White Paper: Recommendations for Improving Offshore Safety

Joint Industry Task Force to Address Offshore Operating Procedures and Equipment

Cautionary Statement

The Joint Industry Task Force has been formed to make recommendations in response to the request of the Secretary of the Interior, and recommendations will be formulated based on limited information and in advance of any investigative findings in relation to the current incident in the Gulf of Mexico. The contributing joint industry task force companies and trade associations express no views regarding the cause, fault or liability of the incident or regarding any mechanisms of prevention, nor should any recommendations be interpreted as a representation of any such views. The oil and natural gas industry is committed to working with this Department and the Administration as we move forward in efforts to improve offshore safety.

Executive Summary

In response to the Gulf of Mexico (GOM) incident, the oil and gas industry, with the assistance of the American Petroleum Institute (API), has assembled two task forces to focus on critical areas of GOM offshore activity: the Offshore Operating Procedures Task Force and the Offshore Equipment Task Force. Task force sessions began on 10 May and participants are working expeditiously to provide recommendations to the U.S. Department of the Interior Outer Continental Shelf Safety Oversight Board. The task forces are not involved in the review of the incident, but bring together industry experts to identify best practices in offshore drilling operations and equipment, with the ultimate goal of enhancing safety and environmental protection.

Estimated production from the GOM federal waters as of October 2009 represents about 30 percent of domestic oil production and about 11 percent of domestic natural gas production. Approximately 35,000 workers and 90 rigs are currently active in Gulf of Mexico federal waters, including 68 mobile offshore drilling units and 22 platform rigs. There are about 3,500 production platforms in federal waters in the GOM; 978 of those are manned.

General Objectives

Short-term (by May 28, 2010)

- Prepare immediately actionable recommendations concerning GOM deepwater drilling operations.
- These recommendations should 1) close any identified gaps in current blowout preventer (BOP) operating practices; and 2) align industry standards for well drilling and completion practices/procedures with recognized industry best practices.

Long Term (within one year)

- Provide a plan to apply findings from the GOM Incident Root Cause Analysis to revise existing API standards and MMS rule making processes to reflect any identified improvements.

Respective Task Force Goals

- The **Offshore Operating Procedures Task Force** is reviewing critical processes associated with drilling and completing deepwater wells to identify gaps between existing practices and regulations and industry best practices. Their recommendations are intended to move industry standards to a higher level of safety and operational performance and approach or achieve industry best practice.

- The **Offshore Equipment Task Force** is reviewing current BOP equipment designs, testing protocols, regulations, and documentation and will make recommendations to close any gaps or capture any improvements.

Task Force Participants

Offshore Operating Procedures

Anadarko, API, BP, Chevron, ConocoPhillips, ExxonMobil, Halliburton, IADC, Marathon, Murphy, Noble Energy, Schlumberger, Shell, Statoil, Transocean

Offshore Equipment

Anadarko, API, Atwood, BP, Cameron, Chevron, ConocoPhillips, Diamond Offshore, Ensco, ExxonMobil, Frontier, GE Oil & Gas, IADC, Murphy Oil, Noble Drilling, National Oilwell Varco, Oceaneering, Pride International, Seadrill, Shell, Statoil, Transocean, West Engineering

Schedule and Work Plans

Offshore Operating Procedures: Phase 1 Deliverables

Deliver early recommendations and conclusions by May 28, 2010. Based on findings in Phase 1, develop work plan and charter for Phase 2 of study.

Offshore Operating Procedures: Continuing Work Plan

- Review findings from GOM incident. Identify Drilling & Completion processes that may have been related to the incident.
- Identify critical processes (3-5) associated with Drilling & Completion of deepwater wells based on risk/exposure to safe and reliable operations.
- Benchmark practices against best-in-class practices and against existing “recommended practices” and regulations.
- Identify opportunities to move “recommended practices” to industry best practices.
- Provide weekly progress reports to the Governance Review Board on progress.
- Issue final report at end of Phase 1.

Offshore Equipment: Phase 1 Deliverables

Deliver 1st set of recommendations by May 28 (Phase 1). Based on findings in Phase 1, develop work plan and charter for phase 2 of study.

