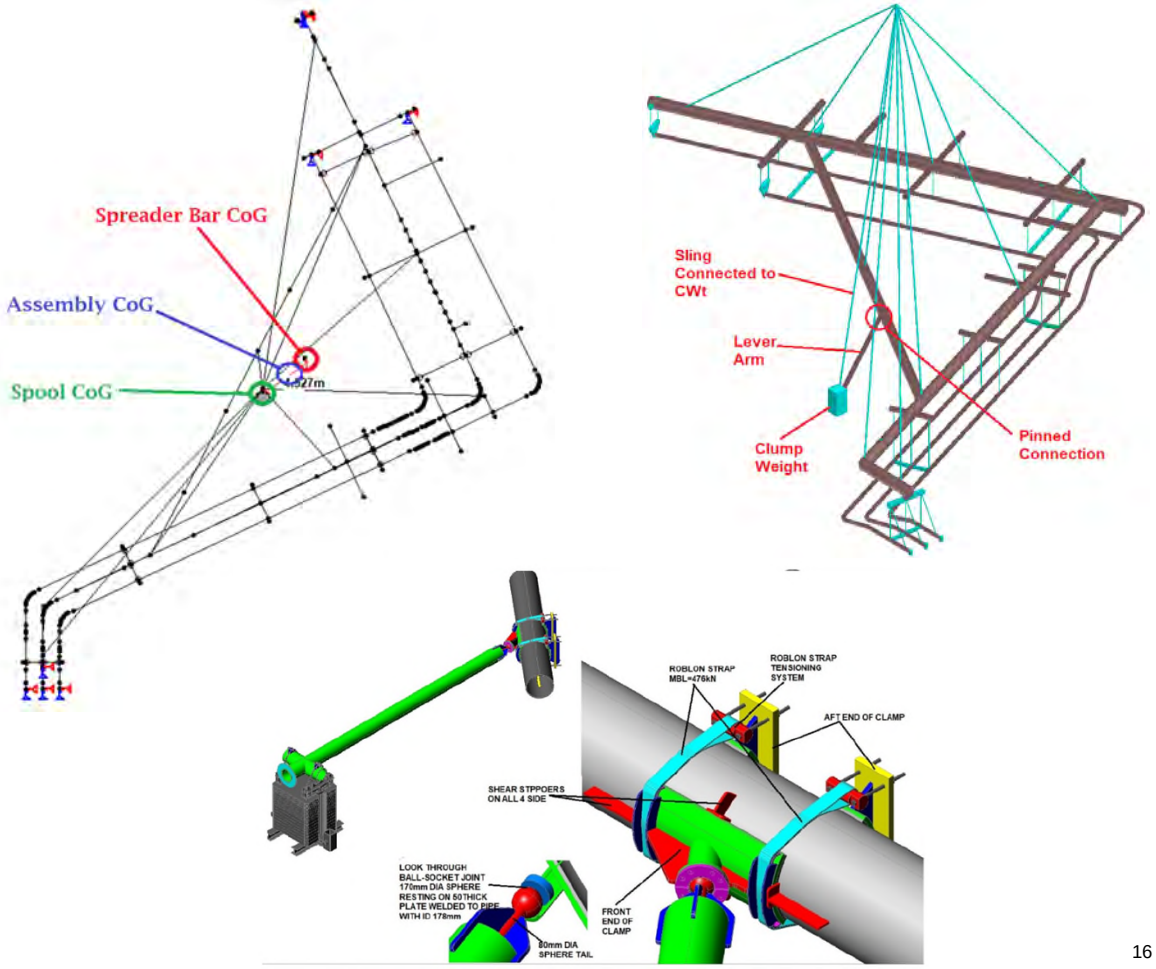
Innovative Technique : Spreader Bar Ballast System

- One of most important aspect of lift design – Adjust CoG Spreader Bar over CoG of Spool
  - Flat / horizontal Lift
  - Stability of spreader after spool landing
- Solution: adjust and try to match CoG of empty spreader bar with CoG of complete assembly by adding a ballast system onto the spreader bar
- Invented a CoG Adjustment System with Pinned Lever Beam
- Main Advantages:
  - Managed to bring down ballast weight within crane capacity
  - Ballast weight directly on crane. No significant effect on spreader bar integrity
  - Pinned connection – easy to adjust angle post-metrology



