AS | MOSLEY

CASE STUDY

BOP TETHERING FOR THE ABANDONMENT OF TWO WEAK WELLHEADS

BACKGROUND

In 2016 an operator was planning to abandon two subsea wells in the North Sea. The wells used old-style 13 5/8" twin stack SG-1 wellheads incorporating multiple housings connected to a 30" conductor. These old-style wellheads were originally installed with 13 5/8" 10K BOP (Blow out Preventer) stacks which were very lightweight with a mass of approximately 70 Te. The mass and stack height of subsea BOPs has significantly increased since the wells were drilled, and the abandonment operation would have to be performed with a much larger BOP (i.e. 210 Te) imposing far higher loads on the wellhead.

CHALLENGE

Initial global riser analysis carried out by AS Mosley highlighted very poor operability and fatigue life for the abandonments.

It was established that the low fatigue life and high structural loads were a direct result of the dynamic response of the 210Te BOP excited by wave motion.

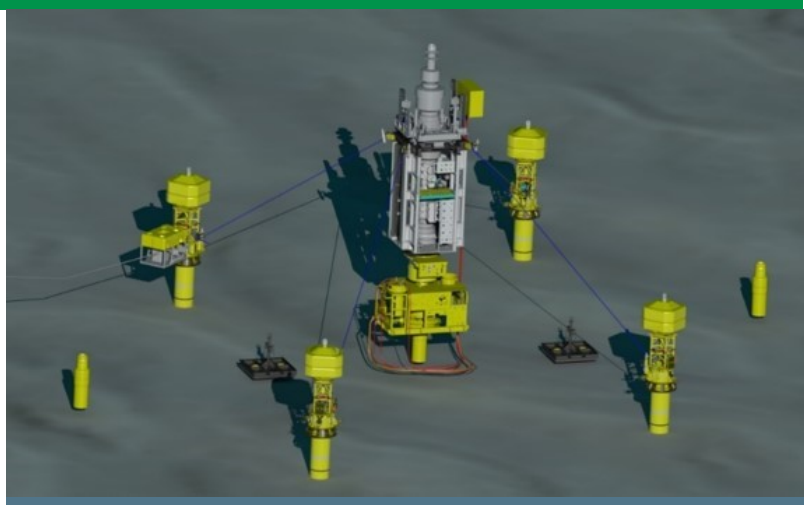
The 13 5/8" twin stack wellhead system used for the wells was not designed to support a large 210 Te BOP and resulted in a very long natural period for the first mode of vibration.

The natural dynamics of the BOP was found to be excited by wave periods between 4 – 6s which occurred very frequently throughout the year. Moreover, waves with 4-6s periods were found to be relatively large.

These factors combined to increase both the fatigue damage rate and peak loading applied to the system. It was also noted that the structural capacity of the wellhead was very low when compared to a modern 18 ¾" wellhead, exacerbating the problem in relation to operability.

It was important to establish that the calculated fatigue life of the wellhead and conductor systems was sufficiently long for the proposed abandonments accounting for all historical damage from previous operations including the initial drilling.

Furthermore, the operating envelopes had to be adequately large to accommodate an accidental vessel excursion, caused by a single mooring line failure, without overloading the system.



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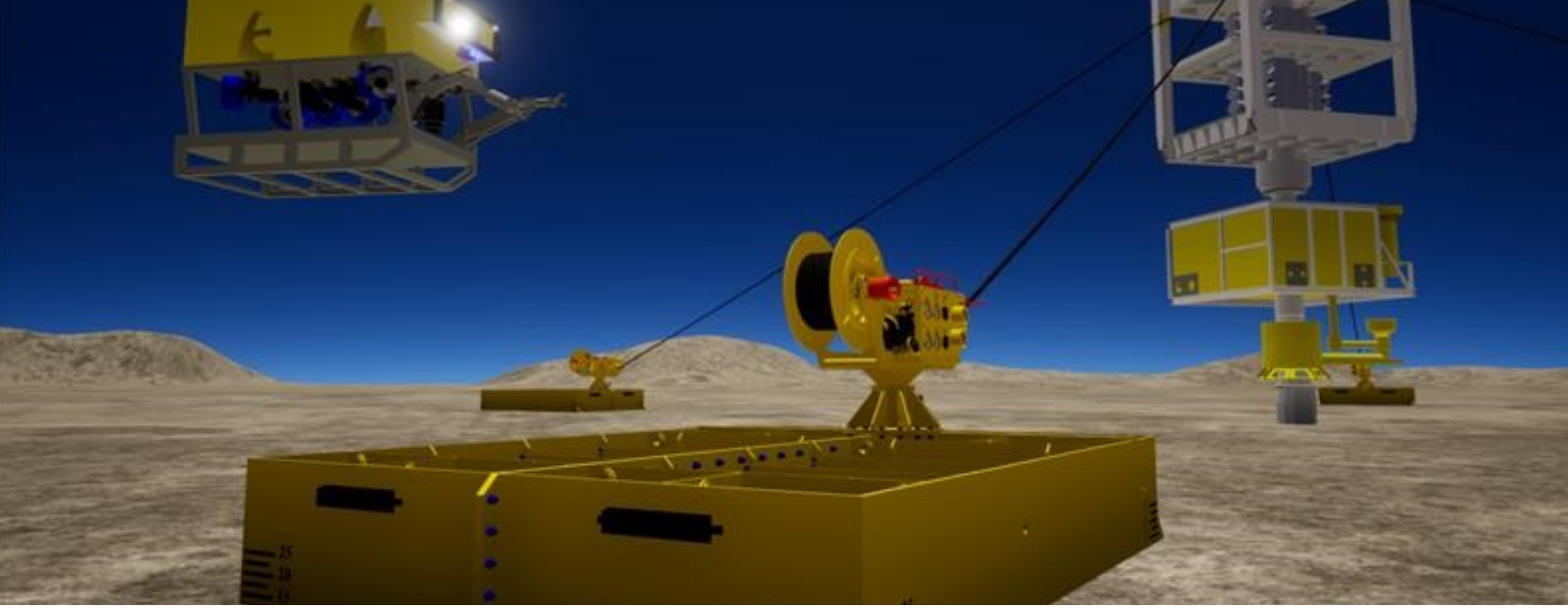

