How did this Happen?

Last Summer, we had a discussion about some guidelines about how to do innovation right in conjunction with a discussion of a horseshoe shaped well on land. https://www.linkedin.com/pulse/can-well-drilled-reverse-eric-gagen Today we will look at a very different example of innovation – rigless abandonment of a group of wells offshore on a minimal well protector location.

The Situation

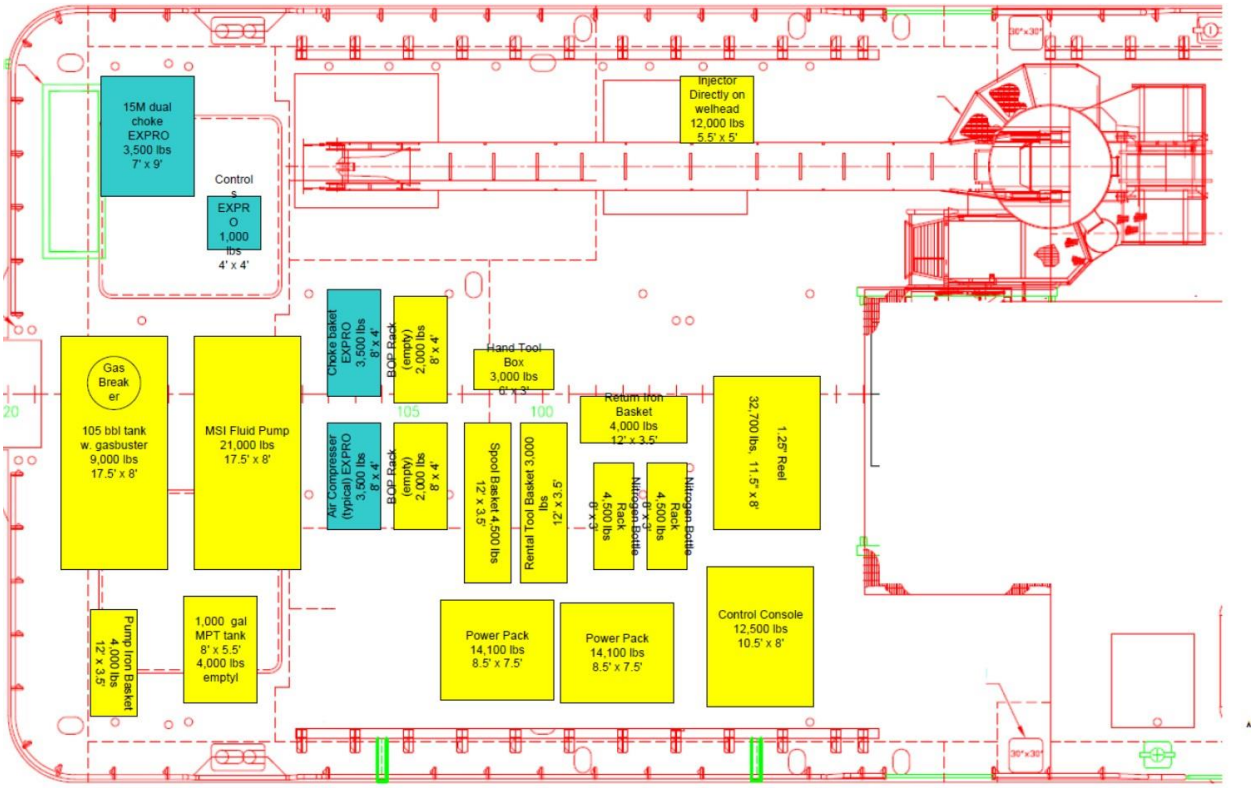
The three wells on this platform had reached the end of their useful lives, and downhole abandonment needed to be conducted to meet lease end criteria. A normal part of the end of an operation. But what do you do when the wells are on little more than a protector, have sand issues, a possible tubing hole and a fish downhole? In hole intervention of some sort is required, but how do you gain access to the wells with the needed equipment?

The 'normal' answer is to use a Jack Up (JU) rig to perform the work. Unfortunately, the combination of water depth, subsea soil conditions, and changes in the regulatory environment meant that only a tiny number of high specification JU rigs could perform the work, and none of them happened to be available in a reasonable timeframe. Innovation was required. Could the work be performed without a rig from a floating vessel?