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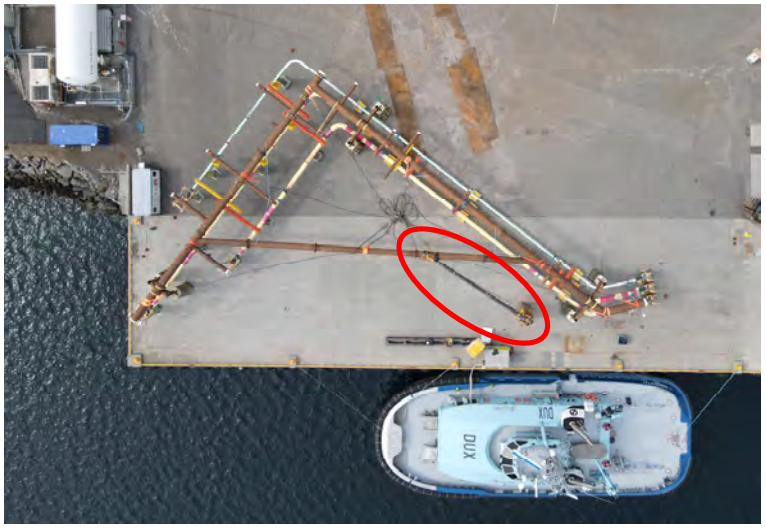
Spreader Bar Ballast System



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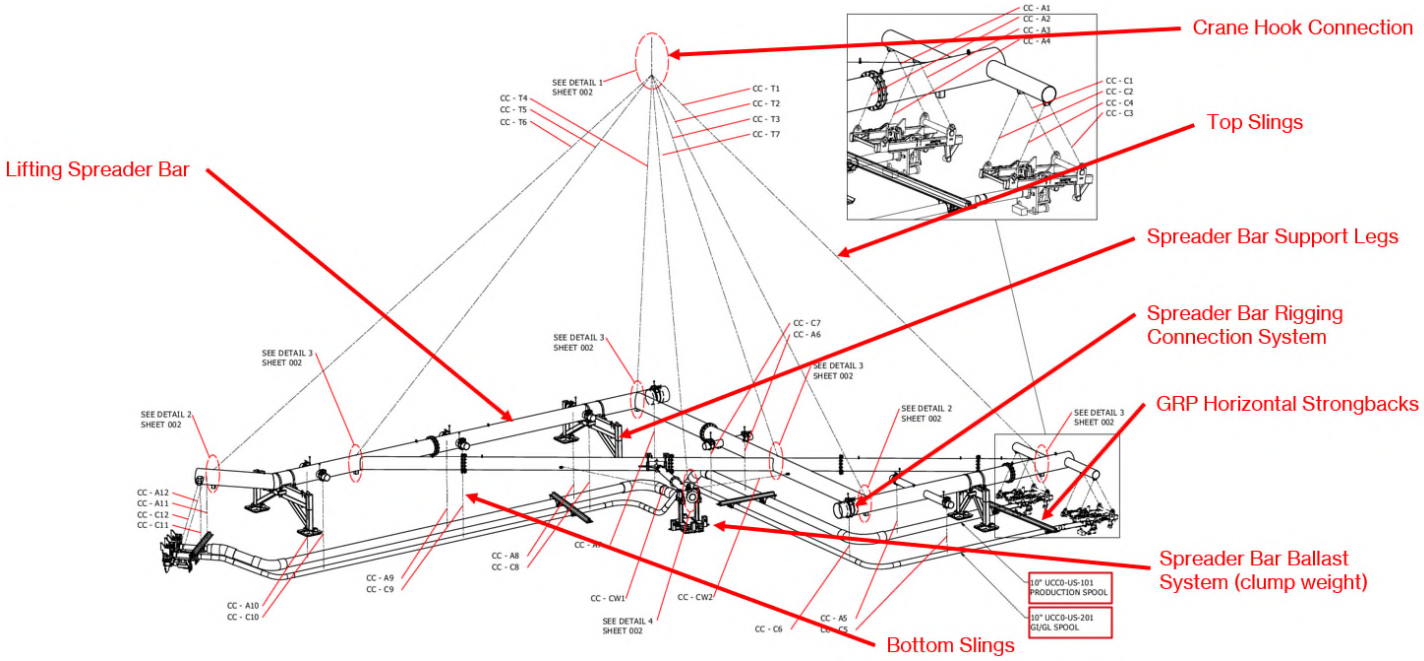
Spools Bundle Overview

