



Mitigate Pore Pressure and Frac Gradient Window Uncertainty Using Intelligent Managed Pressure Drilling Systems



What is Managed Pressure Drilling?



- “An adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore. The objectives are to ascertain the downhole pressure environment limits and to manage the annular hydraulic pressure profile accordingly. The intention of MPD is to avoid continuous influx of formation fluids to the surface. Any influx incidental to the operation will be safely contained using an appropriate process.”



Narrow Mud-Weight Window



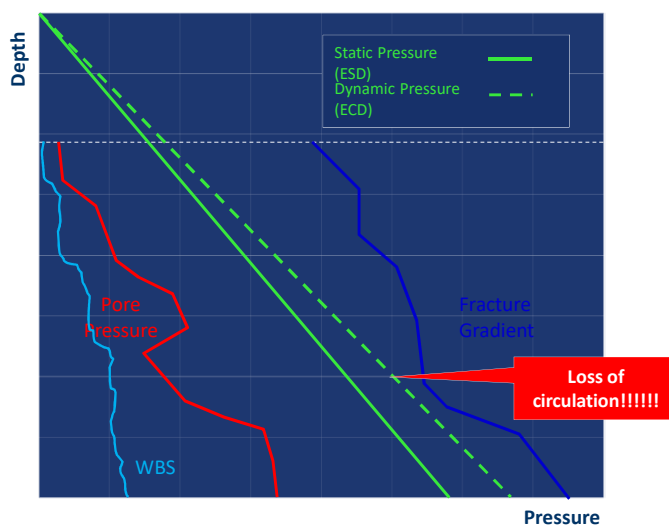
1. Conventional static margin (pumps off)

2. Dynamic condition (pumps on)

Conventional Drilling:

BHP = Mud Hydrostatic + Frictional Pressure Loss

- ✓ Effective BHP is altered via pump speed and/or mud weight.



What does MPD do?



