Well Control Plan Outline[1]

Well control is the process of maintaining pressure inside the drilled wellbore in a manner that prevents gas or fluids from underground reservoirs flowing into the wellbore and escaping to the environment in an uncontrolled manner.

Shell Gulf of Mexico Inc. (Shell) designs and executes operations such that no single operational error or equipment failure should lead to loss of well control. The foundation of Shell's well integrity and well control philosophy is to maintain two barriers, which are mechanical and/or fluid and have been tested, between any subsurface zone that can potentially flow to the environment, and any pathway through which such flow would occur. A "barrier" is a mechanical partition and/or a fluid. All barriers used by Shell have been tested to meet Shell's performance standards.

Below is a summary highlighting the well control mitigations organic to the well planning process:

- Site Selection:

  The location of the well is selected to avoid or minimize the following shallow hazards:

  1) Shallow faults that extend to the mudline
  2) Overpressured water sands created by rapid depositional environments.
  3) Overpressured gas sands pressured by biogenic gas from rapidly decaying biologic materials in rapid depositional environments.

- Pore Pressure / Fracture Gradient Information:

  Casing setting points & mud weights are based on reviewed and approved pore pressure / fracture gradient information. These plots are based on the best technical data at the time of generation, reviewed and then subsequently approved by Shell's Technical Authorities in this area. The data set can include 3-D seismic data, shallow seismic surveys, and known offset well information. Casing points and mud weights are planned to provide the maximum well control potential, isolation of shallow over pressured zones, unconsolidated zones and maximum borehole stability.

- Casing Design:

  Casing design loads are based on Shell's Casing and Tubing Design Manual and the Code of Federal Regulations depending on which set of requirements has the most stringent design and assurance protocol. Shell's manual outlines conventional well loads and survival loads to be placed on the casing strings based on the specific tubular function. Each well design is reviewed and assured by Shell's Well Design Technical Authority. Additional screening and confirmation applied to wells drilled in OCS waters includes:

  1) In additional to Shell's standard survival loads, additional well containment is demonstrated with the Joint Industry Task Force / BSEE: Well Containment Screening Tool.
  2) Well designs, barriers and cementing programs are developed with the involvement of a registered Professional Engineer.
  3) Regulatory requirements for margins between pore pressure, mud weight and fracture gradient are applied to the design.

[1] The Well Control Plan Outline has been re-worded to use language more familiar to Shell's well engineers and responders to a potential well control event. In this rewording, Shell has not changed the quality or substance of its well control response effort.

Using these principles the well design has the required integrity to perform safely and without undue risk during conventional drilling scenarios and survive extreme loads placed on the system during well containment efforts.

- Pressure Control Equipment:

  Shell specifies and maintains pressure control equipment in accordance with the regulations and Shell's Pressure Control Manual. The minimum compliance level is based on the stricter requirement for pressure control equipment.

  Specific requirements applied to pressure control equipment in Alaskan-OCS waters:

  1) Documentation and review of well control equipment / processes as specified in the regulations for permit approval.
  3) Confirmation by onsite BSEE witnessing of Pressure Testing of critical well control equipment in accordance with the regulations.
  4) Testing of the casing & BOP equipment meets at a minimum the maximum anticipated surface pressure + 500 psi to demonstrate the equipment can successfully operate at the highest pressures expected in a well control event.
  5) Physical tests are done on the same make and model of the BOP equipment to demonstrate that in a well control situation the equipment performs as designed with the planned drill pipe and worst case internal pressures.
  6) The BOP is independently reviewed and approved by a 3rd party as being suitable for the given well design and well conditions.
  7) Incorporation of a Dead Man system in the BOP controls allows the BOPs to automatically be closed in the event that the Lower Marine Riser Package (LMRP) is disconnected from the BOP. This feature is tested during the stump testing / initial run of the BOP at the location.

  The minimum requirements in Shell's Pressure Control Manual and the requirements in the regulations provide very high levels of assurance the BOP's will operate in the planned manner if required.

- Operational Monitoring:

  Operational monitoring is conducted to minimize the potential of penetrating an overpressure zone resulting in a loss of hydrostatic overbalance.