- The spool bundles lifted and over boarded by the crane of installation vessel Viking Neptun from deck. A spreader bar assembly will be used to lift the spool bundle in a safe and controlled manner.
- Spool Lifting Arrangement consists in two parts:
  - **top rigging** from crane hook to spreader bar
  - **bottom rigging** from spreader bar to spools



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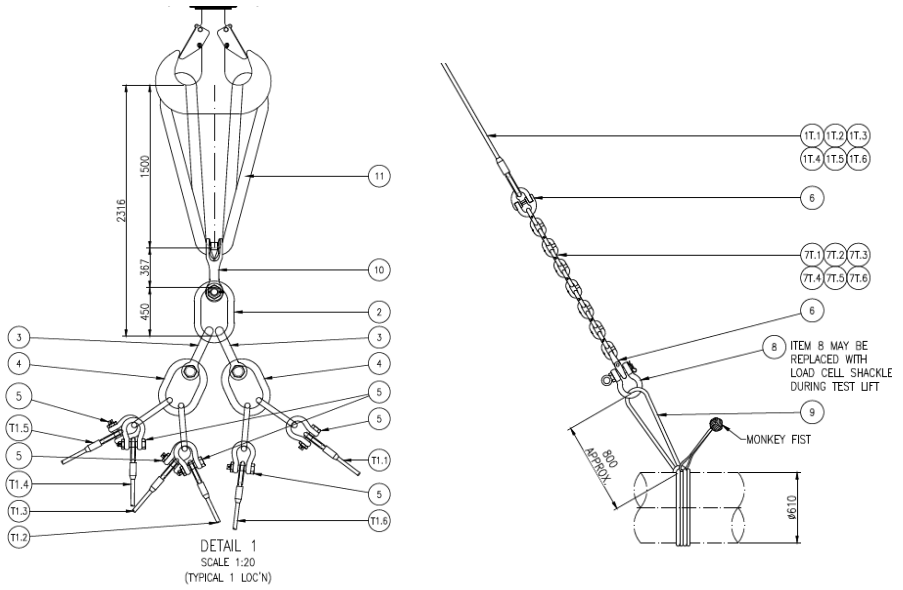
Lift Rigging Details

Top Rigging



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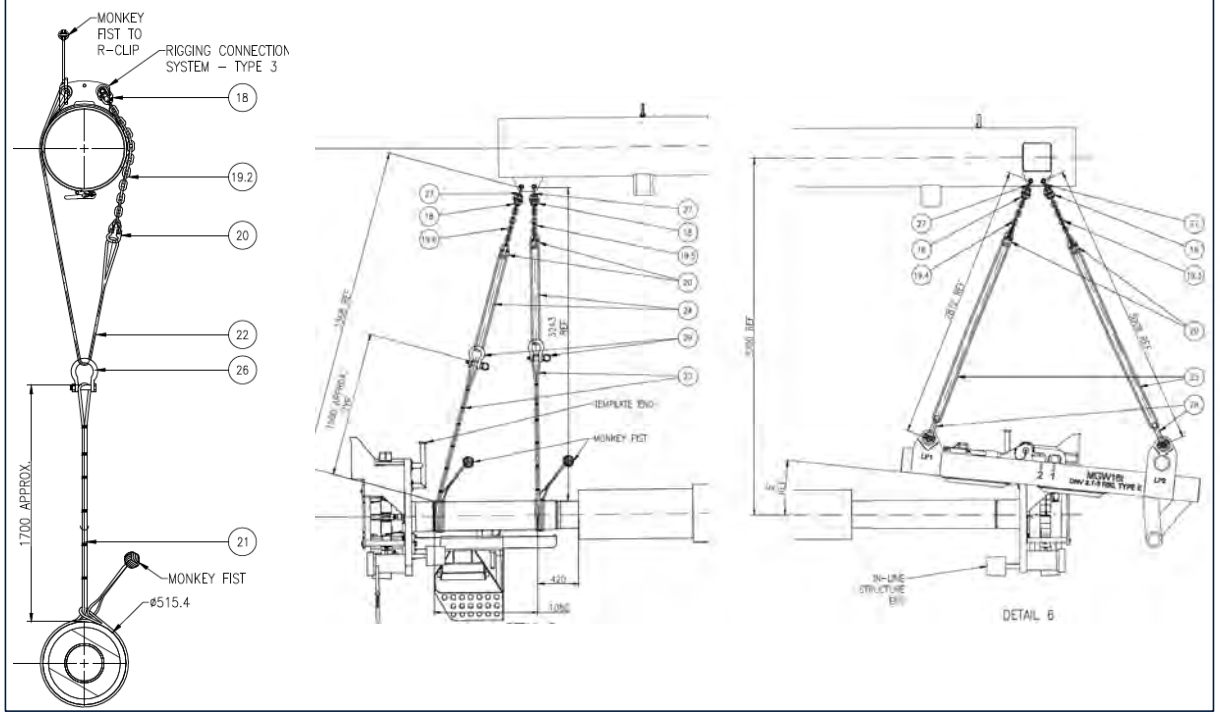
Lift Rigging Details