1. MW Statically under Pore Pressure (pumps off)

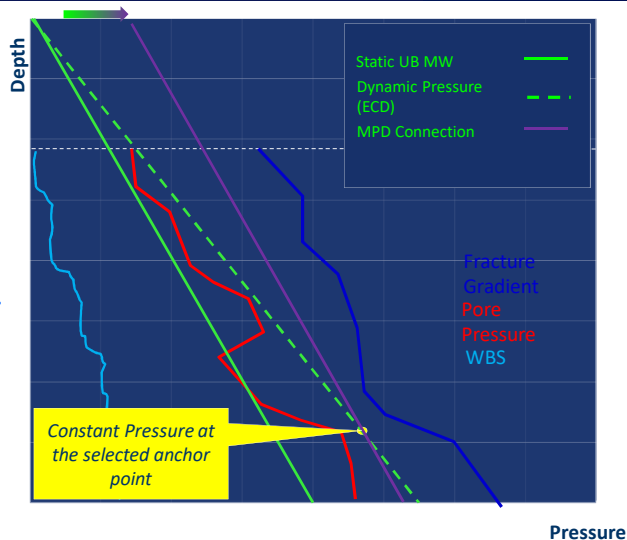
2. Dynamic condition (OB) with pumps on

3. MPD Connection (CBHP) (pumps off)

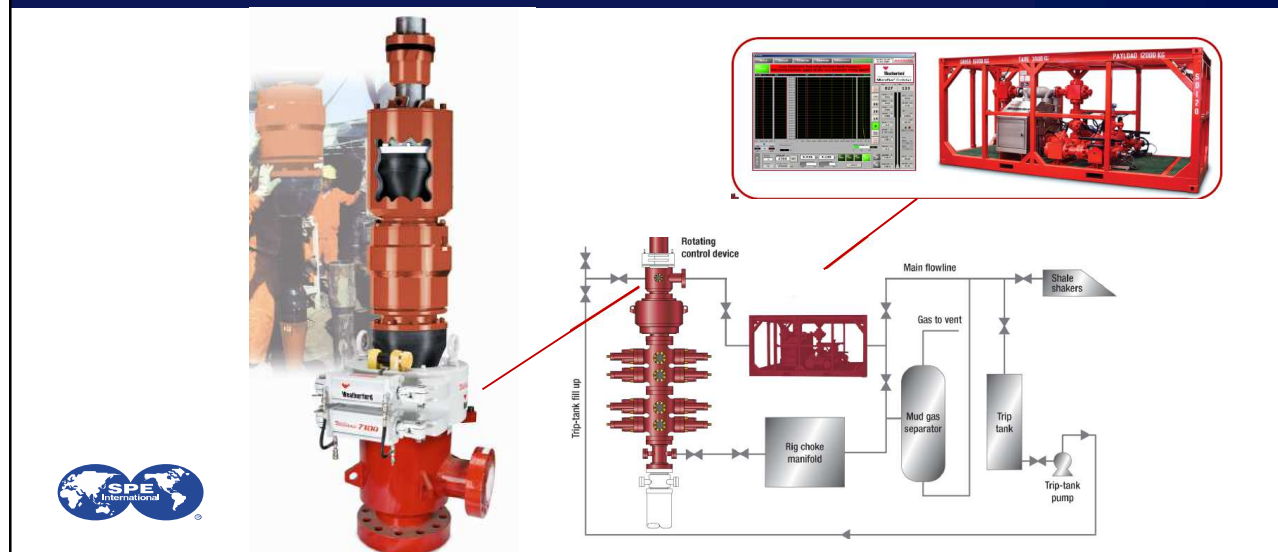
Managed Pressure Drilling:

BHP = Mud Hydrostatic + Frictional Pressure Loss + Surface Pressure

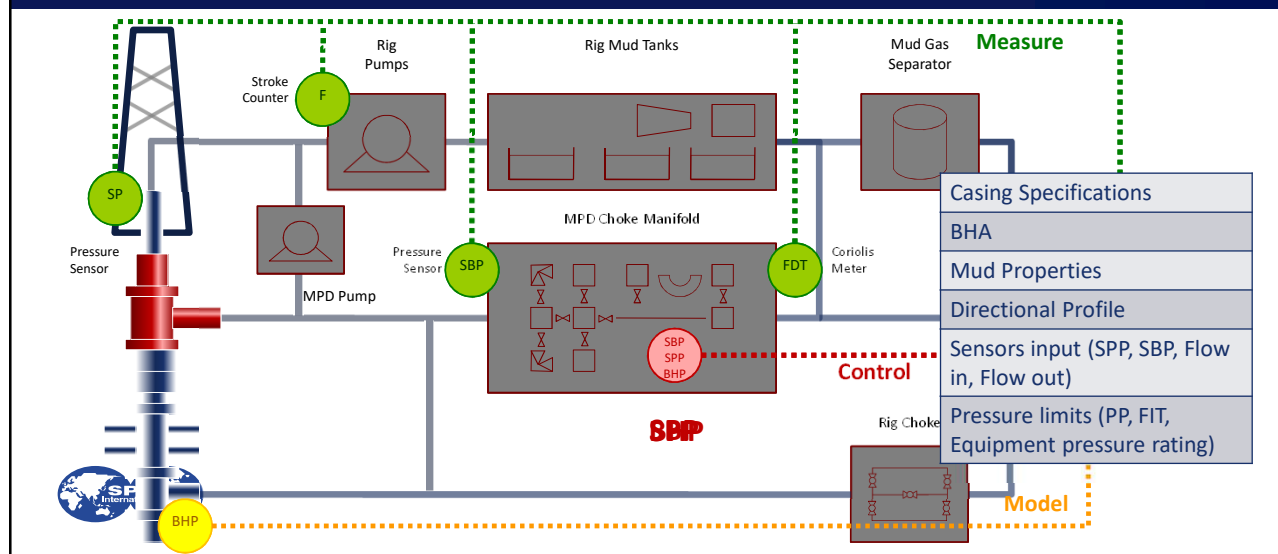
- ✓ Effective BHP (ECD or ESD) can be changed significantly and quickly and controlled automatically using Surface Backpressure.



