

Well Control Barrier Philosophy

1. What is a Well Control Barrier?

- A Well Control Barrier can be defined as any physical component(s) or operational practice that prevents formation fluids from flowing unintentionally from a formation, into another formation or to escape at surface.

2. Types of Well Control Barriers

2.1 Physical Component Barriers – “Something I can touch”

- A physical component or mechanical device which has been designed and/or tested to prevent formation fluids from flowing unintentionally.
 - *Examples include:* Hydrostatically overbalanced fluid column, cement plugs, Blowout Preventer Equipment, Bridge Plugs, Casing, Cement behind Casing, Valves, Managed Pressure Drilling Equipment, etc.

2.2 Operational Practice Barriers – “Something I can do”

- An operational practice or action which requires human recognition to analyze data/trends and react appropriately to prevent or manage formation fluids flowing unintentionally.
 - *Examples include:* Flow checks, Gas Unit Trending, Pressure Testing Physical Barriers, Pit/Trip/Choke Drills, Monitoring for Abnormal Pressure Indicators, Setting Alarms, Effective Communication Between Rig Crew Members, etc.

3. General Well Control Barrier Design Concepts

3.1 Quantity of Well Control Barriers

- Physical Components – Minimum of 2 in each potential flow path - 1 *active* (ex: Hydrostatically overbalanced fluid column) & 1 in a “*ready*” state (ex: Pressure tested Blowout Preventer). Failure of the primary barrier must not result in the failure of the backup.
- Operational Practices – Unlimited – The more discussion, practice & verification that a team utilizes with regards to Well Control Barriers, the more effective that team is at building a Well Control Culture.

3.2 Placement of Physical Well Control Barriers

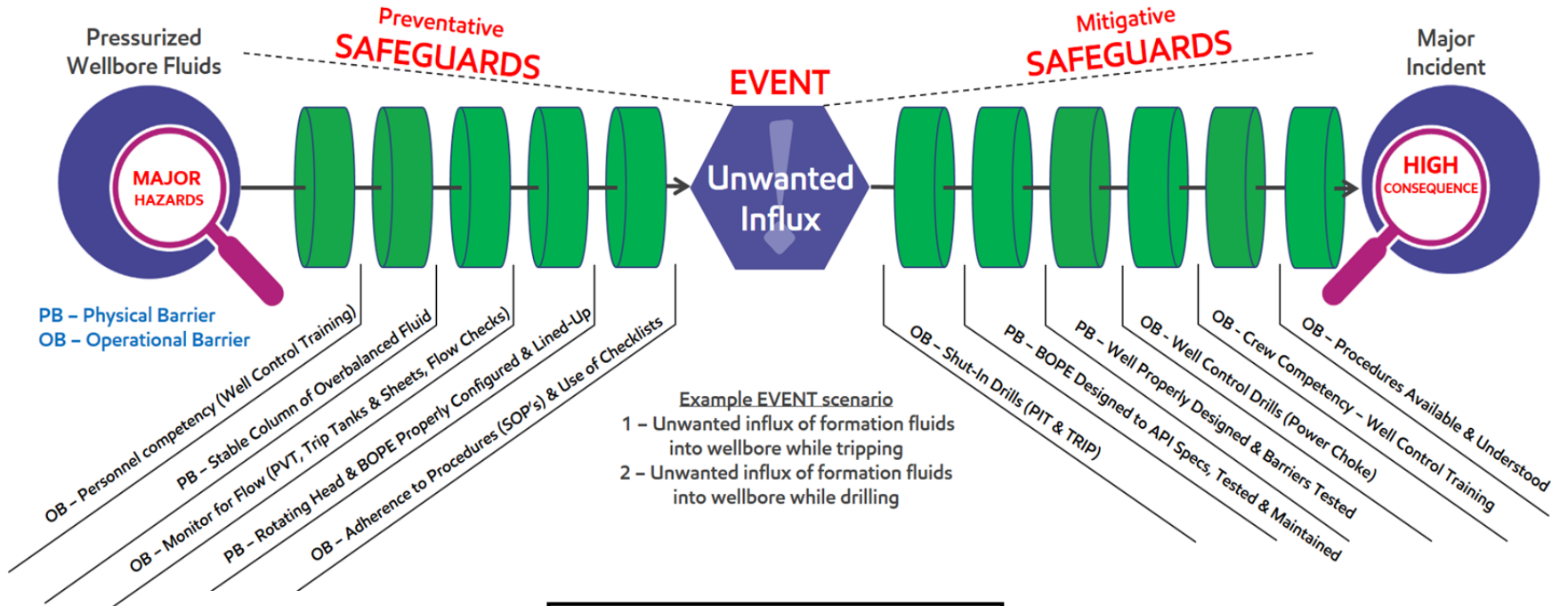
- Physical Barriers are to be placed as close to the source as possible to minimize the potential size of influx. Barriers placed in series are to be placed in such a manner that allows for testing and verification of each barrier independently.
- Physical Barriers which are placed and not able to be effectively pressure tested, will have its integrity verified by other means to ensure that the component is functioning as designed/intended.
- Physical Barrier locations must be known & documented at all times.
- Physical Barriers must be able to endure the environment (Temp, Fluid Type, Pressures, etc) in which it was placed for the period of time which it was intended.

