

# SUBMERGED TURRET BUOY MOORING

## SIX ACTEON COMPANIES CONTRIBUTE TO A SUCCESSFUL OPERATION

While many people were still enjoying their winter holidays, a 450-t submerged turret buoy was being installed in the central North Sea. The 26 December installation was part of Nexen Petroleum U.K. Limited's development of Ettrick field. Six Acteon companies were involved in the mooring operation, principally Trident Offshore, which worked with field development contractor Saipem UK, Sonsub Division (Sonsub), but with important contributions from sister companies 2H Offshore, InterMoor, Aquatic, IMS and Seatronics.

The work had several technically challenging aspects, including towing the buoy with nine pre-attached, 148-m jacketed spiral strand (JSS) mooring cables and the need to complete the final three hook-up connections subsea. This is the first installation of a permanent system in the North Sea using subsea connectors.

Nexen Petroleum U.K. is developing blocks 20/2a and 20/3a in the Ettrick oil field in just over 100 m of water with a subsea tieback to the *Aoka Mizu* floating production, storage and offloading (FPSO) vessel. Mid-water-arch, lazy-S and steep-wave riser and umbilical systems will be connected to the FPSO through the detachable submerged turret buoy. Three sets of three mooring lines, consisting of chain and JSS cable, fastened to driven piles, now hold the buoy in place.

The buoy was installed in four phases. In September 2007, piles were driven into the seabed by Sonsub. Then chain sections were offloaded by Trident/Sonsub, ranged and inspected by IMS (ChainCo), and cut into 30-m lengths. The chains were extended from the piles, each ended with a female subsea connector that was left supported in a frame ready for the second phase.

During the second phase, the remainder of the bottom chain section of each line was deployed under Trident's instruction and supervision and a JSS cable was attached to its end. The JSS cables were installed using an Aquatic AQPR2 powered-reel drive system. The mooring legs were tensioned using a tandem vessel pull to about 450 t with modified shackles provided by IMS. The final length of each chain was calculated, and the chains were cut and laid on the seabed ready for hook up to the JSS cables, which were already connected to the buoy.

For the third phase, the conical turret buoy, which is 11 m high and 11 m in diameter, was prepared by Sonsub and Trident at the Port of Invergordon, UK, before being towed to Ettrick field. In port, the buoy's ballast system was commissioned, and the nine 148-m-plus JSS mooring cables were spooled off using an Aquatic AQPR7A powered-reel drive system and attached to the buoy in two sections.

Large buoy systems are typically installed using large construction vessels. However, in this case, a single anchor-handling vessel was used for the mooring system installation and hook-up operations. This meant that the buoy had to be launched and towed with the top sections of its pre-installed JSS cables suspended to tugs. To avoid cable damage through dragging on the seabed, IMS provided buoyancy modules fitted with acoustic releases supplied by Seatronics. The buoyancy modules were released once the buoy was in deeper water, and the system was towed to its installation location. The assembly and load-out of the buoy and its moorings required four towing vessels and several shore-based cranes, including one of 1200-t capacity.



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The buoy was hooked up in the final phase by offsetting it to enable two of the three sets of mooring lines to be attached. The buoy was then towed onto location and submerged to provide enough slack in the system to enable the third set of lines to be connected using the subsea connectors.

David Cobb, Trident projects manager, says, “I believe that this is the first example of towing a buoy of this type with such a large quantity of pre-attached spiral strand cable. It is also the first permanent system to be installed in the North Sea using subsea connectors. The project used 12 subsea connectors.”

With Sonsub's direction, Trident developed the procedures used for towing out, installing and tensioning the mooring lines and the buoy, and also provided equipment inspection and offshore supervision. Other Acteon companies were involved too, which gave the customer the advantages of Acteon's comprehensive in-house capabilities. Trident brought in 2H Offshore for tow-out and hook-up analysis and drew on specialist expertise from InterMoor. Aquatic supplied personnel and two powered-reel systems.

“Aquatic also assisted Trident in developing the spooling procedures, which were well received by Sonsub. The company hired Aquatic directly, but was able to take advantage of our close relationships within the Acteon group,” says Cobb.

“The operation involved up to five vessels, a remotely operated vehicle and people from several organisations,” continues Cobb. “We developed a great working relationship with the Sonsub team, which enabled us to work efficiently during the offshore operations. I am pleased that the installation was such a success.”

