Tensioning replaces torquing for swivel joint bolting

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LOOP alters process for maintenance of unloading units

A ULCC tanker connected to a SALM berth with the LOOP terminal on the horizon

The Louisiana Offshore Oil Port's deepwater moorings and pump stations in the Gulf of Mexico service super size tankers bringing oil from the world's producing countries. From the tankers, crude oil is pumped onshore to salt dome storage facilities deep under ground, where more than 35 million bbl can be stored. From there, a state-of the- art computer system moves the crude into five connecting pipelines.

Most tankers, the VLCCs (Very Large Crude Carriers) and ULCCs (Ultra-Large Crude Carriers, unloading at WOP are simply too big for shore side ports.

LOOP accommodates them with berths in the Gulf of Mexico 18 miles off the coast of Louisiana. Three super buoys, anchored to the seabed 115 ft down, provide moorings for tankers up to 700,000 dwt.

Each of the three moorings is located a mile and a half from the control platform to give the supertankers plenty of room to maneuver. They pump crude into flexible hoses connected to the mooring base. From there, the oil moves through a 56-inch diameter submarine pipeline running from each of the three moorings to the pumping platform.

Securing the SALM

Each berth is a single anchor-leg mooring (SALM). The SALM system employs a huge tension buoy that is 46 it tall and 26 it in diameter. The buoy is anchored by its single anchor-leg chain to the SALM base, which has to hold the tremendous load of the buoy's 450,000 lb positive buoyancy.

The anchor chain is connected to a rotary fluid joint on a permanently fixed base. The swivel joint lets the berthed tankers discharge oil while moving around in any direction to obtain the most favorable heading. Sub sea mounted components are serviced onshore, but the pieces must be detached and brought up to the surface by a crew of divers. The usual practice is to bring 12 divers out from shore on a jackup service vessel to work one-hour shifts in turn until the needed maintenance is performed.

One interesting point is that LOOP has only six divers on contract. Eight additional divers are required for each service trip, which means many of them will not be familiar with the equipment they need to employ deep in the murky, silty waters of the Gulf. A real premium can be justified for simple, easy-to-use equipment, as LOOP has discovered.

Fluid swivel

A rotary swivel submerged in 110 it of silty saltwater will need constant inspection and periodic servicing. The swivel's mechanical seals begin to wear and must be rebuilt before leakage starts. Every month, divers check out all three swivels to be sure no incipient leakage can contaminate the surrounding seawater. The swivel is securely fastened to the SALM base with 16 stud bolts, which are three in. in diameter and 5.5 it long. To take the swivel out of service, divers are sent down to disconnect the 16 bolts, lift the fluid swivel off the base and ring it up for repair. Later they dive again to reinstall the joint and tighten up the bolts to about 420,000 lbs tension in each bolt. Each fluid swivel needs to be rebuilt about once in three years, so, with three berths in service, a costly and laborious remove-rebuild-reinstall procedure takes place every year on average.

The removable part of the SALM that is bolted to a subsea base using the stud tensioner (not shown).

First round

The LOOP system was inaugurated in 1981. By 1983, the first round of fluid swivel repairs had begun. In 1983-84, and again in 1987-88, a complicated conventional tensioner was used which wasted many costly underwater hours.

There was plenty of margin for error in the tensioner, which involved a tedious process of screwing the puller unit to the bolt by turning the housing backward while the puller bar was pulled forward. This had to be done underwater, with silt limiting visibility. Although a dedicated tensioner was kept on the deck of the service vessel for pre-dive instruction, the divers had many problems.

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Better method

At 110 it, a diver can stay down about an hour. With the old-style tensioner, a particularly adept diver might succeed in tensioning three bolts in that hour. Other divers didn't even complete one bolt. They averaged less than two bolts an hour, which meant 12 hours of diving time were used before the crew secured the swivel joint.

In 1990, another swivel maintenance cycle began. The three tensioners, made of carbon steel, were pitted inside the piston and needed resurfacing and re-machining.

This last step provided the economic justification for replacement with tensioners. Today, tensioning has replaced torquing in most heavy-duty, critical bolting applications. Stretching the stud, rather than wrenching the nut, is so much easier on the bolting equipment. On the other hand, tensioning, as the LOOP divers found, can be complex and difficult to master.

The new tensioners (Biach) are designed to simplify the tensioning procedure for the operator. Their single-piece construction goes onto the stud easily, letting the diver make or break the connection in minimum time. To withstand the effects of corrosion, rather than coating the tools, they are made of maintenance-free stainless steel. To accommodate the additional weight and aid maneuverability, buoying tanks were used with the system.

The new procedure was as follows:

- The piston is automatically returned to the start position when the hydraulic pressure is released.
- The captive puller bar can be threaded to the stud easily and the diver can positively feel and count the turns when it is properly in place.
- The nut turning mechanism is designed to be free-floating and self-aligning allowing the diver to simply place the tensioner down over the stud and nut The diver can follow up bolt extension to verify the tool is working properly a time-saving feature.
- The tensioners can be obtained in stainless steel to better withstand saltwater immersion. A stainless tensioner is somewhat heavier, but that is no problem under water, where a buoyancy pail can be attached to the tool to take the weight.

With all these useful features, the tensioners are easy to work properly, even when visibility is low. Management can also be sure the job is done properly, because hydraulic pressure can be monitored on the surface. Unlike the older unit, the new tensioner incorporates a reliable hydraulic bypass valve that alerts the operator when the tensioner has reached full stroke.

Summing up their experience after first use of the new tensioners, LOOP found that diving productivity had increased substantially. Most divers could now untighten or tighten 3-4 bolts per dive. The best people were 8-10. Diving time that formerly took 12 hours now takes six or less.