Complex Lifting Operations:

Rigid Spool Bundles Installation for Johan Castberg Project

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Ocean Installer at a glance

A marine construction company focusing on SURF, mooring, renewables and carbon capture

Reputable offshore installation company with a solid track record in subsea and marine operations

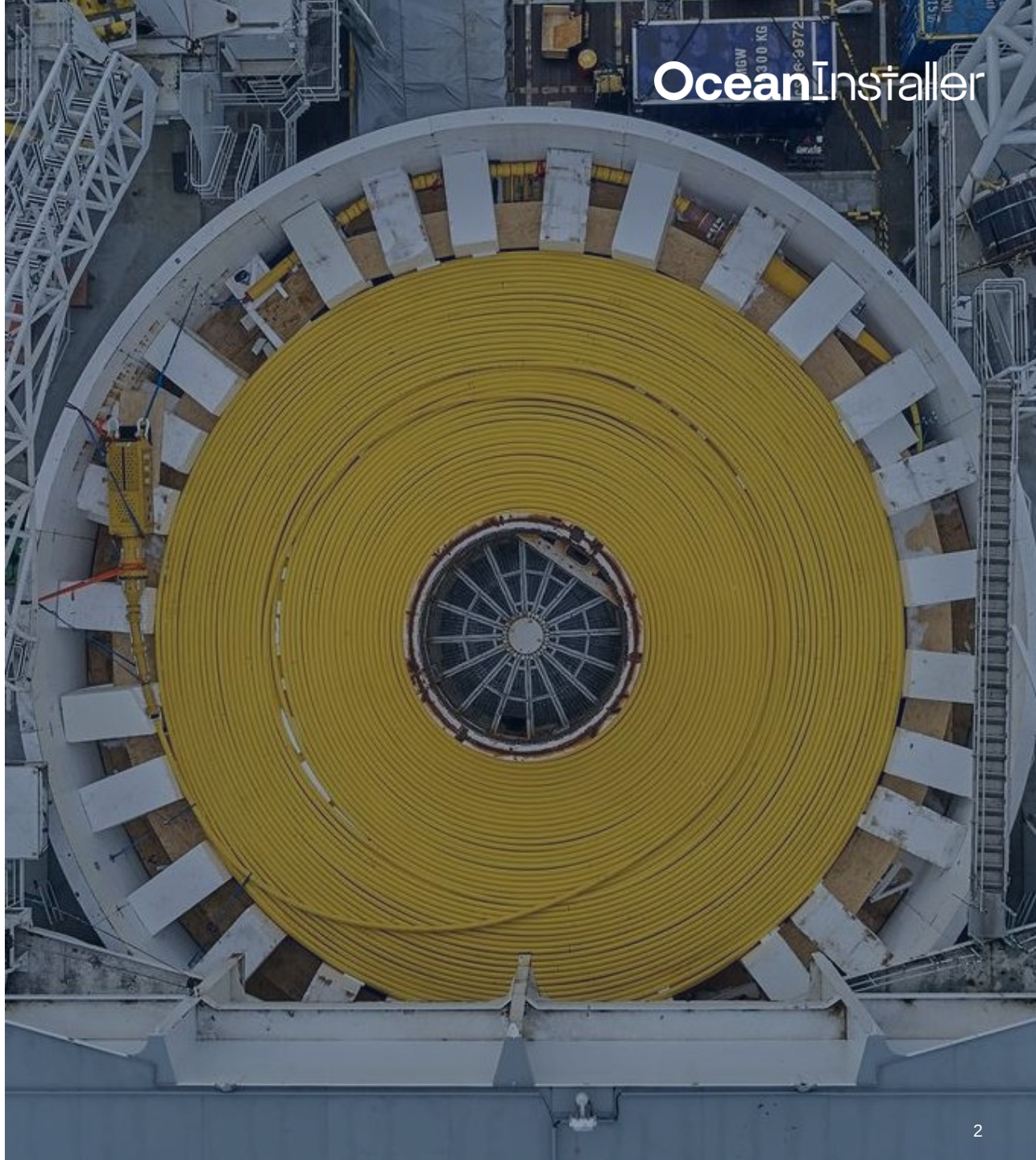
Established in 2011 by HitecVision (100% ownership)

Headquartered in Stavanger, Norway, with offices in Oslo, Houston, Aberdeen & Dubai

Approx. 270 employees, 50% Technical and Operations

Experienced in full EPCI and complex logistical challenges, with strong safety culture and track record

Contract backlog of firm NOK 5,2 + 6bn in partnership agreements (Q2-2023)



Rigid Spool Bundles Installation

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1 Project & Spool Installation Scope Briefing

