Enhanced Subsea Blow out Preventer (BOP) Stack Testing for Dynamically Positioned Rigs in the Gulf of Mexico

Purpose

Subsea BOP stacks are critical safety equipment designed to secure a well in the event of flow. They are tested to ensure that they will function and secure the well. The testing process also confirms there are no leaks in the system that would diminish system integrity. This file note is to document current subsea BOP stack testing practices for dynamically positioned (DP) rigs, and identify areas of enhancement for Gulf of Mexico (GoM) operations.

Standard Practices

Current GoM Mineral Management Service (MMS) regulations require BOP stacks to be stump tested at surface with water, pressure tested once installed on the well and then every 14 days thereafter. There is no GoM MMS regulatory requirement to test the BOP emergency systems once the BOP stack is installed subsea.

Global industry practice before running a BOP stack to the wellhead at the mud line is to function and pressure test it on the rig deck. Where not required by regulation, this is done to avoid unnecessary downtime. The surface test is performed by installing the BOP stack on a test stump and hooking up the hydraulic and electric power and the control systems. Since the BOP stacks have two redundant pod systems, the surface tests include both pods. The function and pressure testing of the BOP stack is typically done using one pod and then it is only function tested using the other pod. This function test includes actuating the components, but not pressure testing them. In addition to function and pressure testing the normal operating functions on the BOP stack, the emergency systems are tested as well. These systems include:

- Deadman
- Autoshear
- Emergency Disconnect System
- Remote Operated Vehicle (ROV) access

BOP stack emergency systems are not typically tested once the BOP stack is on the seabed.

The following is a summary of the emergency systems and how tests are typically performed on the test stump at surface.

Deadman

- Designed to close programmed rams when BOP stack loses hydraulics and electrical power
- Tested at surface by cutting the power and hydraulics to the BOP stack and verifying the programmed rams have closed

Autoshear

- Designed to close programmed rams if the Lower Marine Riser Package (LMRP) has an unplanned separation from the BOP stack
- Tested by inducing a signal that simulates LMRP disconnect, then verifying the shuttle valves for the programmed rams work as designed. This can be done by "dry firing" (no hydraulic pressure) the system to verify the program is working and the shuttle valves operate. The Autoshear can be programmed to close the same rams as the Deadman.

Emergency Disconnect System (EDS)

- Designed to close programmed rams and disconnect the LMRP from the BOP stack
- The EDS system can be set for multiple scenarios (i.e. with or without drill pipe in the hole, running casing, etc.)
- Typically tested at surface by initiating the signal with no hydraulic pressure on the system to ensure the program is working as designed.

ROV Intervention

- A ROV stab panel is installed on the BOP stack to enable ROV intervention to operate select BOP functions
- The ROV system is tested by plugging in a stab to the panel and operating the functions. The pump rates at surface do not necessarily simulate what a ROV could produce subsea.

Subsea BOP Stack Emergency System Testing

As stated earlier, the reason to test the BOP stack once subsea is to ensure that the stack will work as designed to secure the well if required and to verify that there are no leaks in the system that would diminish system integrity. A minimum condition of success would include confirmation that the emergency systems will close the blind shear rams. This can be accomplished by activating the Deadman system. Also, verifying the ROV intervention system is operable will ensure redundancy of closing the blind shear rams and provide opportunity to function at least one other ram, typically a pipe ram.

The risk in testing the Deadman is that in cutting power and hydraulics to the BOP stack and relying on subsea battery power to operate, there could be a drain on the batteries. There is also a risk that the system will not re-start as designed and the LMRP would need to be pulled back to surface to enable repairs. Both of these are manageable risks.

There does not appear to be any significant risk in testing the ROV intervention system once the BOP stack is installed on the well. However, standard ROV systems can only pump seawater in the volumes required. Seawater is adequate as an emergency control fluid, but Stack-magic is preferred for normal operations. This will require retrofits to standard ROV systems.

Autoshear and EDS testing would include actuation of rams and involve disconnecting the LMRP. Testing LMRP release is not a critical operation to secure the well, could damage a connector and imports significant risk to the operation. Since the Deadman test would test the blind shear ram closing functions, it is not necessary to perform these additional tests at the seabed.

A key question arises if the Deadman and ROV intervention systems are tested on the wellhead at the mud line as visual confirmation of ram position is not possible. How do you know the systems worked as designed?

In the case of the Deadman system test, there are two indicators to determine the system worked as designed. Firstly, a ROV should see the control fluid vent as the rams are closed. The second indicator is the volume of fluid pumped to open the rams, which is counted at the BOP stack. If the volume pumped is as expected, it would be a reliable positive indication that the Deadman system operated as designed. There is not a way to get a false positive test.

When the ROV intervention system is tested, there is one current indicator to detect that the system worked as designed. As with the Deadman test, when the rams are opened, the volume of fluid pumped to perform the operation is counted at the BOP stack. If the volume pumped is as expected, this is positive indication the rams were closed by the ROV. A future consideration is to count the gallons the ROV pumps to close the rams, however it is unclear which ROVs have this capability and modification is likely required.

Recommendation

Short and long term actions are required to improve subsea BOP stack testing, reliability and intervention. The short term solution includes enhanced testing procedures when the BOP stack is installed on the well as described above. Long term solutions would include BOP stack system design modifications, improved operational practices and alternative solutions for contingency and intervention. These solutions will require input from operators, drilling and service contractors, and equipment manufacturers.

In order to ensure the BOP stack on a BP-operated DP rig in the GoM will function as designed to secure a well, the Deadman and ROV intervention ram closure systems will be tested when the BOP stack is installed subsea.

For the Development Driller III relief well, we will do a surface ROV intervention system test using the ROV pump and Stack-magic control fluid. To test the emergency system once the stack is connected to the wellhead subsea, we will test the Deadman.

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