Bottom Rigging



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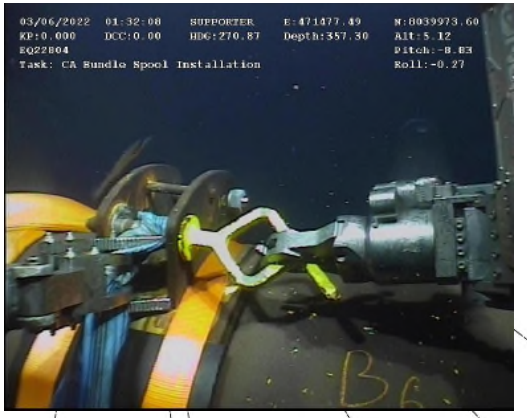
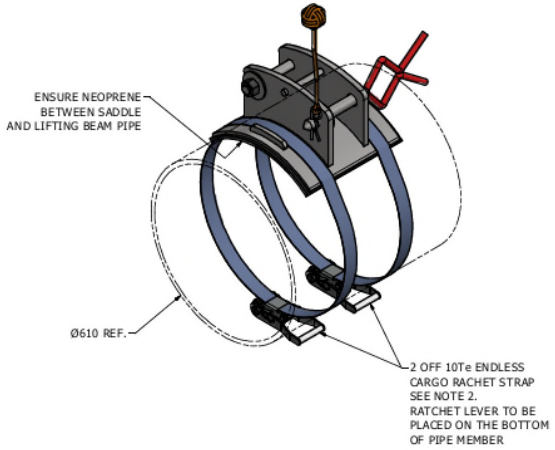
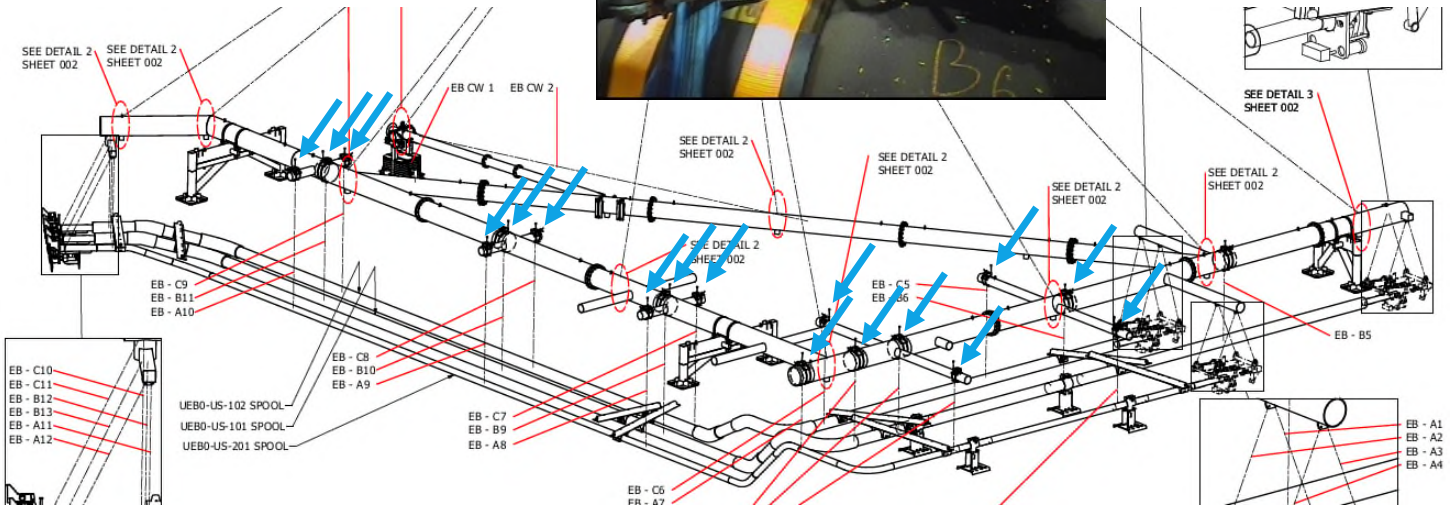
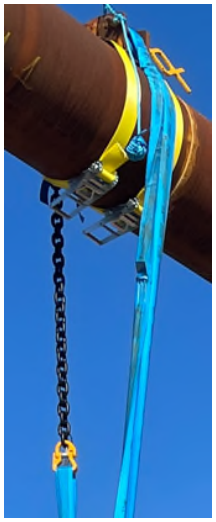
Rigging Connection System

