Deepwater Survey, Investigation and Intervention

Survey, geotechnics and Remotely Operated underwater Vehicle (ROV) operations are all individually very interesting subjects as far as their exponents are concerned. But this combination, with the added dimension of working at an unusual work-site in extreme depths of water, has made the Prestige Project a very challenging programme for participants.

In November 2002, whilst under tow in poor weather conditions, the Bahamas-flagged Prestige oil tanker broke in two and sank approximately 150 miles off the north west coast of Spain and Portugal in 3,800 metres (12,500 feet) of water. The two parts of the hull came to rest on the seabed about three miles apart, on the slope of a seamount. The main Spanish Oil Company, Repsol YPF, was appointed by the Spanish government to find the best solution to the pollution problems caused by the wreck of the Prestige. Contracts were subsequently awarded to Thales GeoSolutions and Sonsub to design and build ROVs for the deepwater survey and investigation; a further contract was awarded to Sonsub, in partnership with Thales GeoSolutions, to carry out a deepwater survey, investigation and evaluation study on the wreck.
Thales GeoSolutions, since a recent acquisition now a member of the Fugro Group of companies, was just one of many to become involved in this complex, technically challenging and interesting programme. The respective project tasks have now been completed to the satisfaction of the commissioning company, thanks to proactive commitment and co-operation on the part of all those companies and organisations who contributed hardware and expertise to the Prestige Project. The participants included equipment manufacturers and suppliers, consultants and academic institutions.
Under the terms of these contracts, worth several million euros, an impressive team of experts was brought together by Repsol, Fugro and Sonsub to fulfil this project, deploying the very latest in survey sensors and geo-technical equipment. Much of this equipment was deployed for the first time from work-class ROVs designed, developed and built for physical intervention work at depths previously not attempted in the industry (4,000 metres). Fugro also made available deepwater survey and inspection equipment, as well as its data processing expertise and facilities.
As prime contractor, the Sonsub team - based in Aberdeen - project managed the work and was responsible for the overall operation from its dynamically positioned vessel, the DPV Polar Prince. This ship was staffed by a full team of both marine and construction crews. In addition, Fugro provided seabed mapping and geo-technical engineering together with precise DGPS and acoustic positioning and was also charged with presenting the information gathered in a GIS database to ease access and analysis for planning further work at the site in the future.
A number of technically significant developments and important milestones were achieved in the Prestige Project. It saw a successful ROV intervention operation at a depth of 3,800 metres. This covered external and internal oil level measurement, mini-cone penetrometer testing (MCPT), leak mitigation (which is currently less than10kg per day from the bow and the stern), precision multi-beam sonar survey, environmental measurements and
geotechnical engineering studies, including soil samples, box and piston cores.

Preliminary Study

Prior to commencing the work, it was necessary to gather and review such information on the site as was available in the public domain, institutional records and governmental files. The Fugro desktop study, while giving the contractors a limited picture of the physical work site, helped in preparing ideas and possible solutions for the task ahead.
The desktop study located data from an oceanographic deep drill programme, cable route survey and installation data, sub-bottom seismic records, and evidence of minor earthquakes in the region. At the site of the sinking there was also evidence of local slumping on the cone of the seamount. Based on this study, geo-technical tools and survey sensors were selected and a 'source and build programme' commenced to bring this all together in Aberdeen, which was to be the main mobilisation port.
In parallel with the desktop study, ROV engineers, geotechnical staff and survey specialists began to develop a technical and operational plan that would result in a precision acoustic and geotechnical survey of the Prestige. This survey was to combine a number of technologies and operational techniques to meet the aspirations and project requirements of Repsol.