3.3 Testing & Verification of Physical Well Control Barriers

- Physical Barriers must be pressure tested & should be pressure tested in the direction of expected flow. Pressure test amounts must be greater than the expected wellbore pressures at the location of the Barrier & should be less than the working pressure rating of the Barrier.
 - **Positive Pressure Test** – 5 min minimum time, low & high test pressure, documented acceptable pressure drop over time, volume to pressure up & bleed back is monitored.
 - **Negative Pressure Test** – Acceptance criteria for a good negative test must be agreed upon prior to test & plan must include procedure for failed negative test.
- If a Physical Component Barrier is not able to be effectively pressure tested, its integrity & position must be verified by another means and documented.
- Physical Barriers or situations in which the above guidelines cannot be followed, must be risk assessed, documented & mitigating procedures effectively communicated to all involved parties.

UNDERSTAND WHAT THE WELL IS DOING AT ALL TIMES

- Major Incident Consequences
- 1 – Surface Blowout
 - 2 – Underground Blowout
 - 3 – Long duration spill/release to environment



Tripping in Hole Practices
<ul style="list-style-type: none"> o DSM to be on rig floor for initial circulation after reaching bottom for a minimum of one BU o Prior to tripping in hole, discuss with Opl Supt plan for circulating during trip o If hole not giving proper displacement, notify operations superintendent to discuss forward plans o DSM to designate competent person to be on pit when circulating BU after trip o CBU at end of build o Trip tanks, with pump running, to be utilized during the trip in the hole

Well Control High Five
<ol style="list-style-type: none"> 1. How will the wellbore be properly monitored during this operation? 2. What can happen or go wrong during this operation? 3. Do I have a plan or the correct procedures in place for what can happen or go wrong? 4. Do I have the right equipment and does it work? 5. Have the hazards, procedures, and desired response been communicated to the crew?

Tripping Out of Hole Practices
<ul style="list-style-type: none"> o Flowcheck prior to POOH o DSM to be on floor for a minimum of first 10 stands, if the hole is not taking proper fill, go back to bottom and circulate bottoms up. o POOH a minimum of 10 stands and perform flow check prior to pumping plug o Additional flowchecks at base of curve, at the casing shoe, and prior to pulling BHA across BOP o If hole not taking proper fill after the first 10 stands, notify operations superintendent to discuss forward plans o Discuss with op supt on decision to pump out of hole in lateral on tight margin wells.

Personnel and Documentation
<ul style="list-style-type: none"> o Well control topic to be reviewed EVERY pre-tour to develop crews and report topics in safety check summary in Wellview o DSM to hold trip/pit/well control drills with all crews weekly or more frequently until deemed competent by DSM o Verify Mud Weight in/out while drilling every 30 minutes, and post on Pason screen o Well Control Readiness Checklist to be conducted each tour and filled out by DSMs. <ul style="list-style-type: none"> - Form to be kept on file - Take slow pump rates at tour change or mud weight change o Well Control Kill sheet to be filled out with current hole section BHA and shoe depths and kept updated hourly or with any mud weight change o Trip sheets to be reviewed by DSM while tripping and retained <ul style="list-style-type: none"> - Trip sheets to be kept when running all strings of pipe - Trip tanks, with pumps running, to be utilized anytime the rig pumps are not on. i.e if

Equipment
<ul style="list-style-type: none"> o Rotating Head is to be installed prior to drilling shed o FOSV (TIW) is to be installed below test plug in open position when BOP test is conducted <ul style="list-style-type: none"> - 5 stands of DP or 3 stands of HWDP below TIW for all tests - Well is to be monitored from cellar with open casing valve on the trip tank or a hose o Hard shut in clearly labeled on choke manifold o Ram locking hand wheels to be installed on all rams o Casing crossover to FOSV required to be made up prior to running casing for intermediate and production hole. o VBR utilization to be approved by op supt o LEL sensors to be installed on rig floor o When flare stacks are utilized, a properly installed check valve shall be installed and verified by DSM

Understanding Well Control Barriers

Uncontrolled Flow

Do I know what the well is doing?

- 1) What barriers are in place & how do I know they are working?
- 2) How am I monitoring the wellbore during this operation?
- 3) What can go wrong during this operation?
- 4) Do I have a plan in place for what can go wrong?
- 5) Do I have the right equipment & does it work?
- 6) Does my team & crew understand what to do and why?

Legend

- **Operational Practice Barrier**
- **Physical Component Barrier**



Pressurized Reservoir Fluids