Components of the MPD System



Intelligent MPD System



Manual MPD vs Intelligent MPD



Manual MPD System

Operator is away from rig floor, communication can be very limited

Reaction dependent on human interpretation and skills

Precision dependent on operator skills

Requires coordination of 3 or more parties to adjust parameters

Modeling needs to be done separately for specific conditions and is independent from the MPD system

Very narrow window scenarios may exceed system capabilities



Intelligent MPD System

MPD Control panel can be installed in the driller's cabin

Automated system reaction based on target BHP and downhole events

Precision based on PID system and proprietary algorithms

System adjusts surface pressure automatically requiring minimum coordination

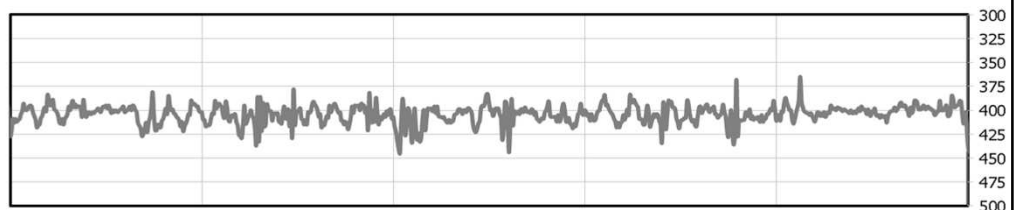
Hydraulics model running in real time controlling the MPD system