G3 ROV Upgrade

As the time between contract award and mobilisation was very short, less than twelve weeks, a major redesign and upgrade was begun of two of Fugro's G3, 3,000-metre rated work-class ROVs, increasing their operational capability to 4,000 metres.
This work included winch upgrades to accommodate a new design, smaller and longer steel wire armoured umbilical to maximise 125 hp, 750 kg thrust and 3.5 knot performance capability, new increased depth capacity pressure-resistant buoyancy, high-strength titanium electronic pods and increased compensator volume reservoirs. To support the additional sensor and geotechnical payloads, the ROV frame and lifting systems were upgraded where required and load-tested to ensure integrity.
It was decided to deploy the MCPT system slung beneath the G3 ROV, as this would allow the deployment of the 1.5-ton weight necessary to prevent uplift when the MCPT rod was pushed into the seabed. In addition, by this method, the MCPT units could be very accurately positioned close to the wrecked hulls. As contingency, a customised underwater mate-able hot stab plate with electrical and hydraulic connectors was also supplied to allow the Tether Management System (TMS)-based Sonsub ROVs to operate the MCPT unit; in this configuration the standalone MCPT would be required to be lowered directly from the surface.
The G3 ROVs were also fitted with an under-slung skid to which the various survey sensors were fitted, with careful calibration and recording of offsets. Also, to carry the considerable extra volume of multi-beam and associated data, extra fibres were employed in

addition to the dedicated survey multiplexer pod featured in this ROV design.

Underwater Operations

Following shallow water trials carried out towards the end of June off Aberdeen in around 100 metres (300 feet) of water, the fully mobilised vessel sailed for the Prestige wreck site to commence work on the survey project. In addition to the geotechnical work, primary underwater operations included acoustically mapping the wreck with a complete ultrasonic, as well as precision multi-beam echosounder measurement and visual inspection of both of the hulls. This involved in particular the forward-section, which was sitting on the softer seabed and constituted the larger of the two and the bulk of the oil-carrying capacity of the vessel.

The Kongsberg EM2000 200kHz multi-beam sonar was chosen as the principal acoustic sonar sensor. A Tritech International laser registered camera was used to provide accurate measurements of objects in view of video cameras, and the Cygnus ultrasonic probe was used to identify the location of steel frames and tankage below the hull plating.

At this point, the hydro-acoustic aided navigation (HAIN) deserves special mention, as all of the sensors and geotechnical tools relied on highly accurate positioning on what is a very large wreck. The combination of Ultra Short Base Line (USBL) and Long Base Line (LBL) acoustics, aided by Doppler velocity log and north-seeking gyro made a practical proposition of mapping the hulls in the extreme water depth. This provided the marine surveyors with a dataset that would enable further studies and future decision making on the part of Repsol and the Spanish government.

Onsite, the DPV Polar Prince was positioned using the Fugro Skyfix-XP Satellite Differential Global Positioning System (SDGPS), which reduced the overall positioning budget by providing timely, repeatable positioning accuracy of 10 centimetres in the X and Y-axis without the need for a reference site in the local vicinity.

During multi-beam operations the ROVs were piloted around 85 metres (250 feet) above the seabed. The logged data was processed and then draped over a 3D CAD model of the original hull. Fly-through graphical presentations were also generated to provide a better understanding of the condition of the hulls, affected by storm damage and subsequent sinking.

On completion of the multi-beam work, the geotechnical work commenced, including MCPT, piston corer and grab and samples of the benthic layer. Recovered samples were processed and stored in the onboard laboratory before being shipped ashore and reports produced by commercial and university laboratories. The geotechnical work validated the data reviewed in the desktop study and provided more detailed local information for Repsol. The MCPT unit, which was modified to meet the demands of the working depth, gave good results that correlated well with the recovered piston cores. Onboard modifications to the two MCPT systems included up-rated cones, drive depth encoders, inclinometers (in the main frame and in the cone) and extended depth pressure pods. The ROV systems monitored and assisted piston coring and grab sampling operations, ensuring that the geotechnical engineers were able to place these units exactly where required.

The Prestige Project would not have been possible for our offshore teams, who successfully completed this work to high standards of positioning accuracy, multi-beam quality and geo-technical operation et cetera, without the expertise and commitment of a large number of specialist companies from around the world, both on and offshore.

The Prestige Project has proved that a deepwater geotechnical and precision survey programme may be successfully undertaken. The valuable lessons learned on this project will result in spin-offs that will benefit both deepwater-wreck investigation and the oil and gas industry, adding to technical and environmental knowledge and expertise available for the future.