  1) Flow checks are conducted with the pumps off to confirm the static mud weight over balances pore pressure.
  2) Frequent pit drills and mock well control drills are planned and conducted.
  3) Drilling Contractor / Shell Staff have relevant and current Well Control Certificates.
  4) Shell requires its operational staff to attend and pass its internal Advanced Well Control Training.
  5) Real Time monitoring of the well and operational parameters is conducted by the Real Time Operations Center that is staffed by a team of experts. Any anomalous signals or indications are immediately relayed to the rig.

  This extra set of monitoring provides a secondary team of individuals to monitor the wells status and minimize the potential for loss of situation awareness by the drilling team.

In the unlikely event that primary well control is lost, despite these design and operational protocols, Shell will initiate Incident Command, Source Control Teams and contingency / response equipment. This includes mobilizing Shell's capping stack and the containment system, to the well site. Shell may also mobilize additional internal / external resources to fully plan and execute contingency response plans and operations.

Secondary Well Control

In the event primary well control is lost, a series of escalating responses are planned to regain primary well control by establishing borehole hydrostatic pressure above formation pore pressures.

The first response is to close the BOP. The *Discoverer* will have six rams in the BOP stack.

- Two (2) Annular preventers which can close around a range of pipe sizes and shapes.
- One (1) Variable Bore Ram (VBR) which can close on a specified range of pipe sizes.
- One (1) Fixed Ram which will close on 5-in pipe.
- Two (2) Blind Shear Rams which will shear drill pipe and seal the well.

The-*Polar Pioneer* will have six rams in the BOP stack.

- One (1) Annular preventer which can close around a range of pipe sizes and shapes.
- One (1) Variable Bore Ram (VBR) which can close on a specified range of pipe sizes.
- Two (2) Fixed Rams which will close on 5-in pipe.
- Two (2) Blind Shear Rams which will shear drill pipe and seal the well.

Once the BOP has been closed, conventional well control methods will be employed to reestablish hydrostatic overbalance, these steps include Wait & Weight, Driller's Method and/or Bull Head Kill Methods (each method is described below). If there is no pipe in the hole, or if the functions above fail, the shear rams will be closed and hydrostatic overbalance reestablished by a Bull Head Kill.

- The Wait and Weight method is applicable only when a mud density increase is required. In this method, the well is killed in one circulation. The kick is circulated out while mud of sufficient density to balance the pore pressure is circulated in.
- With the Driller's Method the well is killed in two circulations. In the first circulation, the influx is circulated out using the original mud. In the second circulation, when weighted up mud is available, the well is killed.
- In the Bullhead Kill Method the influx is forcibly re-injected into the formation. Bullheading into a well is forcing gas or fluid back into a formation by pumping into the annulus and/or workstring from the surface. The well remains closed in so that drilling/completion fluid and influx are displaced into the weakest exposed formation.

Well Containment and Response

If closure of the BOP is not achieved when activating a BOP function on the rig, then a remotely operated vehicle (ROV) can interface with the subsea accumulator module (SAM) located on the seafloor within 500-ft of the Mudline Cellar (MLC) which is connected to the BOP Intervention Panel and then close the BOP. The SAM panel is a self-contained accumulator / BOP control system that can activate the BOP in a contingency situation. This SAM system is attached to the BOP and function tested in the same manner required for conventional BOP Intervention Panels in the regulations.

If secondary well control measures fail, the primary rig, if able, will disconnect the LMRP / riser and pull away to a site upwind and up-current from a well control event (e.g. a blowout) location and initiate relief well drilling operations. As a precautionary measure, relief well preparation operations are initiated in parallel with surface capping/intervention methods being employed on the incident well.

Shell will have available a purpose built 10ksi, Dual Blind Ram capping stack capable of capping and containing the incident well. The capping stack will be located on one of the ice management vessels. Also available is the separate containment system which will provide the means to collect uncontrolled well flows from a subsea blowout as close to the source as possible. The containment system is located on the Arctic Challenger barge, accompanied by a tug.

