What is a blowout preventer?

A blowout preventer, or BOP, is a large specialised unit weighing up to 400 tonnes that is used to prevent an oil spill from occurring. It works like a valve to close an oil well, similar to a plumber closing a valve in a pipe, and are proven to be highly effective in ensuring well safety.
The BOP is located at the top of the well near the seabed and surrounds the pipe or drill string, which passes through it. The fact that the BOP surrounds the pipe and stays in place throughout the drilling operation means that it can be used at any time to shut in or seal off the well.

The BOP is deployed from the rig and installed on the well during the early stages of well construction. It remains in place during exploration activities, serving as a mechanical barrier that can be activated to seal off the well and isolate it from the rig or sea. Once activities on the well are complete, the BOP is retrieved back to the rig to be used for the next well.

The BOP can shut in the well in minutes. If activated, the blowout preventer will automatically close hydraulic rams and activate specialised seals against the drill string to seal the bore. If this does not work properly, there are other rams which can completely cut through the drill string to seal the hole. In all, the BOP has six independent shut-in mechanisms. Blowout preventers are proven to be highly effective in ensuring well safety.

When is a BOP operated?

The BOP is operated anytime the well needs to be isolated at the seabed. When the BOP is closed, the well is said to be ‘shut in’ or ‘sealed off’ (similar to a plumber closing a valve in a pipe). As part of the normal well construction process, it is necessary to shut in the well to perform routine operations such as pressure testing. A well may also be shut in for non-routine events, such as a ‘kick’. A kick is a flow of fluid (e.g. oil, gas and/or water) from the rock layers into the well bore (the hole drilled for exploration). If no action was taken, these fluids could migrate up the well, past the BOP and escape to the surface, in what is known as a loss of well control (LOWC).

The naturally occurring fluid pressure in the rock layers must be controlled as the well is drilled to prevent oil, gas and/or water entering the well bore. To achieve this, the hole is kept full of weighted drilling ‘mud’ (a mixture of water, barite, clay and non-toxic additives) while it is being drilled. This column of mud creates a downward (hydrostatic) pressure that prevents inward movement of any fluids trapped in the rock layers into the well bore. The pressure created by the mud is greater than the pressure in the rock layers.

This column of mud is monitored at all times and provides the first indication of a possible kick. This could occur if the fluid pressure in the rock layers is greater than the pressure produced by the column of drilling mud. Rig crews are trained to identify kicks and follow rig specific procedures to isolate the well if they occur. This training is reinforced by regular kick drills on the rig.

How does a BOP work?

BOPs isolate the well bore using two types of closure devices — ram preventers and annular preventers. For Equinor’s activities in the Bight, the BOP will have a minimum of five sets of ram preventers and two sets of annular preventers. Each set of preventers is designed to withstand the maximum expected pressure in the wells. As such, only one set of preventers is typically required to isolate the well from the surface.

Ram preventers consist of two hydraulically activated ‘rams’ that are positioned opposite each other and designed to seal off a well. A common BOP ram configuration for deepwater is:

- Three pipe ram preventers that can seal the well when drill pipe is inside the BOP. The pipe rams have opposing half-moon section that allow a rubber seal to be made around the pipe.
- Two shear ram preventers capable of cutting a wide range of pipe. Two steel blades are pushed together, pinching the pipe in the middle (similar to the cutting action of garden pruning shears).
Annular preventers have a doughnut-shaped rubber element that is moved by a large hydraulic piston. The rubber element is designed to seal around most shapes and size of pipe and close off an open hole (for example, if there is no pipe inside the BOP).

During normal drilling operations, all the BOP’s preventers are open. This allows tools to be lowered into the well and mud and drill cuttings (generated during drilling) to be circulated up out of the well, through the marine riser to the rig.

When it’s necessary to shut in the well, a control panel on the drilling rig activates one or more of the BOP’s preventers, which are operated using high pressure water-based hydraulic fluid. Once the well is shut in, any pressurised fluids in the well hole can be safely routed through pipes and valves on the BOP to specialised pressure controlling equipment on the rig.

To supplement the BOP, a diverter system is installed at the top of the riser (see Figure 2). It functions in a similar way to an annular preventer by closing around the drill pipe. For crew safety, the diverter may be used to redirect any fluids in the riser away from the rig after the well has been shut in.

How reliable is a BOP?

BOPs have been used worldwide to safely isolate wells. The basic design of ram and annular preventers have been field proven over decades of reliable use.

As a critical piece of safety equipment, a BOP must be maintained and tested on a regular basis to ensure it functions as intended when required. Equinor is committed to maintaining and operating this equipment in a manner that meets industry requirements, government regulations and its own high standards.

Prior to installation, the BOP is inspected and tested by engineers according to strict quality control procedures. Maintenance and testing records are verified by Equinor. The BOP and its components are continuously monitored and regularly tested after installation – if any faults are identified that may impact its reliability, operations are suspended, and appropriate repairs made.

All personnel involved in BOP installation, function and maintenance must meet training and competency standards. These form part of the rig’s Safety Case that is accepted by NOPSEMA. The most important element in maintaining well control at all times is a properly trained crew who is alert and empowered to shut in the well any time a kick is suspected or identified.
What other BOP control measures help prevent a LOWC?

The BOP is typically activated from the rig using a control panel. There are a minimum of three of these control panels located in different areas on the rig. In the rare instance where communication between the rig and the BOP is lost, the BOP has a failsafe closure that automatically shuts in the well.

The BOP can also be operated externally by a remotely operated vehicle (ROV). In the unlikely event the automatic closure function fails, the ROV can manually operate closure devices and shut in the well. In the highly unlikely event of the BOP not working, our response plan also includes access to a capping stack, which can be fitted to the top of the BOP.

Have improvements to BOPs been made since the Macondo accident in the Gulf of Mexico?

The decision to shut in any well at the first indication of a kick is a critical human factor in preventing well control events. Equinor prioritises crew competency in well control. Critical to this is the development of rig-specific well control procedures and crew who demonstrate their well control capabilities through regular training drills.

Improvements related to BOP systems since the Macondo accident in the Gulf of Mexico in 2010 have largely been related to maintenance and testing. Many of these maintenance and testing specifications are published in new industry standards such as the American Petroleum Institute’s (API) Standard 53 (see ‘related reading’). A commitment has been made to ensure future lessons learned relating to BOP systems, design, testing and maintenance are shared and incorporated into industry practice.

Does the BOP cause any harm to the marine environment?

Each time the BOP is activated, the hydraulic control fluid used to function the component is released to the sea. The hydraulic fluid is water-based, of low toxicity and meets Australian standards for discharges into the marine environment. The impact of hydraulic fluid has been risk assessed in the EP.