

PROJECT SHEET

HAEWENE BRIM FPSO
INSPECTION, REPAIR AND MAINTENANCE OF THE
HAEWENE BRIM MOORING SYSTEM

BOSKALIS OFFSHORE ENERGY

Boskalis is a leading global dredging and marine expert. With safety as our core value we provide innovative, sustainable and all-round solutions for our clients in the energy market. Realizing projects in remote locations with a heightened environmental focus is one of our specialties. Under brands such as Boskalis, Dockwise, SMIT, Fairmount, VBMS and Smit Lamnalco we offer more services than any other company in our industry, making us your next one-stop solution provider.

We support the development, construction, maintenance and decommissioning of oil and gas import and export facilities, fixed and floating exploration and drilling facilities, pipelines and cables, and offshore wind farms.

HAEWENE BRIM FPSO

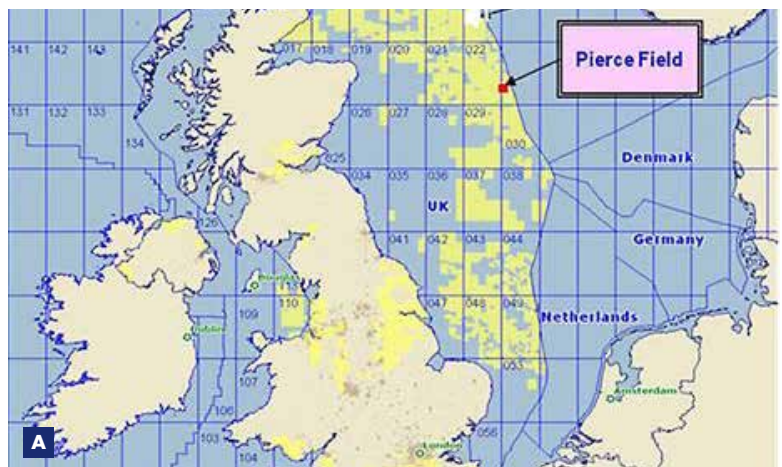
The Hæwene Brim was built in 1996 at the Samsung shipyard, Korea, as a multi-purpose shuttle tanker (MST). She was originally designed to perform shuttle tanker services as a dynamically positioned (DP) tanker. With a few minor changes, she can be converted into a floating production storage and offloading (FPSO) or a deep-water drilling vessel.

Since 1999, the Hæwene Brim FPSO installation has been operational at the Pierce field in the UK sector of the North Sea for Shell UK Exploration & Production. The water depth at the Pierce field is 85 meters. Bluewater purchased the Hæwene Brim in 2001 and operates the FPSO on behalf of the Dutch oil major. The FPSO has a disconnectable internal turret mooring system. The submerged buoy is moored with 8 mooring legs. The buoy is pulled in and fixed in the internal turret on the FPSO. The FPSO is free to 'weathervane' around the buoy. The buoy can be easily released so the FPSO is free to move to port, leaving the in-field infrastructure intact.



FEATURES

Client	Bluewater Energy Services
Location	Pierce field, UK (North Sea)
Period	Q1 and Q2, 2012
Vessel	EDT Protea and DSV Constructor



- A** Pierce Field location
- B** Installed Bird-cage clamp
- C** DSV Constructor during mooring repair campaign

MOORING LINE FAILURE

During a survey in January 2012, a mooring line failure was discovered in line #6. The wire broke close to the seabed, where the upper section of the mooring line, a spiral strand wire (SSW), is connected to the 120mm ground chain.

The mooring system for Haewene Brim FPSO consists of eight (8) catenary mooring lines. Each mooring line comprises the following sections:

- Upper wire rope section to turret (SSW)
- Upper chain section to wire rope section (120 mm ground-chain)
- Wire rope section to ground chain (SSW)
- Ground chain to anchor pile (120 mm ground-chain)



MOORING REPLACEMENT

Bluewater requested the Offshore Energy Division of Boskalis (Subsea Services) to provide an emergency response repair for mooring line #6. Subsea Services provided a method that included procedures, project equipment and personnel. Secondly, Bluewater requested assistance with an overall upgrade (maintenance) of the Haewene Brim mooring system.

The project scope of the Haewene Brim mooring system upgrade consists of the following phases:

EMERGENCY RESPONSE MOORING LINE #6

- General visual inspection of the mooring system focusing on the condition of each mooring component
- Recovery of failed mooring line #6 (SSW) by ROV for re-termination and refitting of the SSW socket
- Re-connection of SSW to ground chain mooring line #6 by AHT

MOORING SYSTEM MAINTENANCE

- Installation of bird-cage clamp on mooring lines #2, 3, 4, 5 and 6 by air and saturation divers. The clamps are to prevent the wire from unraveling
- Cutting of ground chain mooring lines #2, 3, 4 and 5 attached to the anchor pile and installation of a pennant wire with surface marker buoy by saturation divers for later recovery by AHT
- Shortening of SSW to get the wire socket connection out of the "dynamic zone" near the touch-down point
- After AHT laid down the ground chain, the re-connection of the ground chain by saturation divers using the chain leg installation frame

MOBILIZATION

Boskalis mobilized the DSV Constructor, DP3 DSV EDT Protea and the Anchor handling tug (AHT) President Hubert for the emergency repair of mooring line #6. The standard fittings of the EDT Protea include an active heave compensated (AHC) 50mT SWL knuckle-boom subsea crane and a Sea Eye Tiger ROV system. For the first part of



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this project, Subsea Services mobilized a light Work Class ROV, the Sea Eye Panther Plus.

For the upgrade campaign, Boskalis mobilized the DP2 DSV Constructor. The Constructor is equipped with a 12-man saturation diving system rated for 200 meters of water depth. She has a 100-ton offshore crane and a Sea Eye Tiger ROV c/w LARS-TMS System to support the diving works.

The DSV Constructor was used in both campaigns: the emergency response and maintenance/upgrading campaign. The EDT Protea was only used during emergency response.

SAFETY

Safety is an essential part of all Boskalis projects. Safety performance on the project was good. The vessels are on long-term charter and operated throughout the year by Boskalis. The vessels have a good safety record and they are suitable for the safe completion of works in question.

PROJECT CHALLENGES

The main challenges, which were dealt with effectively during project preparation and execution, were:

- Monitoring/managing logistics of multiple assets under time pressure during the execution of the project
- Recovering a failed spiral strand wire from below a live FPSO by ROV;
- Re-terminating the SSW on board of the vessel using a re-termination frame specially designed for this work
- Handling a sensitive SSW. Several special frames were designed for recovering, overboarding and up-ending the SSW
- Subsea reconnection of a ground chain "under tension" using a chain-leg installation frame

CONCLUSION

Thanks to well-prepared engineering prior to mobilization, efficient offshore execution was achieved. The use of the project-specific re-termination frame and overboarding arrangement eased the offshore re-termination operation. The project-specific chain leg installation system proved its worth in the field during the re-connection of the ground chains in a mooring system under tension. All project stakeholders were satisfied with the end result and the FPSO mooring system lifetime has been extended.



- D** Mooring leg installation system for subsea connection of ground chains
- E** Re-terminating the SSW on board vessel

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