- This system will allow for an easy and quick disconnection of most of bottom sling subsea by ROV after spools landing thanks to use of a simple ROV pin.









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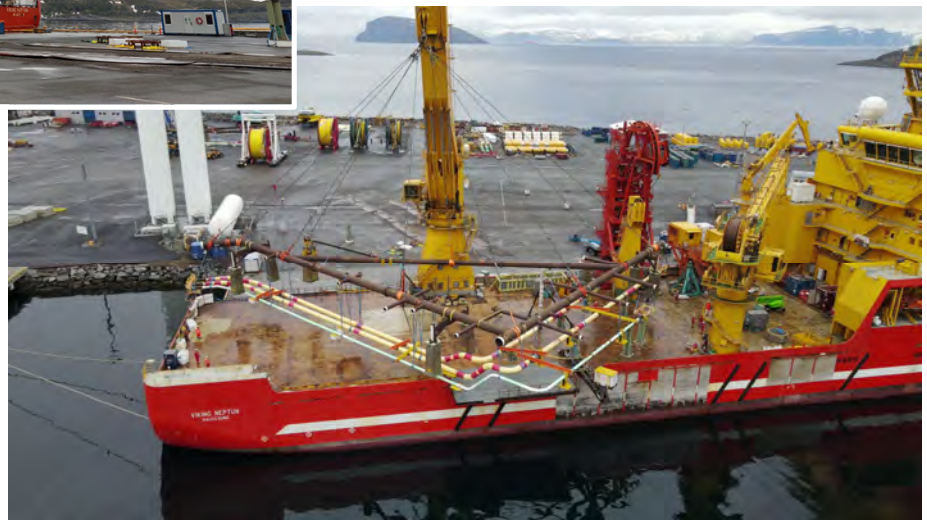
Loadout Operations at Polarbase

- All spool bundles loadout performed at Polarbase quay 4 using Viking Neptun main crane.
- Bundle lifted with all supports (spools and spreader bar) pre-attached
- For the largest bundles, an overhanging platform and support required to ‘extend’ the vessel deck on starboard side.
- Bundle total weight range: **92Te to 174Te**
- Seafastening of bundle on deck made of chains and cargo straps connected to D-rings welded to deck.



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Offshore Lifting Operations

- Full dynamic analysis performed with Orcaflex software for all critical steps including the lift through the splash zone.
- Analysis results provided maximum design sea states for each lift depending on the wave period of the day.
- Limiting factor is actually the movement of the load on deck at the start of the lift.
- Alpha factors (defined by DNV) considered for weather forecast inaccuracy.
- Use of crane tuggers and rigger's slip lines only.
- Crane radius had to be increased during the lift due to size of the bundle.
- Multiple watchers on deck communicating with the deck foreman (banksman) to inform when to start slewing the crane and to warn for potential contact or entanglement.