Can operate in ultra narrow drilling window scenarios

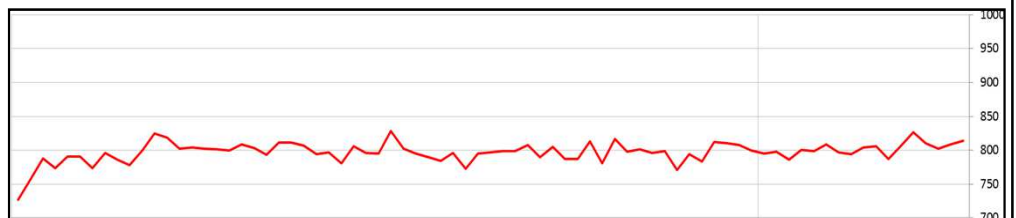
System Accuracy



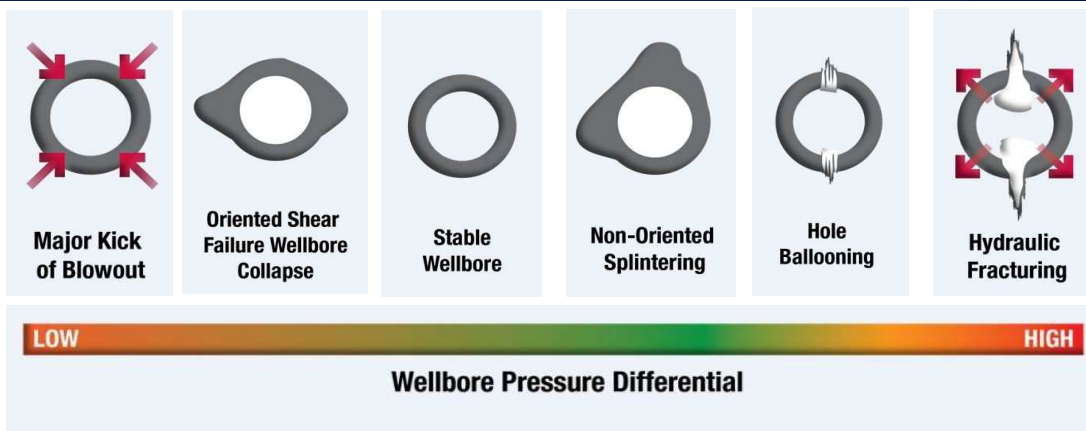
Manual MPD System



Intelligent MPD System



Importance of Determining the Drilling Window



Defining the Drilling Window



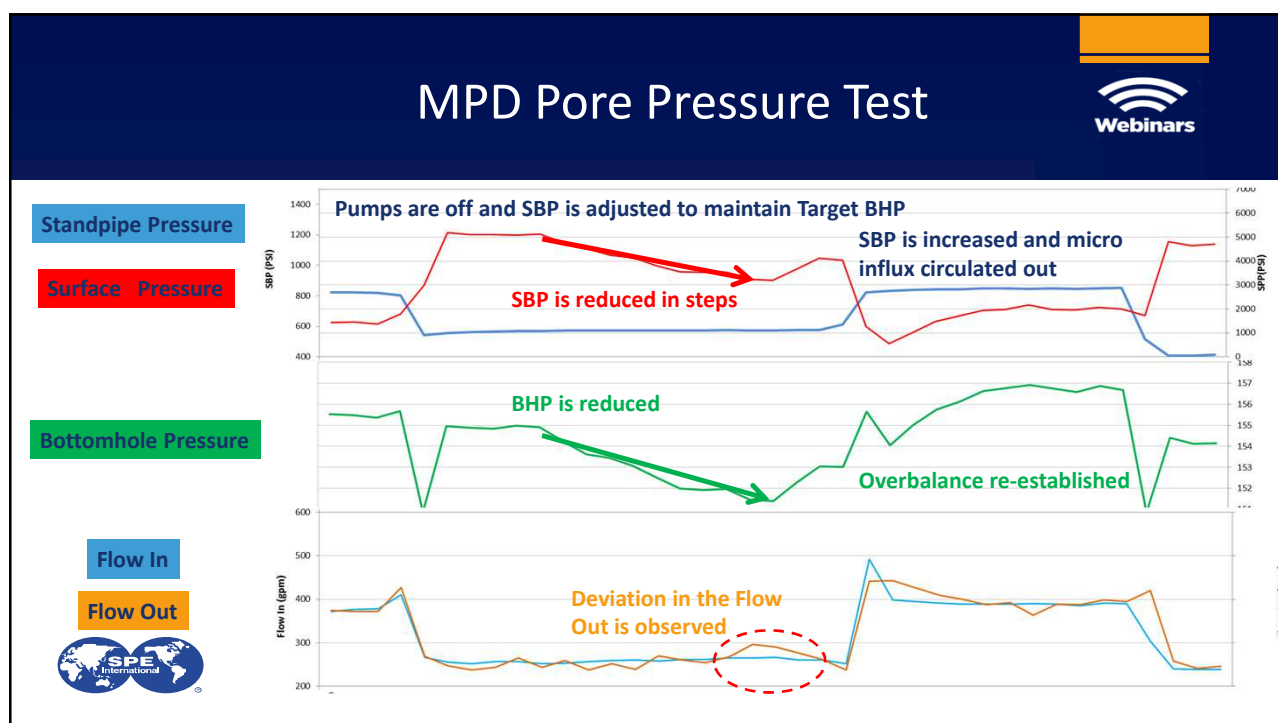
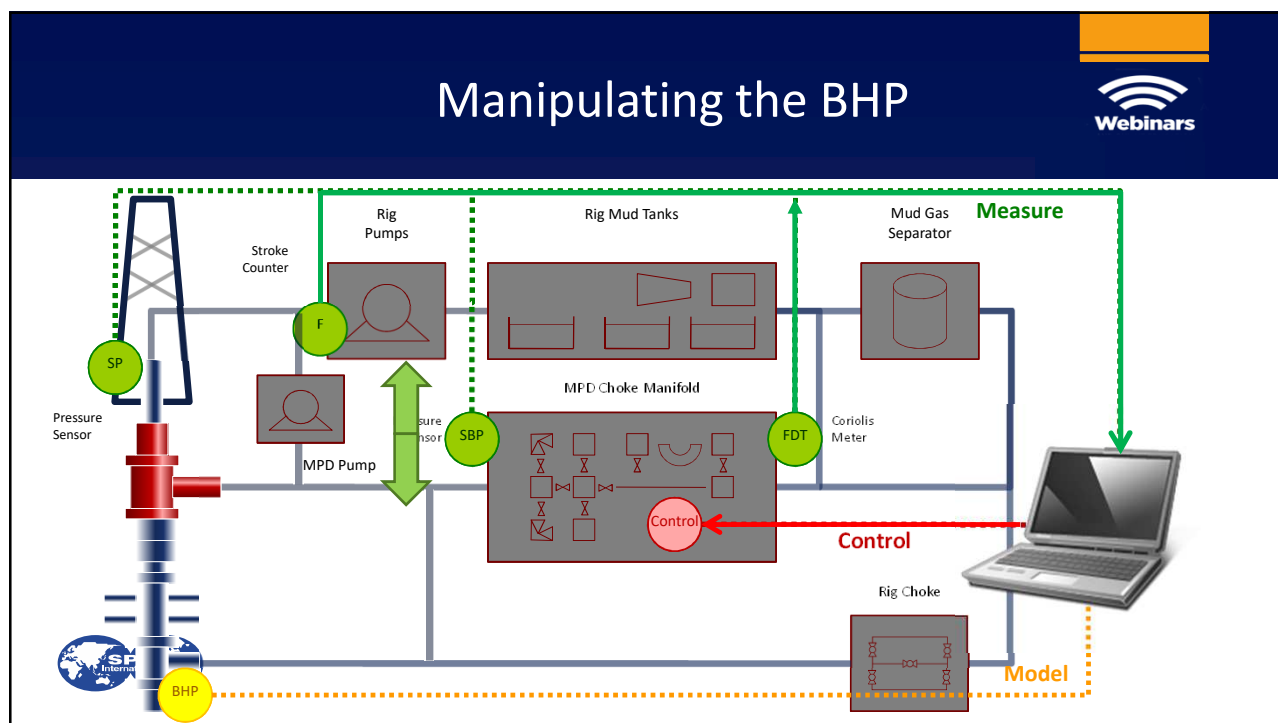
MPD Pore Pressure Test:

