Class Works to Improve BOP Safety

Research efforts target BOP maintenance, inspection, and testing in deep water.

BY RANDY MONTGOMERY AND BRENT MONTARULI

The blowout preventer (BOP) is one of the most critical safety device in offshore drilling operations. The Macondo incident in the Gulf of Mexico (GoM) in 2010, during which tens of millions of barrels of oil were released into the ocean, was a stark reminder of how catastrophic the results of a BOP malfunction can be.

Located at the wellhead, the subsea BOP is made up of several independently operating shutoff valves that isolate the well in the event of an emergency. The BOP also has an emergency shutoff mechanism that allows the well to be completely shut in. In fact, a subsea BOP performs multiple roles—helping to prevent risk and working as an emergency response tool. It is crucial that the BOP work reliably because one or more failed components could affect the BOP’s functions.

While BOP failures are rare, the dramatic consequences of failure have moved BOP safety research to the forefront for operators, drilling contractors, oil service and supply companies and class societies like ABS. Significant time, effort and resources are being invested to evaluate BOP systems and to develop practices that allow them to work more reliably.

Evaluating Reliability

In the course of research efforts that concluded in mid-2013, ABS, ABS Consulting, a number of operators, drilling contractors, and BOP equipment manufacturers joined forces to investigate BOPs and associated control systems operating in deep water. Several BOP configurations were evaluated, including:

- BOP with a five-ram configuration and single annular or a four-ram configuration with a dual annular.
- BOP with a five-ram configuration and dual annular or a six-ram configuration with a single annular.
- BOP with a six-ram configuration and dual annular.

For the purpose of the research effort, analysis targeted the surface and subsea control systems and the BOP stack. BOP stack components included annulars, blind shear ram, casing shear ram, pipe and test rams, choke and kill lines and valves, gas bleed valves, connectors, and stack-mounted accumulators. The surface system evaluation encompassed the hydraulic power unit, electrical power, multiplex (MUX) control line, rigid conduit and hotline, surface accumulators and control panels. The subsea control system included blue and yellow pods (which operate functions on the BOP stack in response to commands from the surface control), the lower marine riser package (LMRP) mounted accumulators, and emergency and secondary controls.

The functional scope of the study comprised failure mode, effect, and criticality analyses (FMECAs) and reliability, availability and maintainability (RAM) studies on a number of BOP functions. These studies examined how to safely close and seal the drillpipe and allow circulation on demand, how to close and seal an open hole and allow volumetric well control operations on demand, how to strip the drillstring using the annular BOP(s), and how to hang off the drill pipe on a ram BOP and control the wellbore.

Additional evaluations looked at controlled operation—shearing the drillpipe and sealing the wellbore—and emergency operations that entailed autoshearing the drillpipe and sealing the wellbore and emergency system disconnects, where the drillpipe would be sheared and the wellbore sealed. The team looked at issues surrounding disconnecting the LMRP from the BOP, how the well would be circulated after the drillpipe was disconnected, and how circulation across the BOP stack would remove trapped gas. The final component of this series of tests was BOP/LMRP connection at landing.

The primary objective of the research was to provide information related to BOP maintenance, inspection, and testing for units operating in deepwater in the GoM. As part of the research, the team compiled and analysed data and information related to BOP system failure events as well as maintenance, inspection, and testing (MIT) activities. This effort involved collecting failure event and maintenance task data from more than 20 rigs and analysing more than 400 failure events.

Results included failure and maintenance event trends and estimation of BOP and subsystem mean time to failure values. In addition to this work, FMECAs were performed on selected rigs. The FMECAs associated equipment-level failure modes to BOP functions, aligned key MIT activities to the equipment-level failure modes, and assessed the risk of equipment-level failure modes.

FMCEA results indicate surface and subsea control system failures account for more than 60% of BOP system failures. The BOP stack accounts for the remaining failures. Further analysis of the failure events indicates that the following five major components account for...
approximately 75% of the BOP system failures:
- Blue and yellow pods.
- MUX control system.
- Pipe and test rams.
- Connectors.
- Choke and kill valves and lines.

Significant equipment-level failures occur in blind shear rams, casing shear rams, connectors, pods, choke and kill lines and valves, pipe rams, and hydraulic supply lines. MIT activities used to detect and prevent BOP equipment failures included function tests, pressure tests, rebuilding/replacing equipment, and dimensional/ultrasonic testing. RAM studies based on a typical configuration for a BOP design were carried out with the goal of estimating the key reliability factor of merit, mean availability. Results indicate mean availability (while the BOP is latched on to a well) is as high as 99.9+%, depending on the BOP design and the assumed functions required to control the well. Results were used to predict the probability of a BOP being operational to control a well kick.

Research work included a review and comparison of BOP MIT tasks in two categories, those required by various regulation and industry standards/recommended practices and those contained in the MIT plans developed by drilling contractors. This effort included a survey of management systems and practices related to BOP maintenance activities. Results indicate API Standard 53 is the key document in defining the minimum MIT tasks for a BOP. The bulk of the drilling contractor MIT plans and BOP OEM installation, operation, and maintenance manuals include tasks that refer to API Standard 53 requirements. Many good practices are in place to help eliminate failure, including computerized maintenance management systems, preventive maintenance systems, and comprehensive maintenance programs, written instructions, and training.

The Way Forward
This research evaluated field data to discover common BOP failures and identified the methods being applied to increase reliability. Additional research could target enhanced BOP safety and improved maintenance, inspection, and testing regimes.

Deepwater drilling operations are critical to meeting the growing demand for hydrocarbons, and the industry can only continue pushing the boundaries of what is possible if the technologies applied are safe and reliable.

For offshore operations to continue to take place in deepwater and harsh environments, there has to be confidence that the work of producing oil and gas can be carried out in a manner that protects the security of life and property and preserves the natural environment.