The capping stack is designed to be deployed on any well on the Alaskan OCS. It consists of a Type E H4 Wellhead connector, 12' spacer spool (to raise ROV panels sufficiently above mudline due to mud line cellar), 4-way diverter spool (two side outlets and two pressure sensors), Double Blind Ram (which seals the well), and upper H4 Mandrel. Side outlets are each dressed with two 5" manual valves for a soft shut-in. Vector connector holds the sacrificial valve (outer valve) in place; this allows change-out of the running configuration to connect flexible flowlines if the well has breached subsurface and it is determined the appropriate solution is to flow back to the containment system. These lines could also be used to execute a top kill. All control of the capping stack is done manually by ROV-operated paddle valves. Sufficient onboard stored fluid in accumulators exists to close the H4 wellhead connector and both blind rams without dropping below 1500psi on the control circuit. Additionally, capability exists to activate individual functions via hot-stab supply of hydraulic fluid – either from ROV or from hot-line run off the SAM (hot-line is part of hose bundle). Acoustic pressure / temperature transducers are designed to be mounted on the capping stack immediately before deployment to the wellhead and will transmit data back to surface through a dunker acoustic receiver to monitor pressure inside the BOP. The receiver system is modular and can be transferred to any vessel in the area. This asset will be kept on an ice management vessel and be ready for deployment. The capping stack includes capability to shut off flow and allow connection to topsides facilities for further production or kill operations.

On both the primary and secondary rig an additional BOP will be available to facilitate relief well drilling. It is noted that throughout incident response efforts and relief well drilling, Shell's Oil Spill Response (OSR) fleet will be onsite collecting and storing oil from the surface of the sea.

When the incident well is intercepted with the relief well, a dynamic kill will be performed to re-establish hydrostatic overbalance. Once the incident well is controlled it will be abandoned per the regulations and Shell's Abandonment Manual. Then the relief well will also be abandoned per the regulations and Shell's Abandonment Manual.

Relief Well Location and Timing

Shell will have in the region two drilling assets capable of drilling a relief well. The first drilling asset to respond would be the primary rig that was drilling the original well since it is already at the location. The placement of the relief well will be based on specific environmental conditions at the time of the response. A second relief well drilling asset, which will be drilling in the lease sale 193 area or may be stationed no further than Dutch Harbor when the other drilling unit is drilling hydrocarbon bearing zones capable of flowing liquid hydrocarbons to a well. This contingency drilling asset would be used as directed by Incident Command, or made the primary relief well drilling asset if the primary is unable to perform the work scope.

A relief well in this situation will not have a mudline cellar (MLC). The relief well will intercept the blowout and perform the kill even if extensive ice management efforts are required. A detailed Relief Well Plan will be submitted to BSEE as part of the Application for Permit to Drill for each planned exploration well.

The estimated total duration from the initial mooring to well kill pumping through a relief well would be approximately 28 days for a Burger blowout (Table 1). In the event of a blowout, the secondary rig if located at the Burger Prospect, will cease drilling, suspend the well so that it cannot flow, recover its BOP stack and moorings, and transit to the relief well drill site. In this case, the estimated duration of flow prior to drilling a relief well to intersection with the original wellbore and killing the flow is approximately 34 days (six days to mobilize and moor and 28 days to kill the well). If the secondary rig is located in Dutch Harbor, the rig will transit from Dutch Harbor to the relief well drill site. The rig will initiate relief well drilling operations upon arrival and mooring and will remain at the site through plugging operations on both the relief well and the blowout well. The max additional time required will be to unmoor in Dutch Harbor, transit to relief well site, and moor is an estimated 10 days (10 days to mobilize and moor and 28 days to kill the well).

