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New system enables rigless subsea well abandonment

A uniquely engineered vessel deployment system has completed what may be the world's deepest rigless subsea production well abandonment.

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Improperly abandoned wells are a serious liability. In remote locations, executing a well abandonment is especially challenging because of the substantial resources required and the normally long timelines. There are also always environmental concerns.

For these and other reasons, abandonment of the recently decommissioned Elang-Kakatua field in the Timor Sea offshore Australia was a milestone project.

Located in 328 ft (100 m) of water, the Elang-Kakatua field, which comprised four subsea production wells tied back to the *Modec Venture* floating, production, storage, and offloading (FPSO) vessel, were completed in 1998 with conventional tubing strings and fitted with early generation spool trees. A ConocoPhillips-led joint venture last operated the field, which was decommissioned in July 2007.

Originally operated by BHP, the Elang-Kakatua field lies in the Timor Gap Zone of Cooperation (ZOCA) 96-16 production-sharing contract 15.5 miles (25 km) northeast of the Bayu-Undan gas condensate field and 6 miles (10 km) northeast of the Elang Kakatua and North Katatua oil fields.

To carry out this abandonment operation, Helix Well Ops' purpose-built rigless tooling technologies were employed in tandem with an onboard deployment system designed to create an over-stern moonpool work area

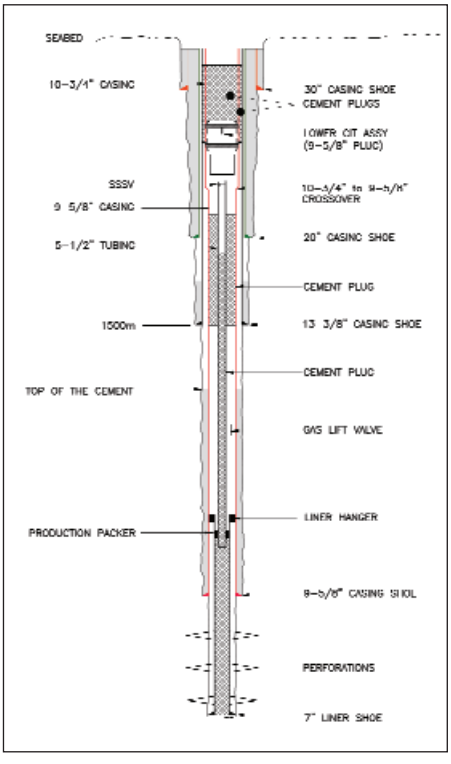

Figure 1. Final Elang-Kakatua well schematic. (Images courtesy of Helix)

either on a typical supply boat or for use over existing moonpools. The equipment is designed specifically to allow subsea intervention and abandonment to be conducted from readily available supply boats, rather than purpose-built intervention vessels.

Putting technology to work

After the field was decommissioned, a contract was awarded for engineering, project management, and the supply and operation of rigless abandonment tooling systems.

Rigless abandonment technology allows for the deployment of subsea equipment, guide lines, and pod lines from a monohull vessel. The system has several features that differentiate it from conventional A-frames, including the moonpool area, a heave compensation system, lifted load containment by use of cursor frames and on-deck transportation via a skidding system. The deployment system also is collapsible for in-gauge road transportation.

One of the key technologies employed with the system is the proprietary rigless wellhead removal system engineered to extract wellheads without the need for a rig or environmentally suspect explosives. Today, subsea wellhead removal is a growing concern with more than 20,000 wellheads purportedly installed worldwide, many of which have already been abandoned.

The patented wellhead removal technology uses an entrained grit, water jet cutting system with medium pressures of 10,000 to 15,000 psi. The system is engineered to cut casings, well conductors, subsea flowlines, umbilicals, piles, and all associated subsea infrastructure, along with platform well conductors and legs. With the help of a remotely operated vehicle (ROV) and a dynamically positioned workboat, the system can operate at water depths beyond 328 ft (100 m).

Rigless intervention technology also incorporates a proprietary cement injection tool designed to perforate the first casing, set a cement plug in the annulus between the first and second casings, and pressure test the plug. All three functions are achieved in a single deployment, saving considerable time and cost when compared with alternative techniques. When used with the vessel deployment system, the tools enable subsea cementing and perforation work to be performed without a rig or special intervention vessel.

Figure 2. The wellhead was removed successfully in what possibly could be the world's deepest rigless subsea well abandonment.

Abandoning the well

AT Elang-Kakatua field, the operator initiated the complex procedure by first mobilizing a pump skid to the FPSO and flushing the flowlines with inhibited seawater to kill the wells. Afterward, the operator deployed a support vessel incorporating an ROV with a specially engineered flange bolt cutter to cut and disconnect the flowlines from the subsea trees. The operation included fitting the ROV with a hydraulic clamp hub, which included a large bore stab receptacle. Upon testing the hub and securing the pressures, the operator disconnected the wells.

The monohull vessel subsequently was mobilized with the onboard deployment system that incorporated a 35-ton heave-compensated main winch, compensated guidelines, deck skidding, and moonpool cursor systems. The project-specific tooling used for the abandonment included cementing spread, subsea controls skid, subsea top drive, tubing cutter, cement injection tool, and the patented wellhead cutter.

Once the assembly arrived on location, the subsea control skid was deployed, and the ROV connected the controls and cementing hoses to the subsea tree using the special hub receptacles installed previously. After the wells were re-killed using water and brine, a 1,640-ft (500-m) cement plug was displaced into the annulus followed by a 6,560-ft (2,000-m) cement plug that was bullheaded into the tubing. Once the plugs were pressure tested successfully, the corrosion cap was removed and the subsea top drive run and landed on the tree.

Following the successful removal of the tree, open-water wireline tools disconnected the tubing hanger plug prior to cutting the tubing 197 ft (60 m) below the tubing hanger. The tubing cutting tool severed the tubing in 2.5 minutes, after which the tools were recovered and the subsea top drive re-run to unlock and pull the tubing hanger. Afterward, the tubing hanger was pulled with the 197-ft tubing and an ROV-deployed cutter severed the tubing from the tubing hanger, which subsequently was returned to the subsea tree for storage.

With the wells killed, cement plugs were placed in the annulus and tubing. After the tubing was cut 197 ft below the tubing hanger, the winch deployed the tree running tool, which successfully latched onto and unlocked the tree. After that, the tree was lifted off the wellhead and placed on the seabed for wet storage.

At this point, the wellhead was exposed, with the 9⅝-in. casing open. Government regulations require the annulus to be plugged; so a cement plug was installed. A proprietary cement injection tool was deployed to 197 ft below the wellhead where it punched the 9⅝-in. casing and squeezed a 131-ft (40-m) cement plug in the 9⅝-in. to 13⅜-in. annulus. The lower portion of the project-specific tool was left in place and secured with 131 ft of cement.

With the top hole cement plug operation complete, the crew deployed the proprietary wellhead cutter severance system and severed all of the casings in a single pass. The entire well abandonment operation was completed as programmed in eight days. F&P