2 Spreader Bar and Rigging Design

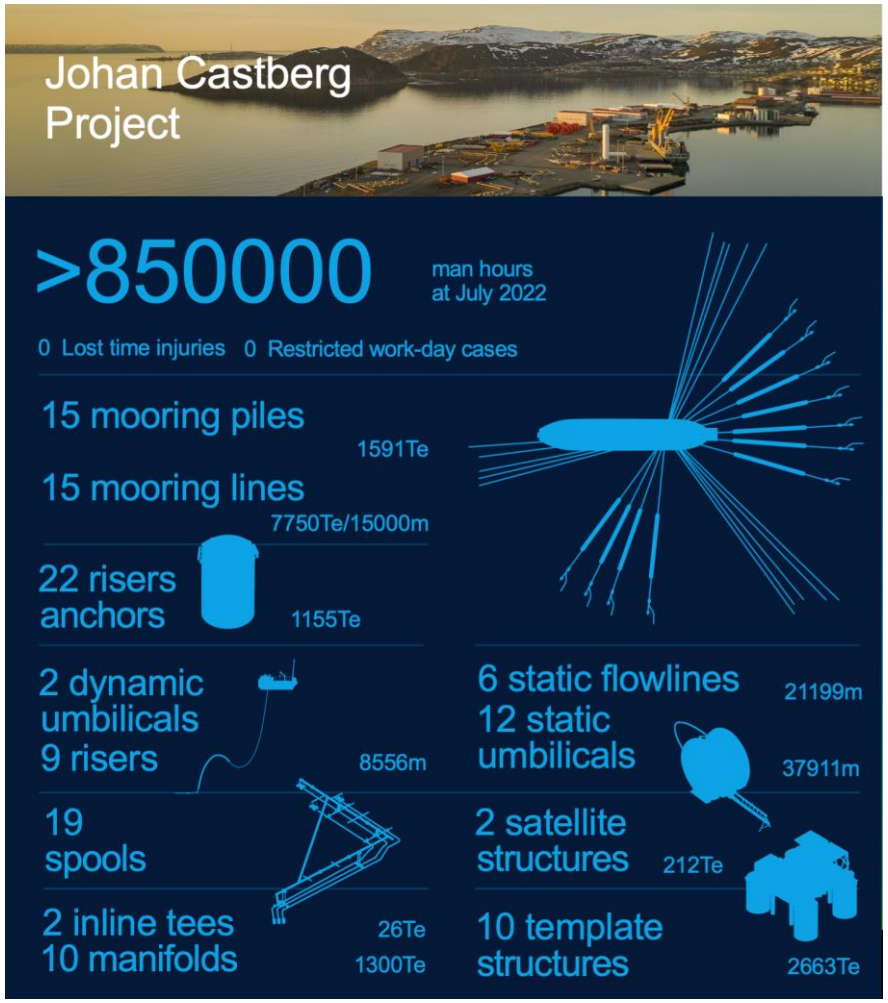
3 Lifting Operations and Subsea Landing

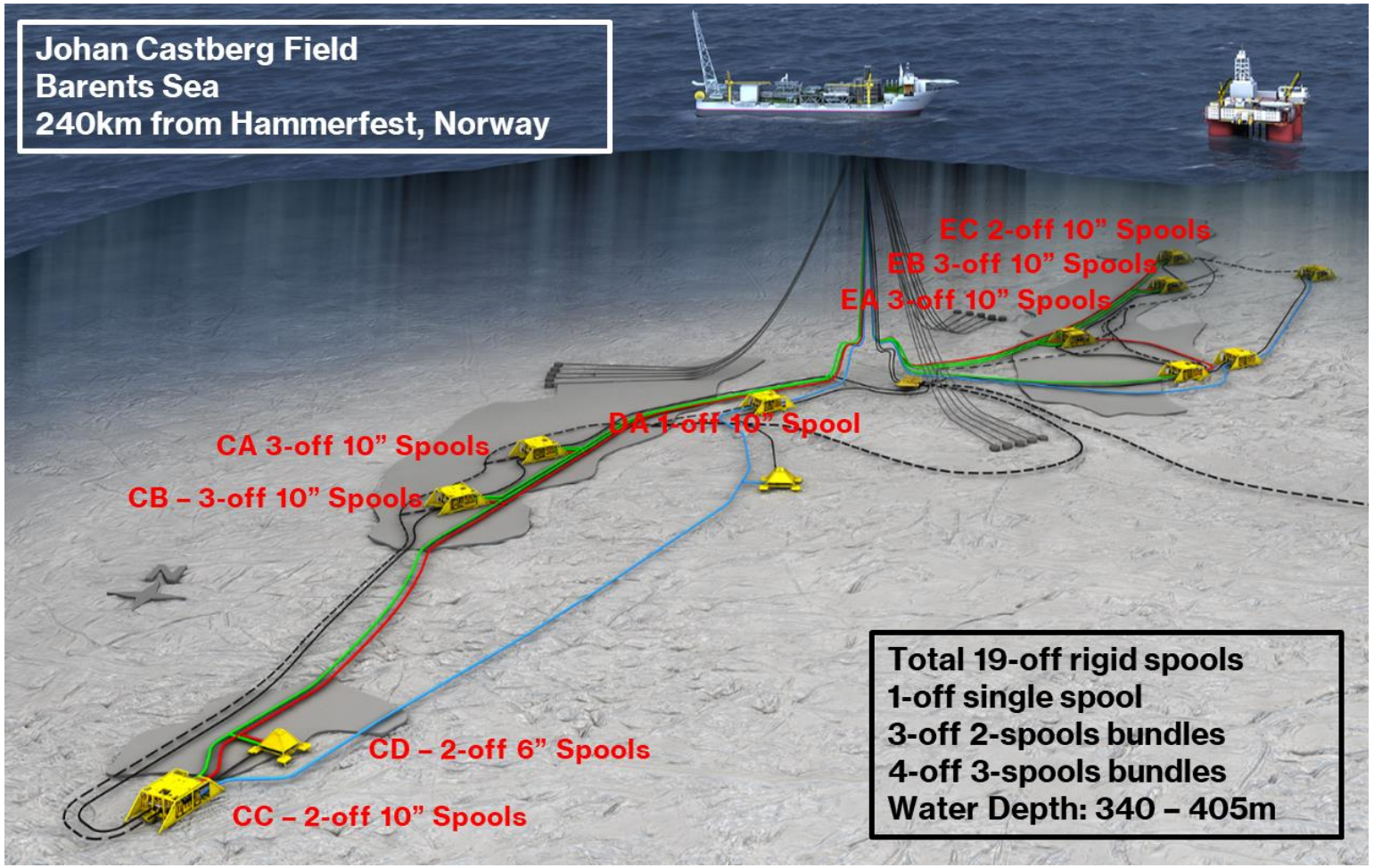
4 Advantages and Challenges Associated with Spool Bundle Lift