Offshore Equipment: Work Plan

- Review industry data associated with operation and testing of BOPs with the objective of identifying issues, areas of concern, potential failures in equipment, etc.
- Review existing testing and inspection requirements, regulations, protocols for BOPs. Based on industry experience, incident data, etc, and overlaying current regulations and requirements, make recommendations that can improve safety and reliability of BOP systems.
- Review information available from recent GOM incident, specifically associated with BOP system (including ROV interface).
- Provide weekly progress reports to the Governance Review Board on progress
- Issue final report at end of Phase 1.

Key Areas of Focus

The Joint Industry Task Forces have initially identified six key areas of focus for Gulf of Mexico deepwater operations.

The recommendations summarized in the table below are detailed in later sections of this document.

Focus Area	Description	Summary of Recommendation(s)
Health, Safety & Environment Case	Safety case methodology designed to reduce risks to the health and safety of the workforce and limit environmental impact associated with offshore drilling and completion operations using a subsea BOP.	A safety case is produced by the owner of the deepwater mobile offshore drilling unit (MODU) (i.e., Drilling Contractor) and reviewed by a competent and independent regulator who may prohibit activities if there are significant shortcomings in the safety case. The IADC has developed a guideline, “Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units,” to provide a sound basis for drilling contractors to initiate Safety Case requirements in the OCS. Develop Well Construction Interfacing Document (WCID) to manage well construction activities and mitigate unexpected events that impact health, safety and the environment.
Procedures Related to Mechanical Loads, Cementing Practices, Barriers, and Well Displacement Procedures	Load and resistance conditions during casing string installation.	Engage casing hanger latching mechanisms when casing is installed in the subsea wellhead. Form API subcommittee to study physical loads, design practices for subsea well completions and completion configurations that provide maximum reliability.
	Variables affecting the cementing operation design, placement techniques, well conditions and execution practices related to cementing casing strings.	Upon release, adopt API RP 65 Part 2: Isolating Potential Flow Zones during Well Construction.
	Independent barriers across potential flow paths during well completion / abandonment activities.	Provide two independent barriers, including one mechanical barrier, for each flow path prior to displacement to underbalanced fluid columns. Perform negative tests to a differential pressure ≥ anticipated pressure after displacement. Positively test each casing barrier to a pressure exceeding the highest estimated integrity of casing shoes below that barrier.
	Well displacement procedures.	Close blowout preventers during displacement to underbalanced fluid columns. Perform separate displacement operations for riser and casing. Monitor displacement volumes in and out. Ensure shearable drillstring components are positioned in the shear rams during displacement.
Secondary BOP Control Systems	Reliable function in the event of unintended disconnect of the lower marine riser package (LMRP) or loss of surface control of the subsea BOP stack.	Ensure BOP can automatically close blind/shear ram(s) and close choke/kill line valves. Perform full surface function / pressure testing prior to running of the BOP stack to simulate 1) unintended disconnect of lower marine riser package; and 2) loss of surface control of the subsea BOP stack. At prescribed intervals, conduct subsea testing of hydraulic function of rams and valves downstream of the trigger to simulate 1) unintended disconnect of lower marine riser package (LMRP); and 2) loss of surface control of the subsea BOP stack. Verify proper operation of the system by testing to MMS-approved Application for Permit

Focus Area	Description	Summary of Recommendation(s)
		to Drill (APD) casing pressure below blind / shear rams after system activation. Arm the system when BOP stack is latched on the wellhead. Disarm and rearm only if approved through a formalized Management of Change process.
BOP Testing and Test Data	Frequency and type of testing. BOP test data retention.	Upon completion of the testing, forward test charts and function test work sheets to the District MMS office that approves the well permit..
Acoustic Systems and Other Secondary Control Systems	Reliability of acoustic systems in ultra-deepwater environments. Availability of non-industry systems.	Establish Phase 2 work group to develop a matrix showing system combinations and capabilities under various conditions. Evaluate these options and recommend systems to be adopted. Evaluate processing in acoustic systems to remove ambient noise and to prevent inadvertent activation. Engage national research facilities to assess major acoustic system manufacturers' signal processing technologies.
Remotely Operated Vehicles (ROV)	Improvement and potential expansion of ROV capabilities and functions.	Ensure ROV can close blind shear rams, pipe rams, casing shear rams, and choke and kill valves. Ensure ROV can unlatch the lower marine riser package. Develop capability to function within prescribed closing times. Standardize ROV hot stab and receptacle per API Spec 17H. Standardize hot stab designs between drilling and production operations. Surface test ROV functionality and ROV pump and verify closure visually. Develop visual reference capability to confirm ram closure (position indicator). Identify methods for testing without introducing detrimental effects of seawater in BOP system. Stage ROV tooling / external hydraulic power supplies strategically in Gulf of Mexico for rapid mobilization.

