TEAM Designs Customized Expert Solution for Unocal's Sub-Sea Platform Repairs

Overview

Unocal discovered damage to a pipeline riser connected to a production platform approximately 120 feet below the surface of the sea while working in the waters of the Cook Inlet in Alaska. TEAM engineered a customized, unconventional solution to repair the pipeline.

Project
Blindfolded Engineers Develop and Implement Solution Ahead of Schedule

TEAM Service
On-Line Leak Sealing and Repair

Location
TV Cook Inlet in Alaska

The Need and Challenge

Unocal engineers learned about TEAM based on previous experience with TEAM products that have been used on other Unocal facilities in Alaska.

The problem discovered on the platform included damage to a ten inch pipeline riser which exits the leg of a production platform about two feet above the seabed. The line, used to transfer natural gas from the platform to the shore, travels down through the middle of the platform, turns and exits the two foot thick platform leg, and terminates at a flange approximately twenty inches outside the leg.

As a standard solution, Unocal would typically send divers down to install a sub-sea pipeline repair clamp. Unfortunately no "off the shelf" repair clamps were available to suit this repair and the lead time for a custom made clamp. To add to the troubles, the entire fix had to be completed in early November. Any later, winter weather and sea ice makes diving impossible.

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Solution and Outcome

TEAM's engineering team studied the damaged pipeline and realized immediately that a customized, unconventional solution was needed to repair the pipeline. First, the shear size of the platform leg and the presence of the gussets left virtually no place for a conventional leak sealing enclosure to land.

Second, any conventional leak sealing solution which might be designed would require exact measurements and a high degree of technician expertise for installation. These factors, combined with zero visibility, eliminated the conventional leak sealing option.

TEAM began to cultivate the idea of an insert "sleeve" featuring a gasket system that could be energized remotely. The concept was based on a self imposed requirement that the gasket system must facilitate a fairly loose sleeve tolerance and require only general go/no-go measurements that could be taken by divers wearing gloves in the zero visibility environment. Moreover, the design TEAM was certain that a sleeve, designed with a reasonably loose fit between itself and the existing pipe, could be installed in a zero visibility environment. TEAM presented the concept to Unocal and agreed to tackle the job. The final scope of work included the development and manufacture of the insert sleeve, the measuring device to determine the go/no-go tolerances, and a full mock up that could be used to pressure test the sleeve and to allow diver training dockside.

The Design

After developing and manufacturing the measuring device, it was shipped to Alaska. An expert dive TEAM then performed a dive to determine the minimum inside diameter of the pipe and any weldment areas and the length of pipe from the flange to the elbow that turns the pipe up toward the platform. Once that was accomplished, the final design for the sleeve was produced.

The final design was based on four major components: the sleeve (later named the stile); a nosepiece assembly that threads to the stile and holds the gaskets in place; a plunger assembly used to energize the gaskets; and the gaskets. Possible misalignment of the existing flange to the damaged pipe was also considered. Even a slight misalignment could potentially hamper installation and prevent the sleeve from fully and properly seating.

The stile was fabricated using a ten inch, fifteen hundred pound blind flange and a six inch pipe threaded on one end. The flange was cut to allow the pipe to be inserted and seal welded. To address the misalignment concern, each stud hole in the flange was oversized to allow a threaded coupling to be inserted and welded in place. Two inch pipe were threaded on one end and screwed into the couplings. These pipes could then be adjusted in or out to compensate for any alignment problems. Finally, six, one inch through-holes were drilled and tapped around the flange to allow the mounting of jacking bolts that would be used to engage the plunger and energize the gaskets. The photo below shows the stile complete with the alignment tubes and the jacking bolts.

As the design progressed, the compatible gasket material was identified and a search for the material was undertaken. It was soon discovered that gaskets of this size and geometry were not readily available and would

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require custom molding. The lead times first quoted were unacceptable and diligent pursuit of different sources by TEAM members resulted in finding a manufacturer that could mold the material and meet time requirements.

The plunger was fabricated using another ten inch, fifteen hundred pound flange and a length of eight inch pipe bull-nosed on one end. Again, the flange was cut to allow the pipe to be inserted through it and seal welded. Likewise, each stud hole was oversized to allow the alignment pipes to pass through and the plunger to move freely along the stile. Finally, the nosepiece, which holds the various gaskets in place, was machined.

Assembly was accomplished by inserting the stile through the plunger, passing the alignment tubes through the holes in the plunger flange, installing the gaskets over the threaded end of the stile, and then threading the nosepiece onto the stile. Locking the nosepiece into position holds all the pieces in place.

The mock-up to allow the simulated installation of the assembly and pressure testing was manufactured using a ten inch section of pipe blinded at on end and welded to a ten inch flange at the other. The assembly was then mounted to I-beams and heavy plate for stability.

Mock-Up and Installation

Once the complete sleeve was manufactured, the first trial installation was attempted. TEAM personnel were blindfolded in order to simulate the zero visibility conditions that would be encountered on site. Using the overhead crane in TEAM's LaPorte shop, the sleeve was lowered toward the mock-up. As the sleeve was lowered into place and alignment attempted, it became readily evident that a pinch point hazard was created when inserting the sleeve into the mock-up flange. Because of changing balance points during the procedure, even small crane movements in/out or up/down could result in considerable movement of the sleeve and the possibility of pinching the diver's hand between the sleeve and the flange. After much discussion, the TEAM concluded that using two, long, guiding rails could be installed on the mock-up flange and used to direct the sleeve into place. The rails were produced and proved and ultimately worked efficiently. Once situated on the guide rails, the sleeve became more stable and the diver's hands were no longer subjected to the pinch point hazard. The photo below shows the entire sleeve assembly inserted in the mock-up and resting on the guide rails.

The second attempt saw the sleeve enter the pipe easily. The adjustment tubes were used to square the flanges and the studs were installed by the blindfolded TEAM employees. The jacking bolts were then used to move the plunger and energize the gaskets. The mock-up was pressurized to 1.5 times the maximum operating pressure of the system and held overnight with no leaks. Subsequent runs were made to allow the development of a written installation procedure, and additional pressure tests were made and witnessed by the customer using a calibrated chart recorder to plot pressure and temperature during the tests.

The completed assembly was sandblasted and coated with paint specified by the customer and designed to withstand the harsh environment of the Cook Inlet. With all testing completed and a proven installation procedure in hand, the sleeve and the mock-up was shipped north on October 30, 2004 two days ahead of schedule. TEAM's solution including the customized design of many of the components solved many potential problems including injury to divers during the implementation phase. Ultimately, the quick turnaround and customized solution saved Unocal from a significant loss in production.

This work may have been performed by a company subsequently acquired by TEAM.