5 Simulations Training and Comparison with Reality

Rigid Spool Bundles Installation for Johan Castberg Project

Project Summary





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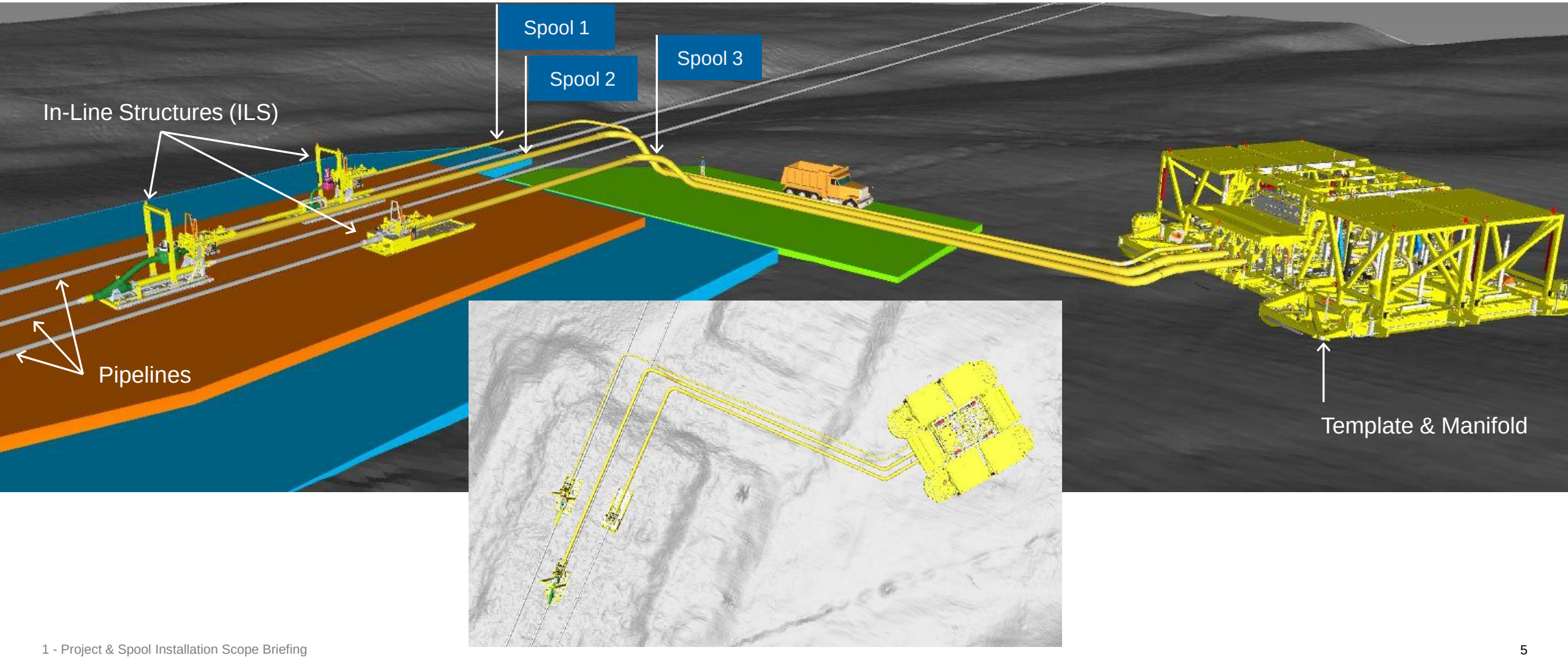
Typical Spools Configuration Subsea



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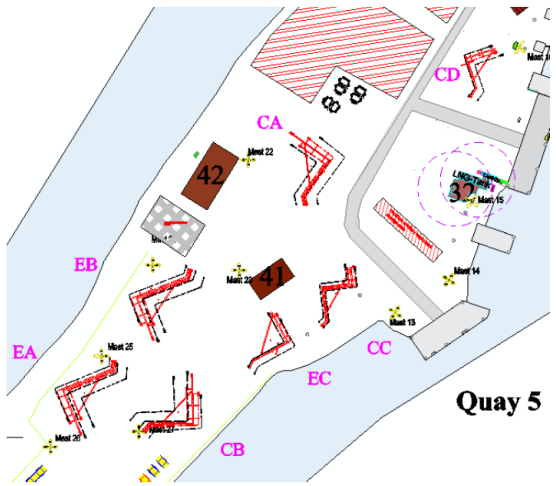
Mobilisation base: Polarbase in Hammerfest