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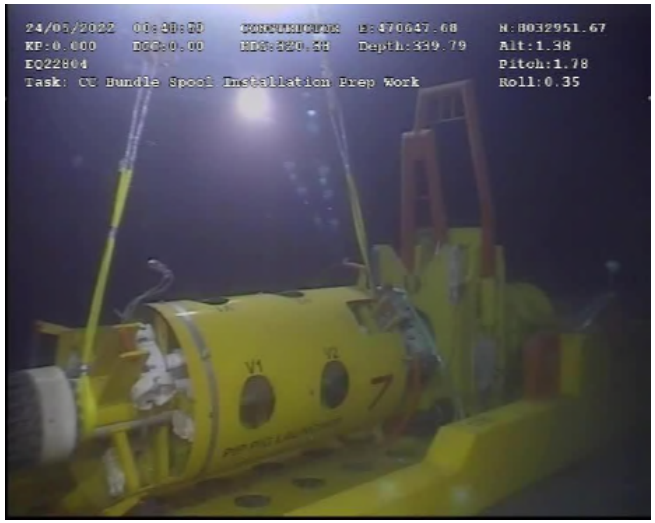
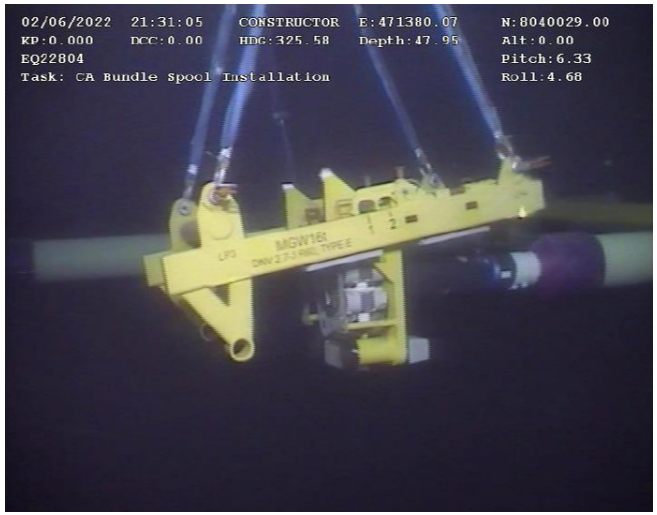
Subsea Landing Operations

- Disconnection and removal of PLR (Pig Launcher and Receiver)
- Installation of long guideposts onto porch receptacles, 2 different heights
- Spool bundle lowered through the water column
- ROVs are monitoring each end of the bundle (ILS ends and Template ends)
- Several ROV relocation required – slow but controlled operation





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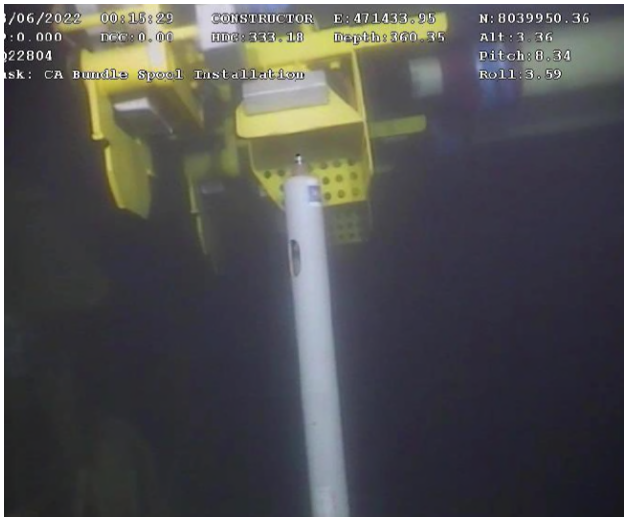
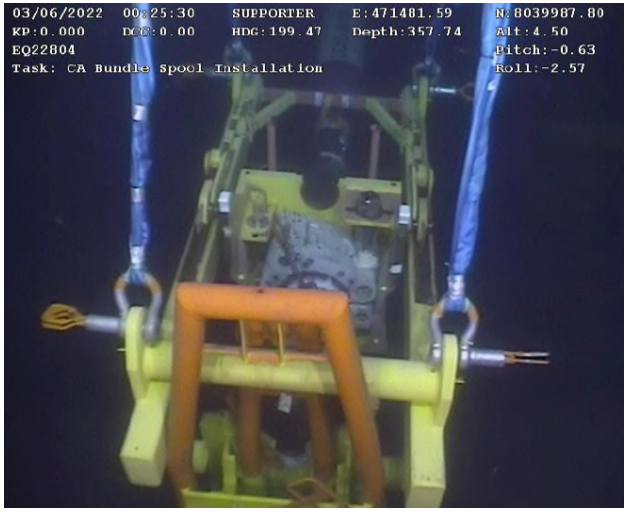
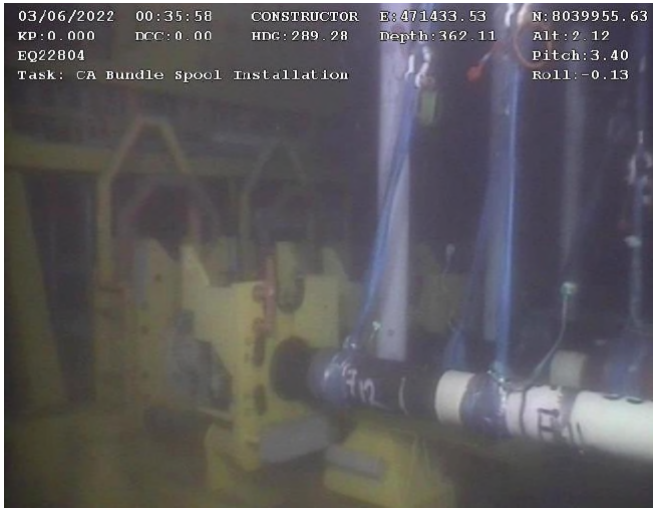
Subsea Landing Operations