SOLUTION

In order to meet the required fatigue life and operability for the well abandonments, a tethered BOP solution was investigated.

AS Mosley performed global riser analysis to investigate the feasibility of tethering the BOP with four tether lines attached to gravity anchors laid on the seabed away from the well centre.

The results of the investigation showed very good improvements, not only to the fatigue life but also in reducing wellhead loads during accidental vessel excursions.

Based on the positive results of the feasibility study a detailed design solution was developed using a pre-existing tethering that had been successfully used on another project. Global analysis was carried out to determine the optimum deployment location for the gravity anchors accounting for the hitch points on the BOP stack and subsea infrastructure.

However, as the gravity anchors were to be deployed from a vessel, perfect positioning would not be possible. Therefore, additional analysis was carried out to determine allowable deployment envelopes, for the gravity anchors, which would not compromise the fatigue lives or operating limits.

Fatigue analysis was carried out for the fully tethered BOP stack and during each stage of the tethering operation with 0, 1, 2 and 3 tethers connected. This allowed the fatigue life remaining in the system to be monitored during each stage of the operation. Additional analysis was also carried out to calculate the historical fatigue damage accumulated by the system during previous BOP on wellhead operations.

Operating envelopes were generated for each stage of the tether installation, specifying the optimum order of installation and applied tension.

Additionally, analysis was carried out to determine the effect of a failed tether on operations and recommendations made with respect to vessel positioning to mitigate risk. Tether failure was to be monitored by both the ROV checking load cell readouts on the tether anchor points and though the BOP monitoring system.

By monitoring the natural frequency of the BOP stack and comparing it to the expected values, determined by AS Mosley, failure of a tether could be quickly detected so that the riser could be disconnected to avoid damage to the wellhead system.

AS Mosley provided all the loading required to qualify the design of the winches, tethers and gravity anchors.

RESULTS

The analysis showed that tethering the BOP stack significantly improved the operability and fatigue life of the weak wellhead and conductor system. Peak wellhead loading was seen to reduce by a factor of 5 and the fatigue life improved by a factor of 200 for the fully tethered system.

The improvements achieved were sufficient to enable the abandonment operations to take place. Based on the support of AS Mosley the two subsea wells were successfully abandoned in the summer of 2016 with no incidents. The system deployed to tether these wells has now been used successfully on several wells in a range of fields to overcome low operability, poor fatigue life or both.

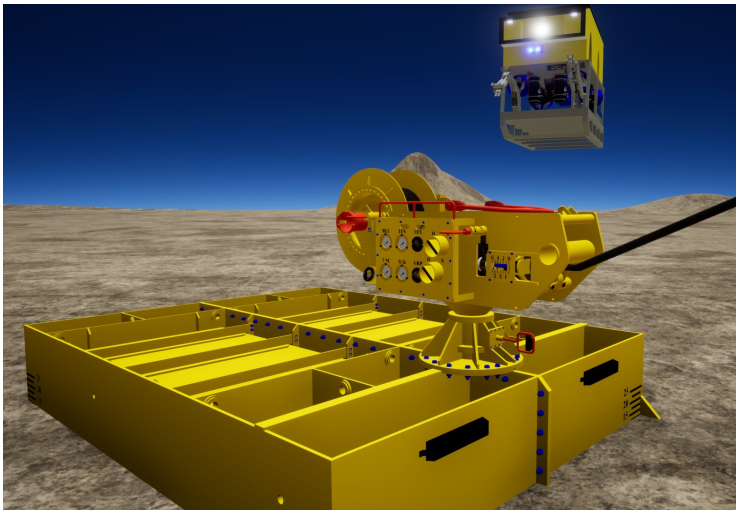

Image credits: Trendsetter Vulcan Offshore