- Main onshore base for the entire project
- Fabrication of the 19-off rigid spools including field joint coating and testing
- Storage of project equipment including rigging and installation aids
- Preparation of the spools into bundle configuration including onshore test lift and transport of bundle assemblies to quayside
- Load out of spool bundles onto installation vessel



Installation Vessel:

***Viking Neptun**, state-of-the-art DP3, heavy construction vessel with high capabilities for heavy lifting (400Te main crane AHC, 2x WROVs)*

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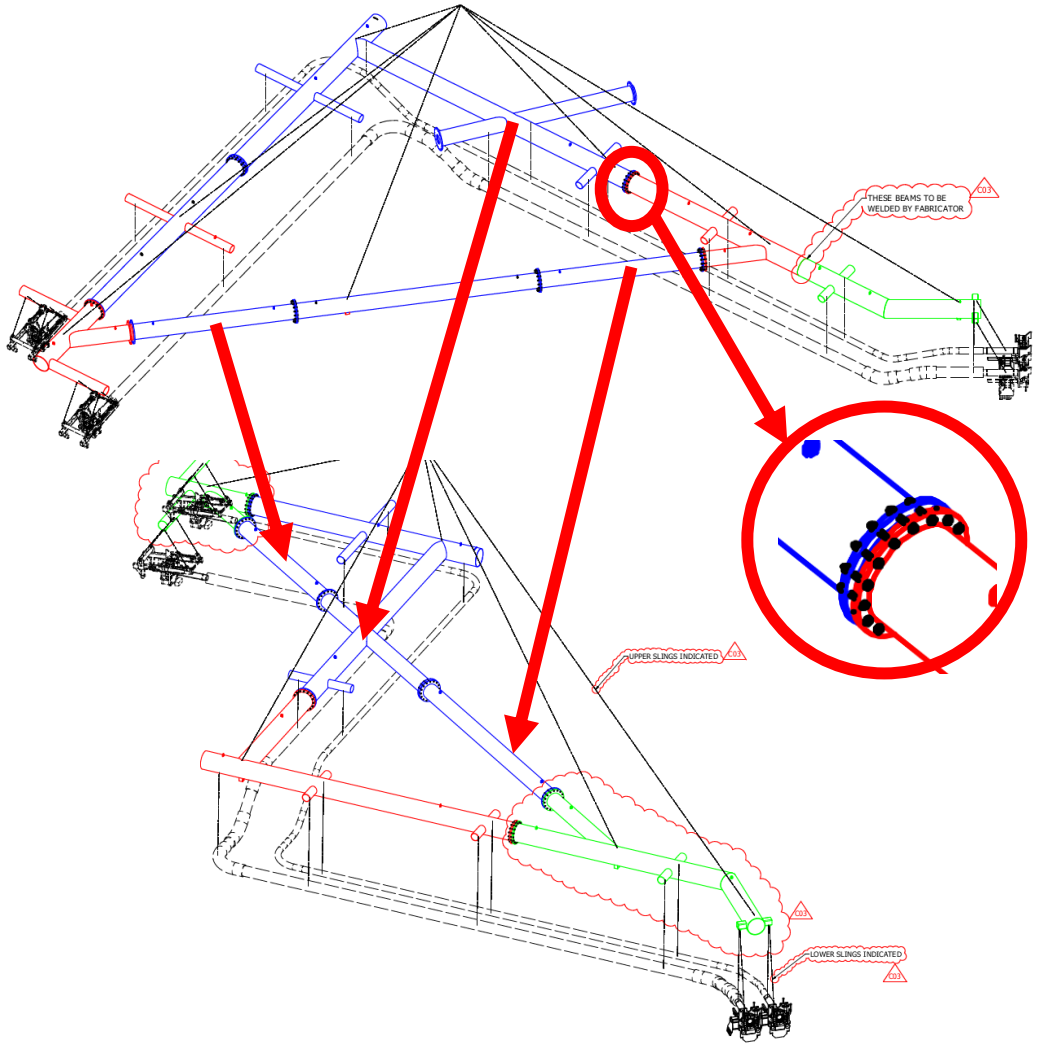
Spreader Bar Design and Modularity