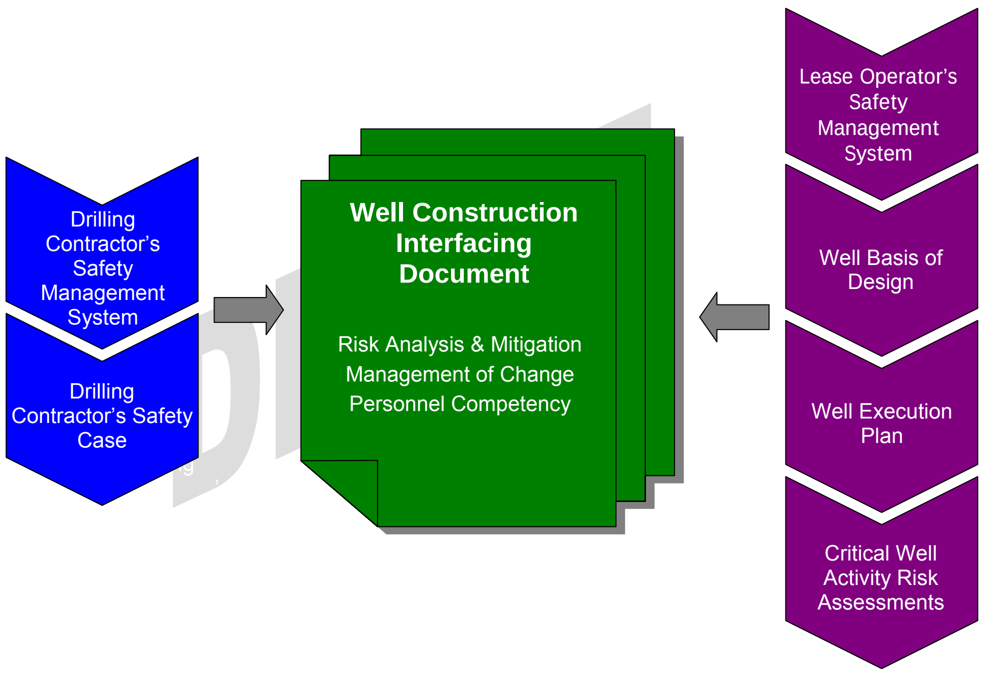
Acronyms

ALARP	As Low As Reasonably Practicable
APD	Application for Permit to Drill
API	American Petroleum Institute
BOP	Blowout Preventer
DOI	Department of the Interior
EDS	Emergency Disconnect System
HSE	Health, Safety and Environment
IADC	International Association of Drilling Contractors
LMRP	Lower Marine Riser Package
MMS	Minerals Management Service
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MUX	Multiplex
OCS	Outer Continental Shelf
OIM	Offshore Installation Manager
ROV	Remote Operated Vehicle
RP	Recommended Practice
SMS	Safety Management System
WCID	Well Construction Interfacing Document

1. Health, Safety and Environment (HSE) Case

This task force recommends the adoption of a process that includes a safety case methodology, well basis of design, well execution plan and critical risk assessments for all operations using a subsea blowout preventer (BOP) stack on the U.S. Outer Continental Shelf (OCS). The process would incorporate well-specific Management of Change (MOC), risk assessment and personnel competency requirements that would be implemented to improve risk recognition and response when executing critical well operations.

The primary purposes of a safety case are to reduce risks to the health and safety of the workforce and limit environmental impact associated with offshore facilities.



The Well Construction Interfacing Document (WCID) addresses the management of well construction activities and mitigates unexpected events that impact HSE.

A safety case demonstrates that the facility and the operation are sufficiently described in order to verify that the design, systems and operating parameters are capable of providing a safe working environment for personnel and that there are sufficient barriers to reduce identified hazards and risks to as low as reasonably practicable (ALARP).

The safety case is produced by the owner of the deepwater mobile offshore drilling unit (MODU) (i.e., Drilling Contractor) and reviewed by a competent and independent regulator who may prohibit activities if there are significant shortcomings in the safety case.