The Solutions

Finding suitable vessels was easy, in the sense that only one vessel was available which was even remotely a reasonable choice.

It was certainly large, with a powerful crane, an excellent Dynamic Positioning (DP) system and plenty of crew quarters but unlike what is seen in this commissioning picture, most of the deck was full of equipment for saturation divers, so considerable effort had to be put forth to get all the parts needed to perform the work to fit.

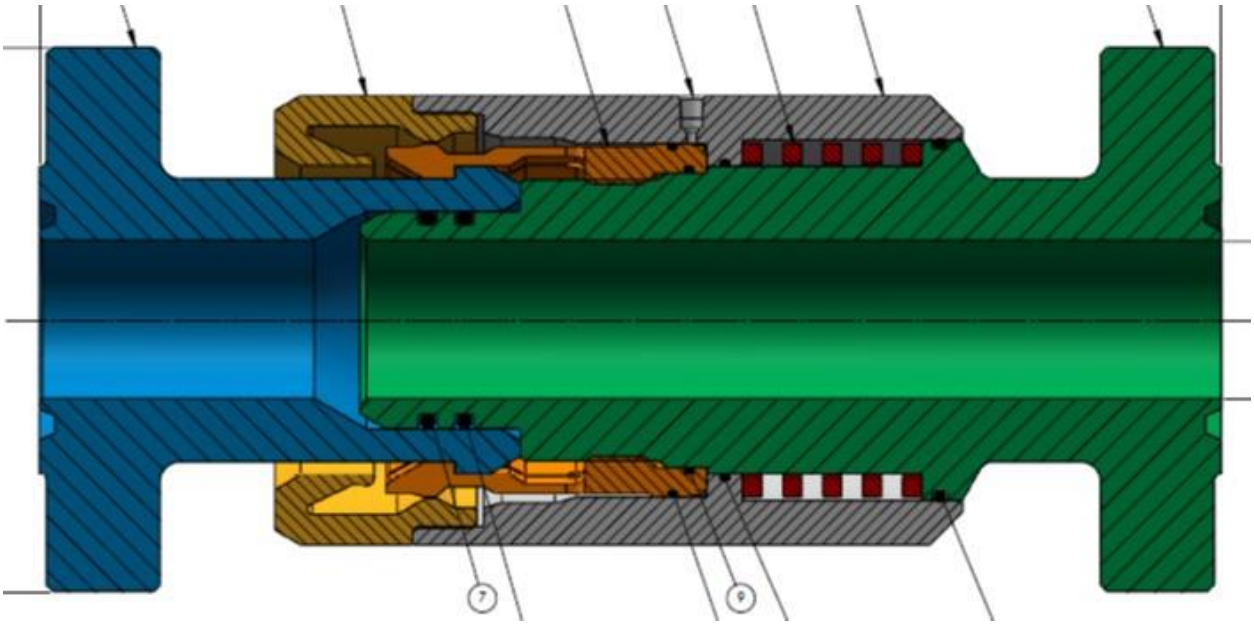


This shows everything laid out on the stern of the vessel, and all the rest of the space on the vessel was used up. This is obvious from a photo taken during the operation:

No better panoramic picture could be taken because the saturation diving equipment was stacked 3 stories high on the deck, and there was no safe way to access a higher point while at sea. The light-yellow equipment in the distance of the stern is the well work equipment. Removal of the diving equipment was not possible, because the divers were still living in their saturation habitat preparing for the atmospheric mixture they would inhabit on their next project.