- 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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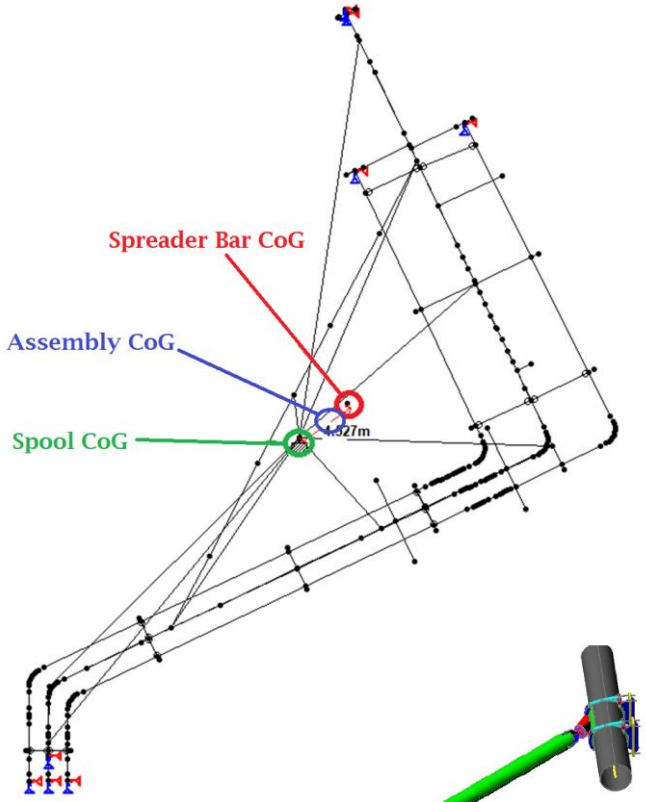
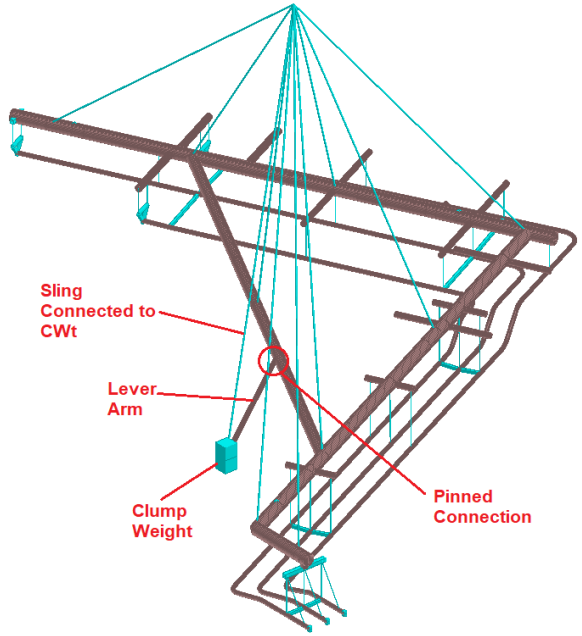
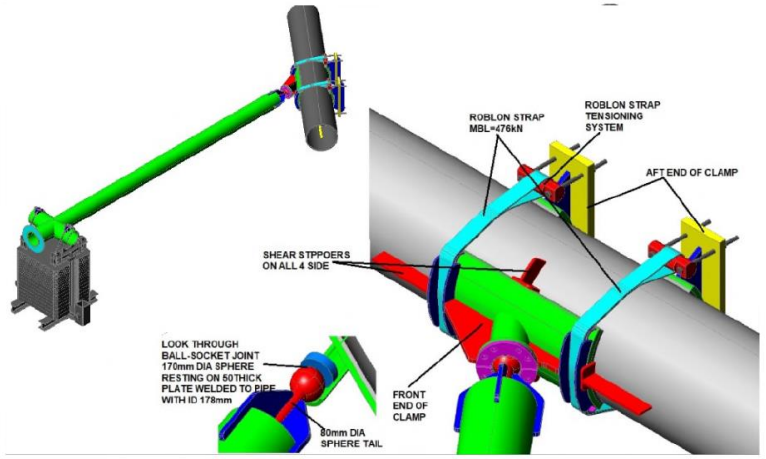
Innovative Technique : Spreader Bar Ballast System

- 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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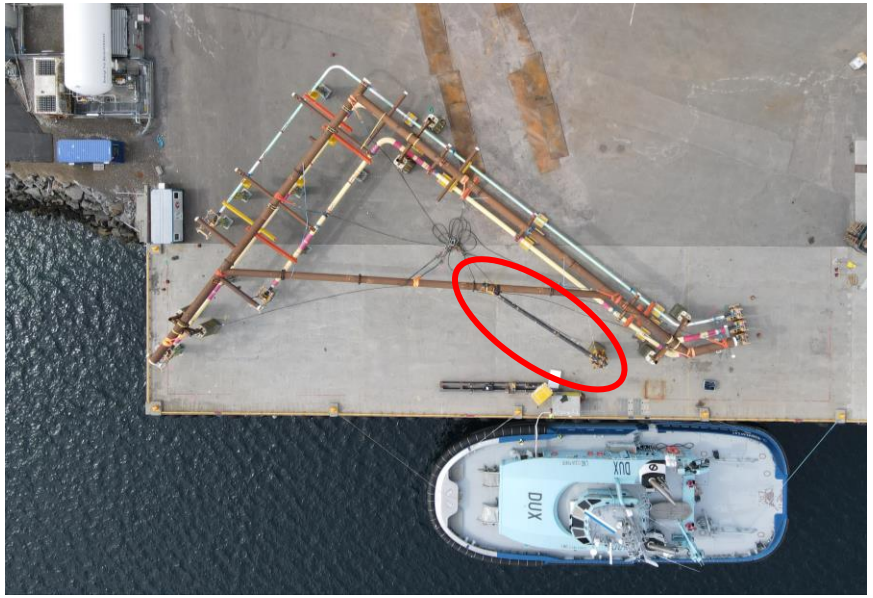
Spreader Bar Ballast System