- Positioning spool termination heads above guideposts
- Spools engaged into all three guideposts
- ROVs guiding spools onto ILS guide rails
- All spool termination heads (up to 6) landing on porches at the same time
- Once full and correct landing confirmed, bottom rigging slacked and started rigging disconnection by ROVs
- Recovery of empty spreader bar to deck







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Advantages and Challenges Associated with Spool Bundle Lift

Main Advantages:

- 19 single spools VS 8 spool bundles
- Fewer lifts (loadout and over boarding offshore with high risk)
- Shorter offshore campaign, less vessel transits and mobilisations
- Reduced time subsea on each site (efficiency and flexibility in the overall offshore schedule)
- Reduced risk of clash between spools or other subsea structures
- Better re-use philosophy for spreader frame compared to single spool lift with specific bracings
- Deck space requirement marginally equal between single or bundle solution

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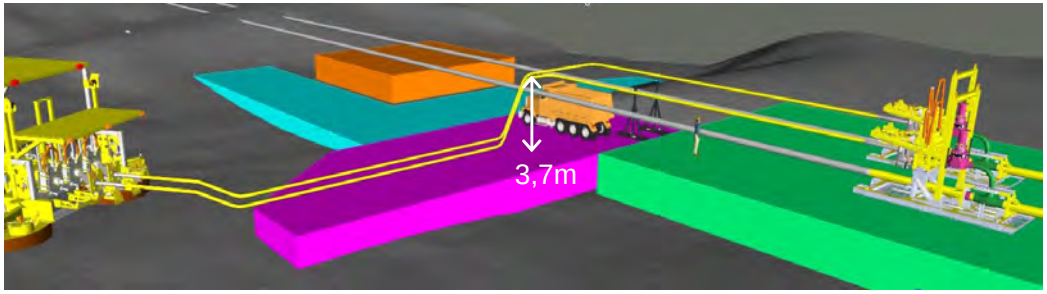
Advantages and Challenges Associated with Spool Bundle Lift

Main Challenges:

- Harsh environment in Hammerfest (start of onshore preparation in February to be ready in May)
- Large amount of rigging to be managed – remote location no rigging should be missed/forgotten
- Very large bundle (footprint and height)
  - Deck space
  - Sufficient storage area on the base
  - Additional crawler crane mobilized in Polarbase
- Accurate positioning (dim control) of spools within the bundle to make sure landing is possible