Principle features of a safety case are as follows:

- Identifies the safety critical aspects of the installation, both technical and managerial, with clear linkage to the Safety Management System (SMS)
- Defines appropriate performance standards for the operation of the safety critical aspects

- Requires workforce involvement

The International Association of Drilling Contractors (IADC) has developed a guideline, "Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units,"[1] to help drilling contractors meet regulatory requirements in the countries that operate under a Safety Case regime. This guideline effectively addresses the focus areas described above and will provide a sound basis to initiate Safety Case requirements in the OCS.

A Well Construction Interfacing Document (WCID) will be developed to manage the well construction activities and mitigate unexpected events that impact health, safety and the environment. This document will link the safety case with the lease operator's Safety Management System (SMS), well-specific information such as the basis of design, the well execution plan and critical risk assessment. It will describe how management of change and risk assessment processes will apply during well construction activities and ensure personnel competency. The WCID will also provide alignment between the parties to ensure that their health, safety and environment (HSE) standards are not compromised while undertaking shared activities. The WCID will assign or delineate specific responsibilities for the operator's personnel as well as provide a vehicle for the contractor to intervene in the case that unsafe acts are identified.

Attachment: Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units

2. Barriers and Mechanical Loads

Casing and Cementing Overview

Standard drilling practices call for steel casing (pipe) to be installed within a drilled wellbore hole section at predetermined intervals. The casing string reaches from the bottom of the drilled section to the surface of the well (wellhead).

Following casing installation, cement is pumped through the drillstring to create a solid barrier between the exterior of the casing and the exposed wellbore formations. A one-way valve (casing shoe) located at the bottom of the casing string holds the cement in place outside the casing and prevents formation fluids from entering the casing. After cementing operations are completed, testing is conducted to verify both cement and casing integrity.

The casing is suspended (hung) inside the wellhead located on the seafloor. A properly sized and pressure-rated blowout preventer stack (BOP) is then attached (latched) onto the wellhead/casing string. The BOP stack is connected to the wellhead and provides a sealable barrier between the wellhead and the riser (pipe connecting the floating rig to the well).

Subsequent to the successful testing of all system equipment, drilling of the next wellbore section can proceed. The well is drilled to total depth by continuing to drill, case and cement each successive hole section before proceeding to the next section.

Load and Resistance. This task force recommends that casing hanger latching and/or lock down mechanisms shall be engaged at the time the casing is installed in the subsea wellhead. In addition, the blowout preventers (BOP) shall be closed during displacement to underbalanced fluid columns to prevent gas entry into the riser should a seal failure occur during displacement.

[1] www.iadc.org/hsecase/index.html

An American Petroleum Institute (API) subcommittee will be formed to study the physical loads and design practices used in subsea well completions with long strings and liner/tieback wellbore configurations. The purpose is to further understand the relative merits of each configuration and provide operators a framework to select the completion configuration that provides the highest overall system reliability.

The subcommittee will complete this activity and provide recommendation to industry by end of year 2010.

Cementing. The success of any cement job is a function of design, placement techniques, well conditions and execution. This task force recommends that API RP 65 Part 2 be adopted by industry. RP 65 Part 2 is currently being released and addresses the gaps in primary cementing practices that have been identified in recent years. Once the specifics of the investigation of the Gulf of Mexico incident are made available, the Industry will consider the information and determine whether additional recommendations can be made.

Attachment: API RP 65 Part 2: Isolating Potential Flow Zones during Well Construction.

Fluid Displacement Overview

Each well section is drilled with a specialized, weighted drilling fluid. This fluid is pumped down the drillstring and exits through the bit at the bottom of the drillstring. The fluid circulates back to the surface via the annulus (the space between the outside of the drillstring and the wellbore wall). A primary function of the drilling fluid is to overbalance formation pressure to prevent the uncontrolled intrusion of formation fluids (e.g., gas) into the wellbore while drilling.

When drilling operations are completed and the production casing is in place, prior to removing the BOP stack from the well the drilling fluid is replaced with seawater. Before this displacement is performed, the well is checked to confirm it is secure and will not flow when the pressure is removed (negative test), Positive testing is conducted on the barriers and casing.

Abandonment and Wellbore Barriers. This task force recommends that two independent barriers, including at least one mechanical barrier, should be in place for each flow path (i.e., casing and annulus), prior to the displacement of kill-weight drilling fluid from the wellbore.

If the shoe track (the cement plug and check valves that remain inside the bottom of casing after cementing) is to be used as one of these barriers, it must be negatively tested prior to the setting of the subsequent casing barrier. A negative test should also be performed prior to setting the surface plug.