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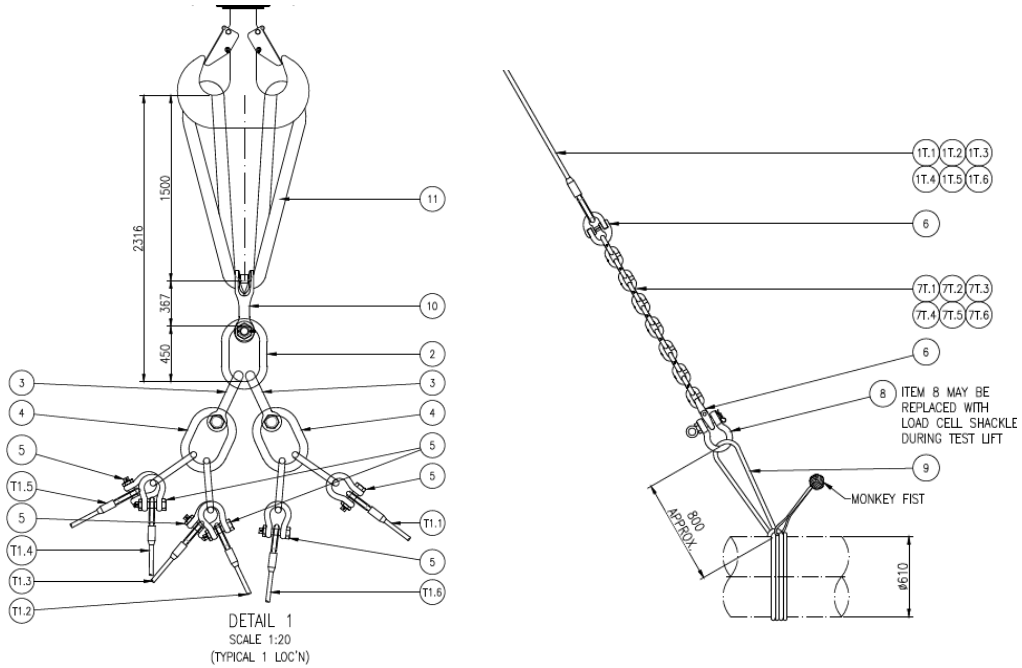
Lift Rigging Details

Top Rigging



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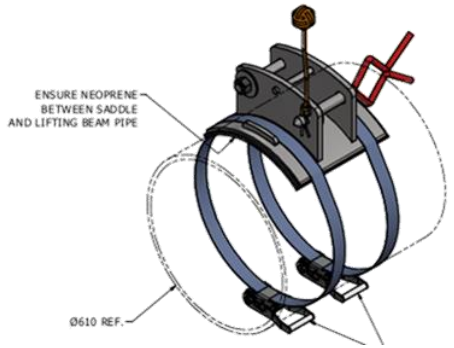
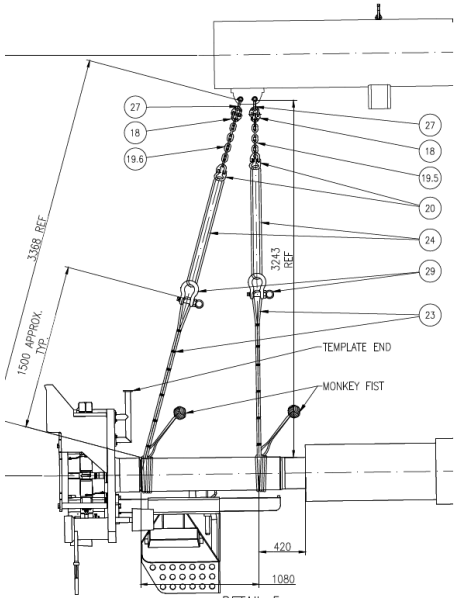
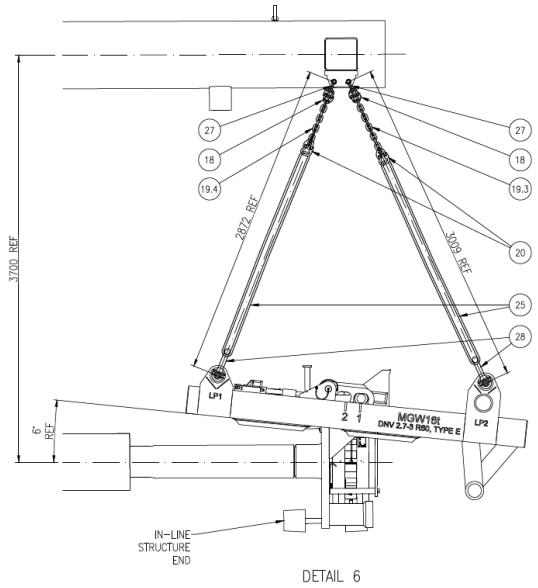
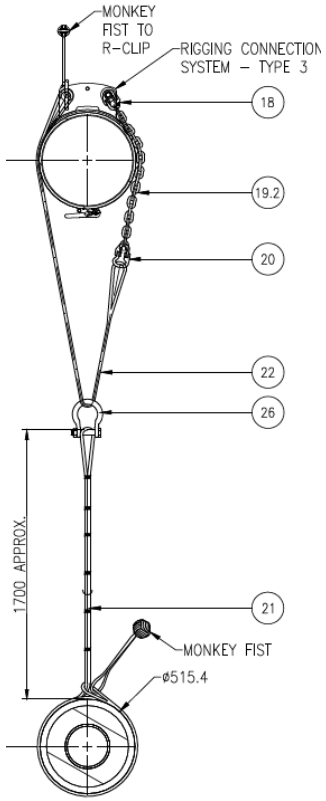
Lift Rigging Details