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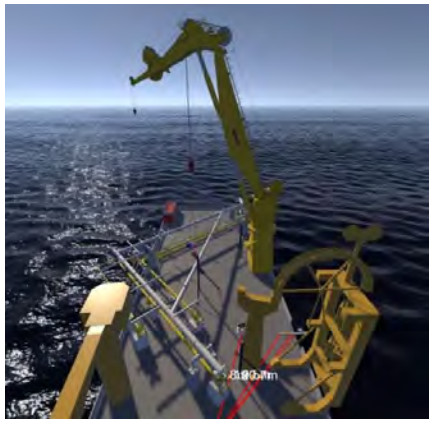
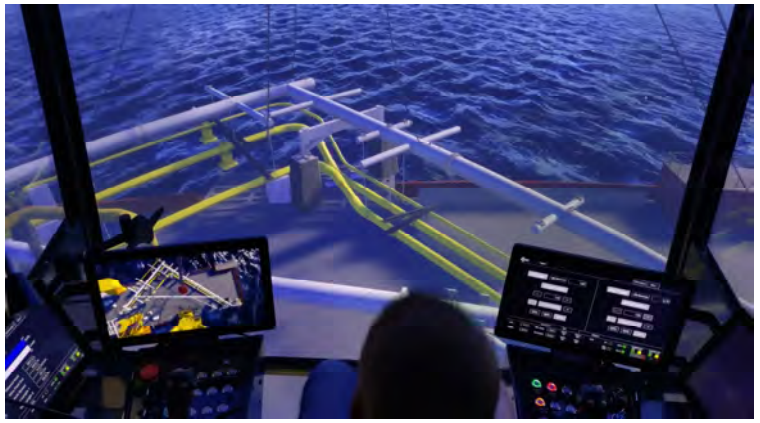
Simulations Training at OSC

- Spool bundle installation simulations that were performed at OSC in Ålesund, Norway.
- The simulator consists of real-life environments of the vessel bridge, main control desk, 2-off ROVs, crane driver, and deck team stations that are linked together in a virtual world.
- The Viking Neptun model was prepared for the full operation, including 2 off deck winches. The crane was fully modelled including crane tugger winches.
- The Viking Neptun model hydrodynamic properties respond realistically to waves, winds and currents in the virtual environment.





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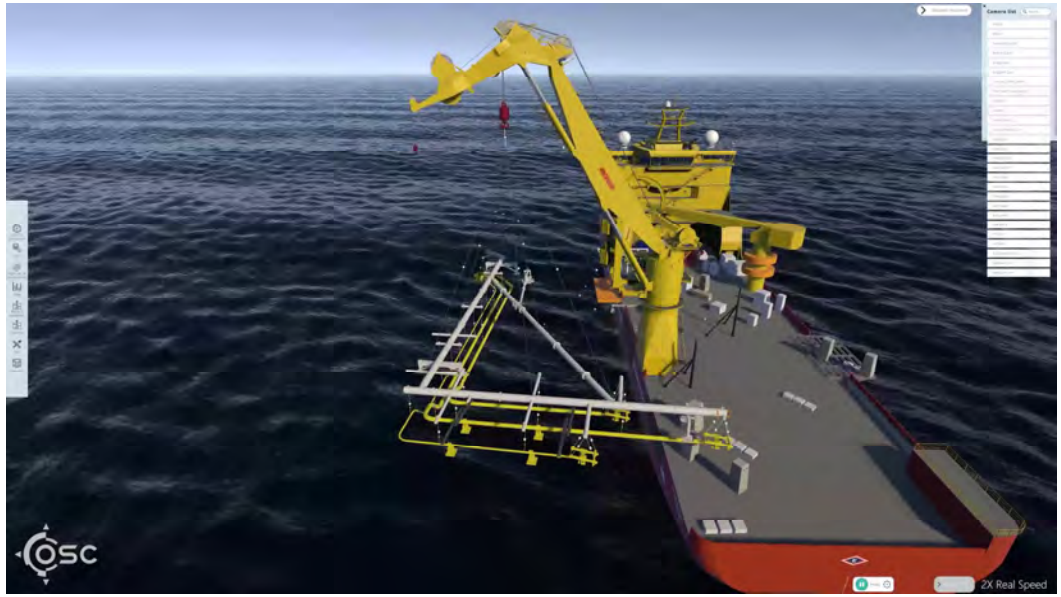
Simulations Training at OSC

- The following scenario have been simulated and tested:
  - Bundle overboarding simulation (with different wind and sea conditions)
  - Subsea Landing of bundle
  - Connection of main block on deck
  - Empty spreader bar recovery to deck
- Main findings and actions
  - Use of slip lines instead of deck winches (pay out speed can be an issue)
  - Add protection to vessel permanent structures and guideposts on the lift path
  - Focus on crane tugger operability and readiness (key equipment)
  - Increase crane radius as much as possible at the end of overboarding
  - Maximum wave height for controlled lift (1.25m Hs)
  - Possible snagging points when lifting off crane block with main rigging
  - Several findings to improve the subsea landing

- Videos:
  - **Comparison between simulation and reality**
  - **Subsea Landing**



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Thank you

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