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.
Understanding Well Control Barriers

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?

Pressurized Reservoir Fluids

Gas Unit Trending
Well full of Overbalance Fluid Column
Abnormal Pressure Indicators
Understood Procedures & Contingency Plans
Communication Amongst Team
Trip Sheets Used Correctly
Physical Barriers Set as per Design
BOPE Checklists
Physical Barriers Tested as per Design
Effective Flow Checks
Abnormal Pressure Indicators
Pressurized Reservoir Fluids
Uncontrolled Flow
Ignition Source Mgmt
Bottom Hole Pressure Mgmt
Effective Choke Drills
Proper Well Design (Casing, Cement, etc)
Effective FIT or LOT – MACP Known & Understood
Crew Responsibilities Known/Understood
Applicable Alarms Set & Monitored
BOPE Properly Pressure Tested & Maintained
BOPE Properly Configured & Lined Up (Hard Shut-In)
Effective PIT Drills
Drill Debrief/Learnings
Effective Trip Drills
Understood Procedures & Contingency Plans
Physical Barriers Tested as per Design
Trip Sheets Used Correctly
Physical Barriers Set as per Design
MPDE Properly Pressure Tested, Configured & Maintained
PVT & Flow Alarms Set & Monitored
Effective Flow Checks
BOPE Checklists

Legend
- Operational Practice Barrier
- Physical Component Barrier

Influx
Preventative Barriers
Mitigative Barriers
UNDERSTAND WHAT THE WELL IS DOING AT ALL TIMES

Preventive SAFEGUARDS

- MAJOR HAZARDS
  - PB – Physical Barrier
  - OB – Operational Barrier

- Personal competency (Well Control Training)
- Stable Column of Overbalanced Fluid
- Monitoring for Flow (PVT, Trip Tasks & Sheets, Flow Checks)
- Rotating Head & BOPs Properly Configured and Line-Up
- Adherence to Procedures (SOPs) & Use of Checklists

Pressurized Wellbore Fluids

EVENT

Unwanted Influx

Example EVENT scenario
1. Unwanted influx of formation fluids into wellbore while tripping
2. Unwanted influx of formation fluids into wellbore while drilling

Mitigative SAFEGUARDS

- MAJOR INCIDENT
  - OB – Shut-In Drills (FIT & TRIP)
  - PB – BOPE Designed to API Specs & Maintained

Well Control High Five
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?

Personnel and Documentation
- Well control topic to be covered EVERY shift to develop, review, and report topics in safety check summary meetings
- Well Control Knowledge assessed with the exam every 6 months or more frequently
- Well Control Planning to be conducted with input and feedback from BOPs
- Weekly Well Control Meeting to be conducted with input from site and feedback from BOPs
- Well Control Procedures to be conducted with input from site and feedback from BOPs
- Trip check to be reviewed by BOPs while tripping is underway
- Trip check to be reviewed by BOPs while tripping is underway

Equipment
- Most equipment to be handled prior to tripping out
- BOPS (FIT) to be handled by the last person in the mudline before tripping out
- BOPS (TRIP) to be handled by the last person in the mudline before tripping out
- Ensure all equipment is marked with company name and contact information
- Equipment to be handled by the last person in the mudline before tripping out

Equipment Maintenance
- Ensure all equipment is marked with company name and contact information
- Ensure all equipment is marked with company name and contact information
- Ensure all equipment is marked with company name and contact information
- Ensure all equipment is marked with company name and contact information
- Ensure all equipment is marked with company name and contact information
- Ensure all equipment is marked with company name and contact information
KICK DETECTION & SHUT-IN METHODOLOGY

Monitors pit levels, flow rates, temps, gas, trip/connection trends, ROP, alarms & pump pressures, etc., etc.,

- DSC

Monitors flow rates and pressures

- MPD Operator

Monitors mud parameters, mud & pit condition, mud transfer, mud volumes, etc.

- Mud Engineer & Derrickman

Monitors drilling parameters, position, formation logs, downhole pressures, etc.

- Directional Driller, LWD/ PWD Engineer

Monitors BOPE functions

- Subsea Engineer / Motorman

Monitors BOP/Riser & interfaces with BOP as directed

- ROV Operator

Monitors pit levels, flow rates, temps, gas, trip/connection trends, ROP, alarms & pump pressures, etc., etc.,

- Mud Logger

Monitors mud weight, flow, temp & cuttings out

- Shaker Hand

DRILLER / RELIEF DRILLER

Monitors pit levels, flow rates, drilling parameters & pump pressures & liaises with other noted personnel as required so that kick indicators are picked up as soon as practicable.

Shuts in well as soon as reasonably practicable

Inform CVX DSM & Toolpusher

Inform Office
CVX Drilling Operations Group

Kick Indications? (May bypass Flowcheck)

Flowcheck. Well flowing?

Yes

SHUT IN WELL
(This is done prior to informing the CVX DSM & Toolpusher)

No

Install/operate safety valves as directed by Driller

Roughneck