Bottom Rigging









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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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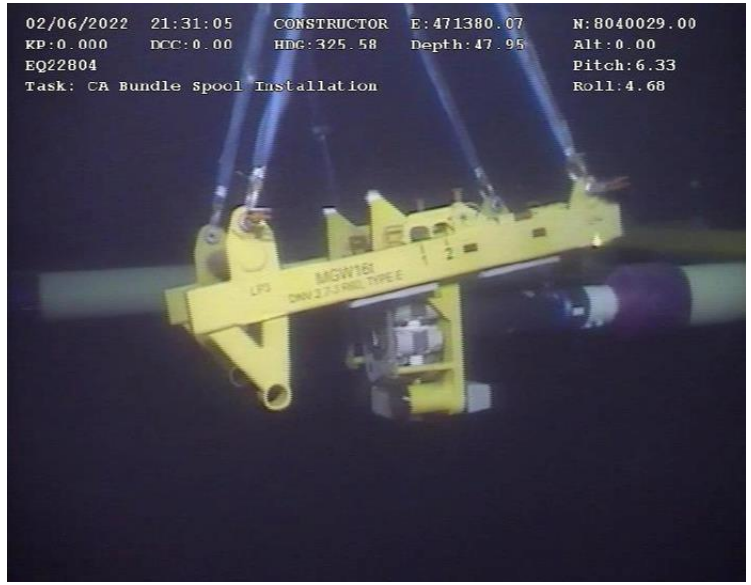
Subsea Landing Operations

- 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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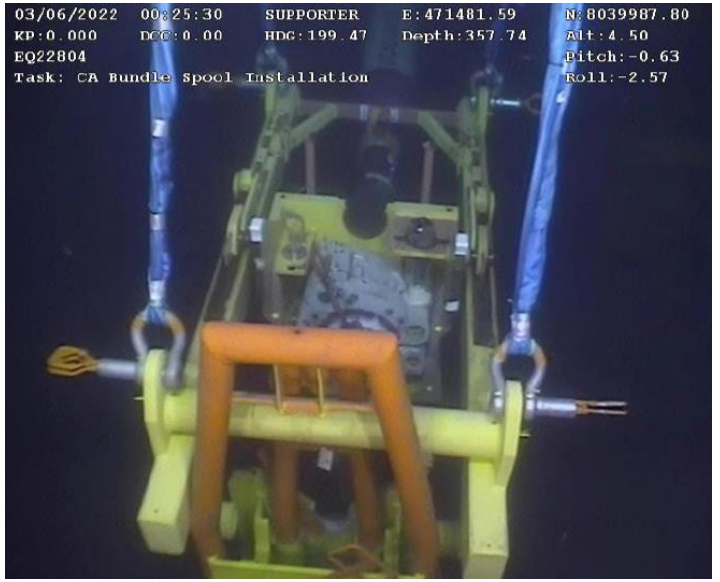
Subsea Landing Operations

- 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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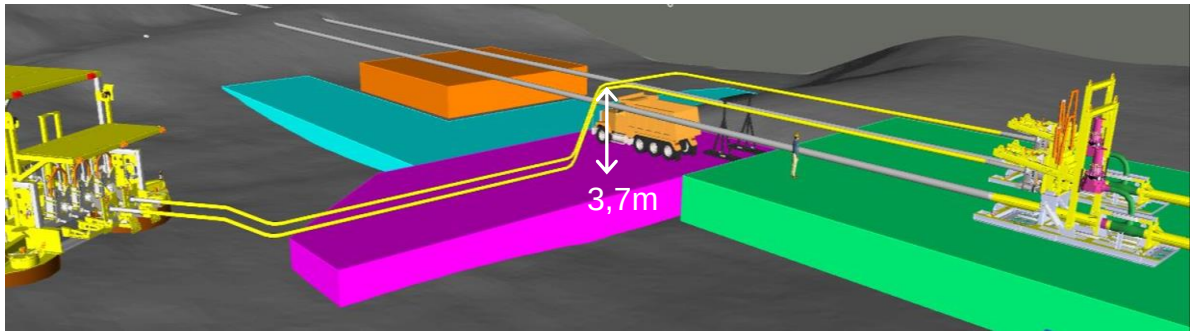
Advantages and Challenges Associated with Spool Bundle Lift

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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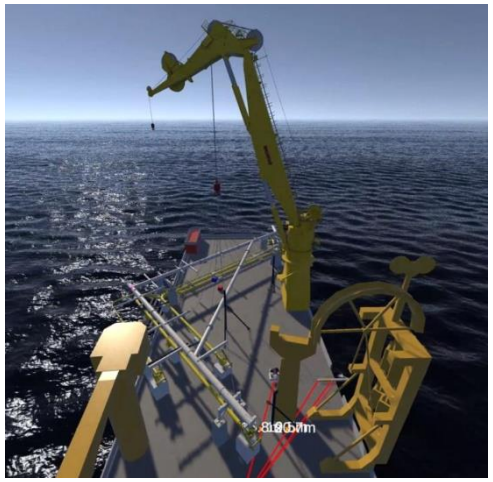
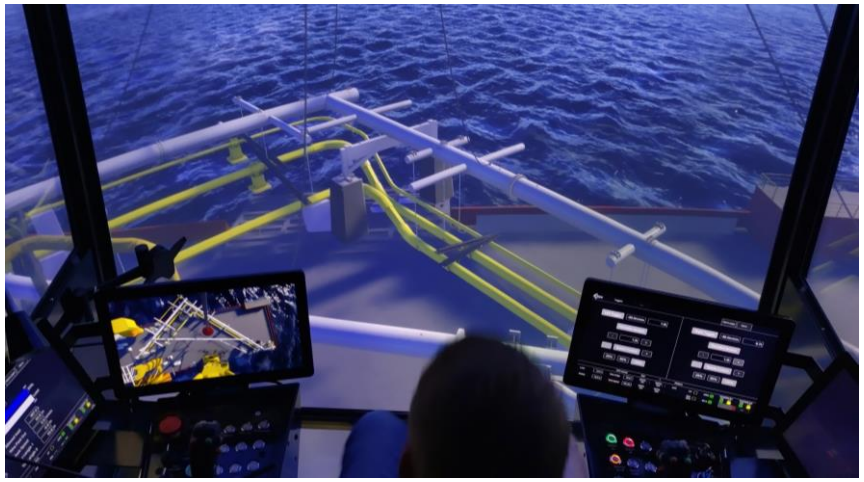
Simulations Training at OSC