The Challenges

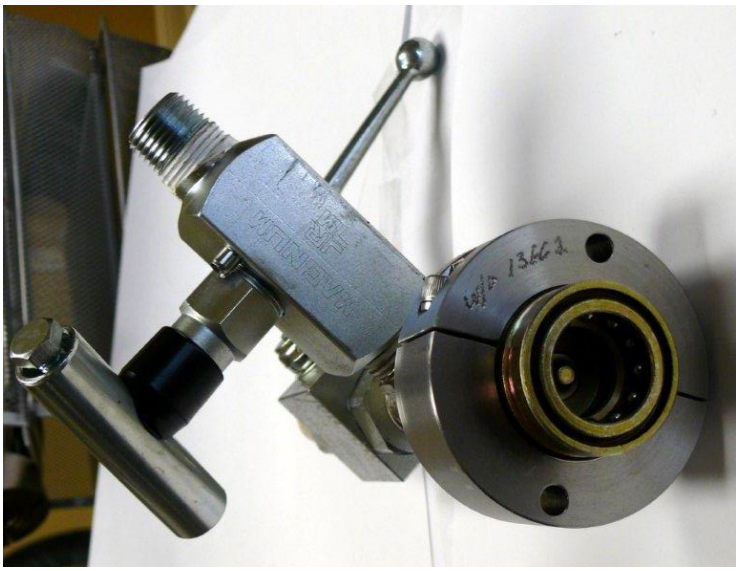
The obvious challenge is what to do in the event of an emergency. The wellheads are fixed, and placed at the surface, and the well servicing equipment is on a vessel which cannot safely stay on station in the event of some sorts of weather or well control situations – or may not be able to stay on station at all due to a failure of positioning. Every connection between the vessel and the wells must be severable/severed in a scenario where a 'drive away' event must take place. Severing coiled tubing pipe or wireline was the easiest thing to do, with blind/shear rams positioned on the vessel and on the platform. However, pump and flowback lines and a multitude of hydraulic lines had to go between the two also. Disconnects for pump lines already existed for use with fracturing vessels but had to be modified for this use. Positive pressure from a small hydraulic line had to be applied to the connection to hold it 'locked closed'. The hydraulic line was connected to the breakaway panel such that it would lose pressure in the event of a drive away and allow the line to disconnect.



Schematic of the modified disconnect devices.

The device during rig up. A second one is sitting on the deck behind this one awaiting installation. Lifejackets were required for all personnel working at all times to increase the rate of recovery in the event of a man overboard scenario (this did not take place)

The hydraulic connections passing between the vessel and the wellhead area were connected through these breakaways. All fluids used during the project were seawater and cement, so there was no pollution potential in the event of a drive away.



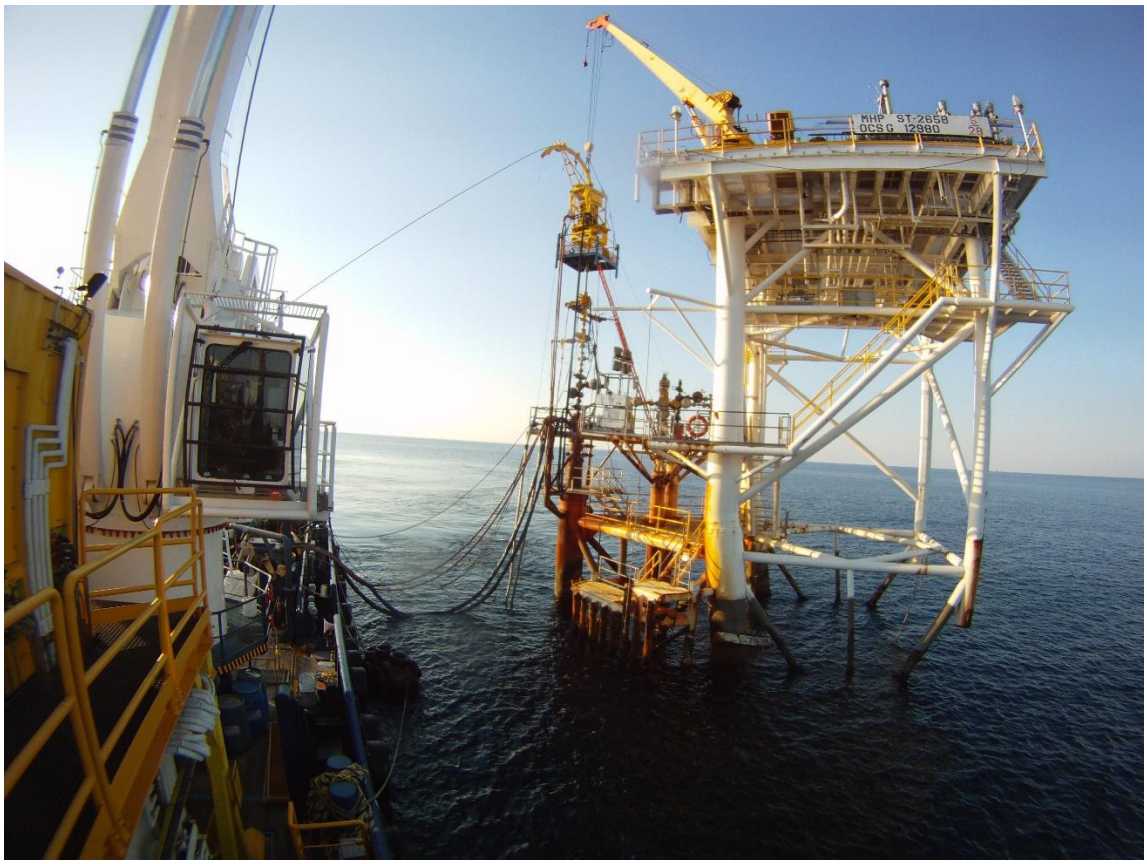
The breakaway connections were in a variety of sizes from 2" diameter to ¼" diameter and were all assembled together on a steel panel which was welded on to the deck of the vessel (unfortunately I do not have a good photo of this) The breakaways could be set up to hold pressure, or to bleed off when disconnected. This was important because some circuits needed to hold pressure when separated, and others needed to bleed off immediately. All hydraulic systems were flushed and 'hydrablue' an environmentally friendly substitute for ordinary hydraulic oil was utilized in the event that a leak or disconnect occurred.