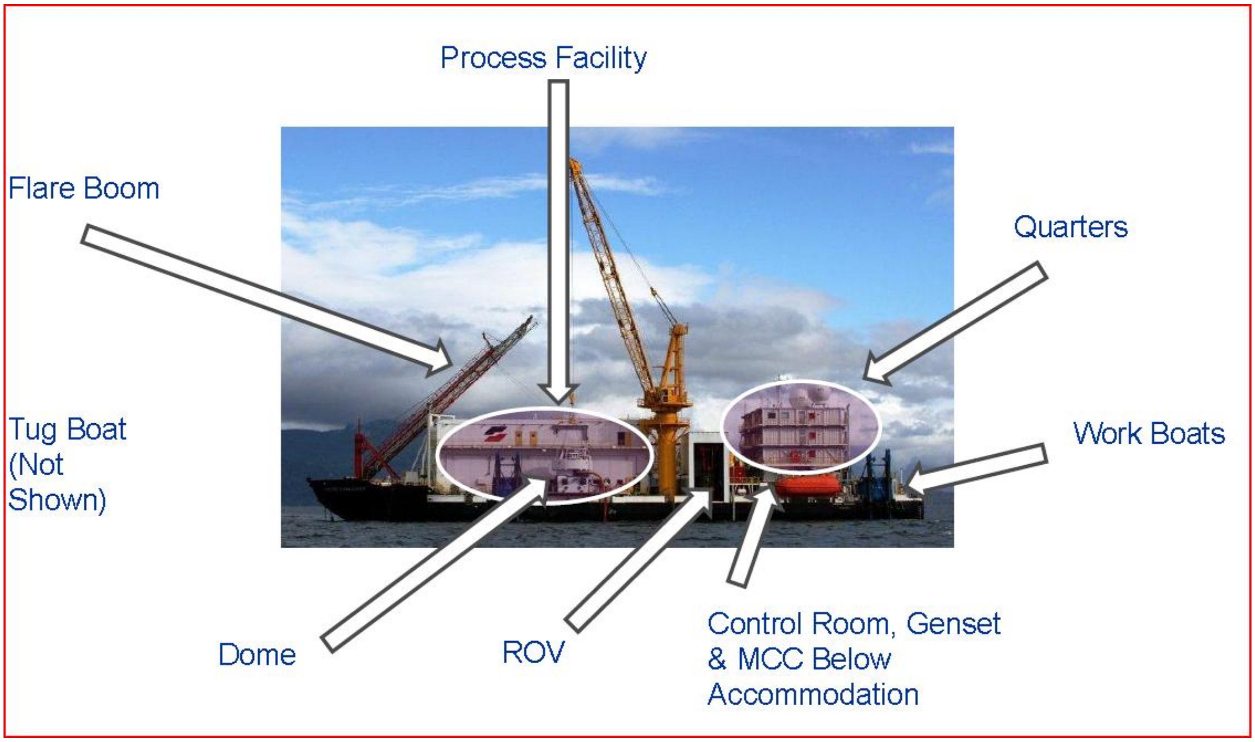
Table 1. Activities and estimated total duration from the start of a blowout to well killing through a relief well.

Activity	Unmooring at Dutch	Transit from Dutch to Burger	Mooring at Burger	Drilling to intercept point
Timing	1.0 days	7.5 days	1.5 days	28 days
Comments	Based on pulling and racking anchors and commencing transit.	Built around 6 knots travel speed based on previous average transit incorporating a variety of weather conditions.	Based on 2 anchor handlers and past anchoring times.	Base time of 23 days from original estimate with logging, MLC and P&A operations removed. Adds in ranging runs. Nominal estimate of NPT at 20% takes estimate to 28 days.

Blowout Well Ignition and Blowout Well Intervention

Blowout well ignition and blowout well intervention remain options available during blowout response which could be executed with the named support fleet. Placing human safety as the highest priority, Shell would consider the feasibility of igniting the blowout and the benefits this may bring to personnel and assets supporting capping and containment work. Any action taken to ignite the blowout would be a product of careful planning, repositioning of the fleet, and concurrence from the Unified Command. Blowout well intervention is considered an opportunity which would always be evaluated dependent on the wellbore condition and blowout scenario. Unless the primary rig is damaged, either rig would be capable of intervening back into a blowout well after successfully stopping the flow i.e. activation of the BOP, well kill through relief well, wellbore depletion, or the well bridging over.

Figure 1. Arctic Challenger Barge and Containment System



Close-up of the dome