- 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.
- Installation vessel model was prepared for the full operation, including 2 off deck winches. The crane was fully modelled including crane tugger winches.
- The installation vessel model hydrodynamic properties respond realistically to waves, winds and currents in the virtual environment.





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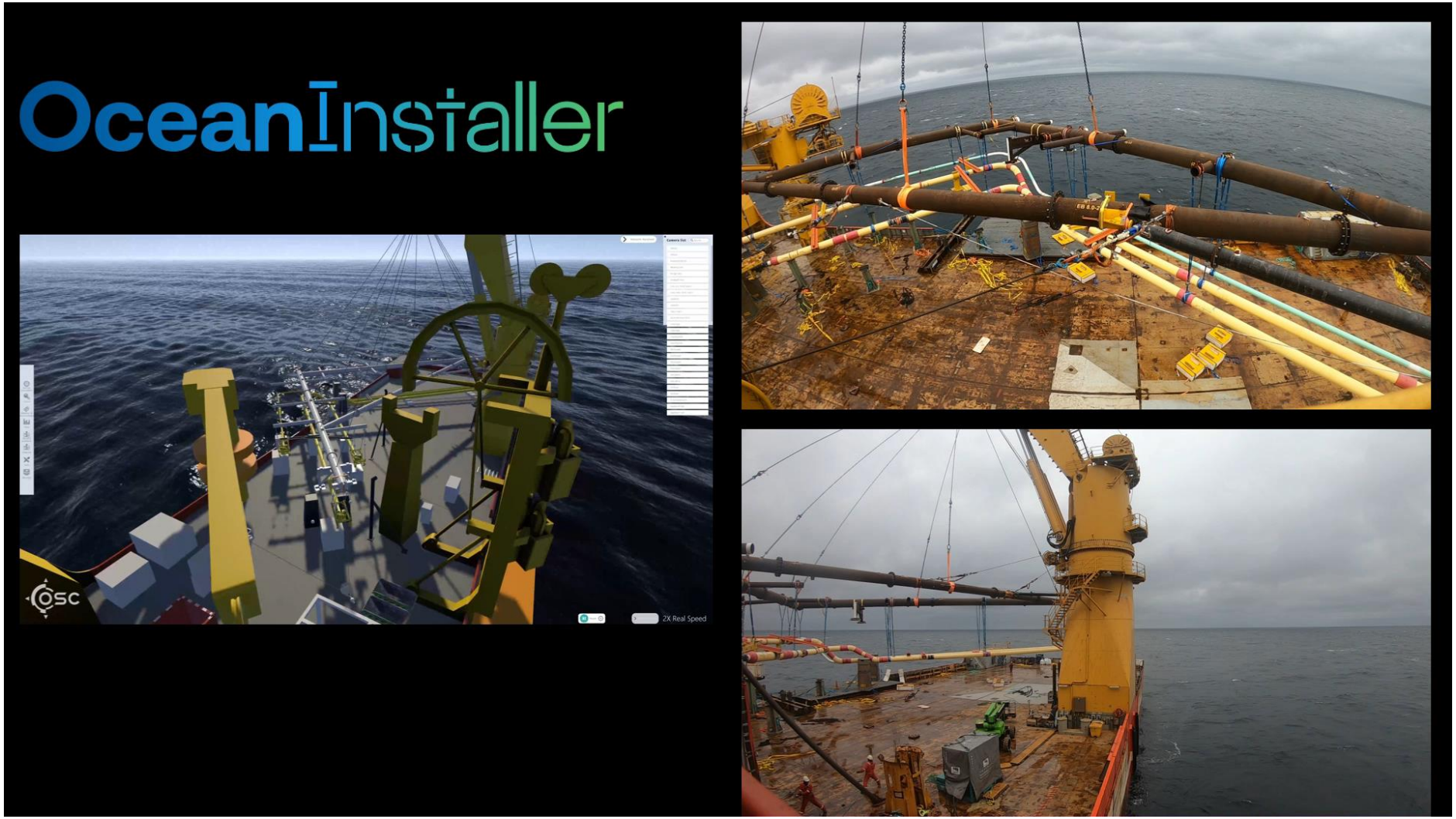
Video 1: *Overboarding: Comparison between Simulation and Reality*



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Video 2: *Subsea Landing Simulation*

Thank you

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