Testing

The hydraulic disconnect systems and pump line disconnect systems were tested at shore bases before operations began. To the degree that it was possible the equipment was set up on the vessel in port, and everything was tested again after transport and assembly was completed.

Execution

During the preparatory and testing phases of the operation, the end user exploration and production company, and the provider of the vessel insisted that far too much time, effort and expense was put into automatic hands off failsafe disconnect capabilities. They insisted with reasonable and sound arguments that the event of a sudden well control incident was unlikely, that the DP capabilities of the vessel had multiple redundant systems, and that there were other excellent ways to go about the necessary emergency processes. Of course Murphy's law immediately kicked in. http://www.murphys-laws.com/ After connecting all lines and hydraulic equipment and preparing to pressure test the vessel lost ALL DP functionality of all sorts, and gradually drifted off location while attempts were made to restore it. The DP electrical system had failed at the electrical room and new breakers and control circuits had to be installed from spares on board. After reconnecting everything and preparing to pressure test again, the vessel lost ALL power and control of all types, and a small fire broke out in the main electrical control space of the vessel as it drifted off. In both cases the automatic breakaway equipment worked perfectly and prevented a bad situation from becoming a potential disaster. It was discovered that a recent upgrade to the electrical system of the vessel had created a fault, and the system was repaired a second time rectifying the problem. No other problem occurred through the course of the operation, with the weather mostly cooperating, the DP system and vessel, well servicing equipment, crews and all other associated operations performing precisely as intended. The operation was completed in 25 days from shore to shore, which includes all the difficulties with the DP systems, and all 3 wells were successfully cleaned out and squeeze cemented leaving the location safe for top hole abandonment and platform removal.



Conclusions

When trying something new, the earlier article posed a series of questions to ask about how to introduce novel operations or equipment so we will revisit them and find out how this project looks in retrospect:

- Why exactly are you trying to do something novel? *To safely Plug and Abandon a group of wells without access to the equipment they were designed to be accessed with*
- What about the new technique, method or technology is materially different from past practices and experiences? *Operations on fixed wellheads from vessels had been performed before, but in protected inland waters or lakes and/or with very limited objectives which mitigated risk.*
- What does the new and different thing mean for the operation as a whole? *The vessel must be able to drive away from the wellsite at any moment under any foreseeable conditions leaving both the vessel, and the remaining equipment at the wellsite in a safe condition.*
- what if the novel element doesn't work the way it is intended to? *Multiple testing rounds conducted and manual disconnect backup options were available, except for the*

blind/shear rams which had two sets installed in different locations, one at the platform, one at the vessel.

- Keep the novel elements to a minimum required for the project to succeed. *Two novel elements – disconnects for the pump lines and disconnects for the hydraulics. Both were modifications of existing items rather than completely new items.*
- Get the basics right! *Double power supplies were provided for critical electrical and hydraulic components. Extra spares were taken on. Crews which were of high quality who had worked together extensively in the past were selected. Preparatory meetings with all parties were performed to ensure everyone understood their role to play.*

This project was successful because it followed the 'rules' for introducing novel situations and ideas, which allowed it to overcome what could have been a crippling set of early failures.