Negative tests will be made to a differential pressure equal to or greater than the anticipated pressure after displacement. Each casing barrier should be positively tested to a pressure that exceeds the highest estimated integrity of the casing shoes below that barrier.

Displacement of the riser and casing to fluid columns that are underbalanced to the formation pressure in the wellbore should be conducted in separate operations. In both cases, BOPs should be closed on the drillstring and circulation established through the choke line to isolate the riser, which is not a rated barrier. During displacement, volumes in and out must be accurately monitored.

Drillstring components positioned in the shear rams during displacement must be shearable.

Blowout Preventer Overview

A typical offshore BOP stack contains annular blowout preventer(s), pipe ram(s) and shear ram(s). The annular BOP and pipe ram(s) are designed to seal around the drillstring should it become necessary to shut-in the well to control an influx of formation fluid. The ability to control ("kill") the influx of formation fluid is facilitated by the capability to pump kill-weight drilling fluid to the bottom of the well via the drillstring. Activation of the shear ram(s) severs the drillstring at the sea floor. Therefore, the shear ram(s) are generally considered a measure of last resort.

In order to ensure that the BOP stack functions properly under a wide range of emergency conditions, including loss of surface control or unintended disconnect of the riser, secondary control systems are in place on every rig. Activation of secondary control systems can be executed with remotely operated vehicles (ROV). At present, other secondary control options such as acoustic systems are being evaluated for application in ultra deep water operations.

The BOP system and related components are regularly tested for functionality and their ability to seal under rated pressures within a prescribed amount of response time. A typical deepwater BOP stack is rated to 15,000 psi.

1. Secondary BOP Control Systems

The recommendations below are designed to ensure that secondary BOP systems are verified and functioning as designed. These recommendations are in addition to testing requirements currently in place for primary BOP control systems.

Secondary BOP control systems (often referred to as Deadman / Auto Shear) are to be required for all floating drilling rigs. These systems are to be automatically activated if either of the situations below occurs:

1. Unintended disconnect of the lower marine riser package (LMRP).
2. Loss of surface control of the subsea BOP stack.

When activated, the BOP must automatically perform the following functions as a minimum:

- Close the blind / shear ram(s).
- Ensure closure of choke / kill line valves.

The secondary BOP system is to be tested at the following frequency:

- Conduct full surface function and pressure testing prior to running of the BOP stack to simulate 1) unintended disconnect of lower marine riser package; and 2) loss of surface control of the subsea BOP stack.
- With the BOP subsea, conduct testing of hydraulic function of rams and valves downstream of the secondary BOP activation mechanism to simulate 1) unintended disconnect of lower marine riser package (LMRP); and 2) loss of surface control of the subsea BOP stack. This should be done after initial running and latching of the BOP stack, or every six months minimum if the BOP stack is not recovered to surface between wells.

- Confirm the system has operated as designed and is able to contain pressure by testing to the MMS-approved Application for Permit to Drill (APD) casing pressure below the blind / shear rams after system activation.

The secondary BOP system shall be armed when BOP stack is latched on the wellhead. Disarming and rearming the system shall only be performed through a formalized Management of Change approval process.

These recommendations should be initiated as soon as possible, with implementation completed no later than 1 May 2011 on all rigs with subsea BOP equipment operating in the GOM region.

2. BOP Testing

It is recommended that Industry submit all BOP test charts and forms (stump test, function test and pressure test) to District MMS offices for verification and retention.

The current method of retention for these test charts is to file them onboard the MODU after review and sign off by the Offshore Installation Manager (OIM) and Lease Operator's Representative. These test charts remain filed onboard and are witnessed by MMS inspectors during periodic inspections on offshore MODUs.

Industry proactively proposes that all test charts and function test work sheets be forwarded to the District MMS office that originally approved the well permit. This will allow easier access for the MMS to review and verify test data immediately after each test period and at any subsequent time. It will provide greater transparency and a retention component that is currently not in place. It will also ensure there is a copy of all tests at a secure shore base facility should the records become damaged or lost on an offshore facility.

3. Acoustic Systems and Other Secondary BOP Activation Systems

The addition of acoustic or other secondary BOP activation systems may provide additional redundancy for the systems currently used to ensure proper operation of critical BOP functions.

We recommend the establishment of a Phase Two work group to evaluate possible secondary system combinations and capabilities under various conditions. The goal of the work group is to evaluate these options and make recommendations concerning the safest and most reliable systems to be adopted.

It is recommended that the following options be included in the scope of work:

1. Reliability of Acoustic Controls
    a. Evaluate the status of processing to remove ambient noise and to prevent inadvertent activation.
    b. Use existing industry alliances with national research facilities to evaluate major acoustic system manufacturers' signal processing technologies. The goal is to determine if better acoustic systems are available outside industry.

4. Remotely Operated Vehicles (ROV)

Our recommendation for improvement of ROV capabilities is as follows:

1. Minimum Functionality for ROV Intervention Panel
    a. Close blind shear rams

    b. Close pipe rams
    c. Close casing shear rams (if equipped)
    d. Close choke and kill valves
    e. Unlatch LMRP

2. Minimum Requirements for ROV Pump and Associated Equipment
    a. Develop ROV capabilities to perform the functions listed above within API Spec 16D requirements for BOP closing times.
    b. Require industry standardization of hot stab and receptacle in accordance with API Spec 17H.

3. ROV Testing Requirements
    a. Test ROV on surface using flying lead to demonstrate functionality, using fluid volume count and visual observation to verify closure.
    b. Test ROV pump on surface with test fixture using hot stab to verify flow rate and pressure.
    c. It is recommended that when possible, a time/date stamped record be made of ROV test(s) performed to verify closing capability.

4. Implementation Schedule

    Implementation of these recommendations should begin as soon as possible, and should be completed no later than December 2012.

5. Further ROV Improvements

    Our recommendation is to form a Phase Two work group to develop further improvements to ROV operating capabilities. Among the items to be explored are the following:

    - Standardized stabs and receptacles between drilling and production.
    - Develop visual reference capability to confirm ram closure (position indicator).
    - Methods of subsea testing without introducing detrimental effects of seawater in BOP system (example: ROV with external hydraulic supply).
    - Require staging of ROV tooling and external hydraulic power supplies at strategic locations across Gulf of Mexico to allow rapid mobilization.

Equipment Definitions

Emergency Disconnect System (EDS): A BOP control system when armed and initiated that sequentially operates specific BOP functions to secure the well and disconnect the LMRP from the wellhead. The EDS can be a subsystem of the control pods or a stand alone alternate control system.

1. **Active EDS:** An active EDS system is initiated when the rig moves a predetermined distance from well center and is computer controlled – no human interaction is necessary. Applies to both MUX and conventionally piloted systems.

2. **Passive EDS:** A **manually** activated system usually corresponds or triggers when a Red Alert is issued for station keeping. Requires human activation. Applies to both MUX and conventionally piloted systems.

Deadman Circuit: A BOP control sub-system when armed and initiated that sequentially operates a series of BOP functions to secure the well.

1. **Active Deadman**

   a. **MUX System:** Initiated by the loss of electrical AND hydraulic supply to the pod to activate a series of functions to secure the well; no human interaction is necessary.

   b. **Conventional Piloted System:** Initiated by the loss of pilot pressure AND the loss of hydraulic supply to activate a series of functions to secure the well; no human interaction is necessary.

2. **Passive Deadman (MUX Only):** Manual function that is hard wired and bypasses the normal pod communication system to activate a series of functions to secure the well. Used if software communications are lost with the pods.

Auto Shear: An automatic function that when armed is triggered by separation of the LMRP from the lower stack and activates a series of functions to secure the well. No human interaction is required. Applies to both MUX and conventionally piloted systems.

Acoustic Controls (MUX & Conventional): A stand alone alternate control system that is manually triggered by encoded acoustic sound waves which activate a series of functions through a dedicated pod to secure the well. Activation is from permanent and/or self contained portable control units on the surface.

Remote Operated Vehicle (ROV) Intervention: An interface that when activated allows an ROV to connect to and control specific functions or systems on the BOP to secure the well and may include non-emergency functions. Applies to both MUX & Conventionally Piloted Systems

1. **ROV Active Function:** A function or series of functions that is both activated by an operating fluid supplied by the ROV through a stab to complete the function(s).

2. **ROV Piloted Function:** A function or series of functions piloted by the ROV, through a stab, that activates functions on the control pod which are supplied operating fluid from stack mounted accumulators to secure the well.

3. **ROV Passive Function:** A function or series of functions lined up by the ROV and supplied with a “flying lead” and stab from stack mounted accumulators or external accumulator banks to secure the well.