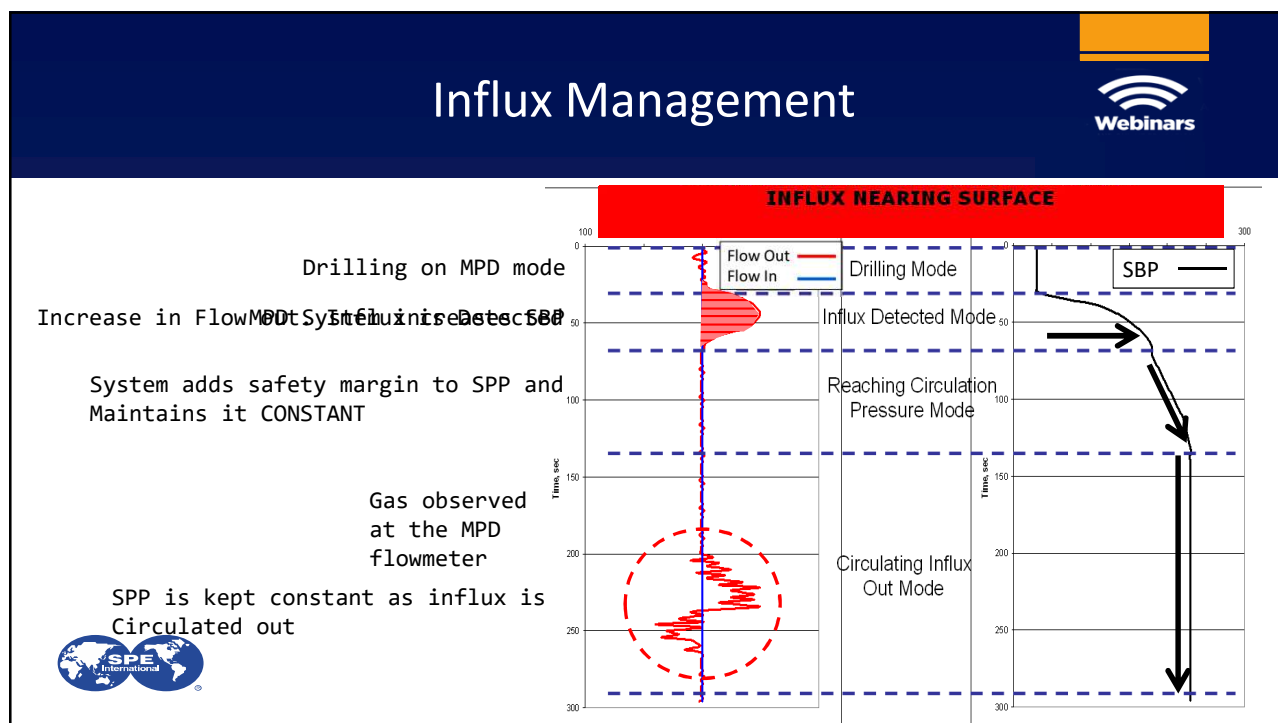
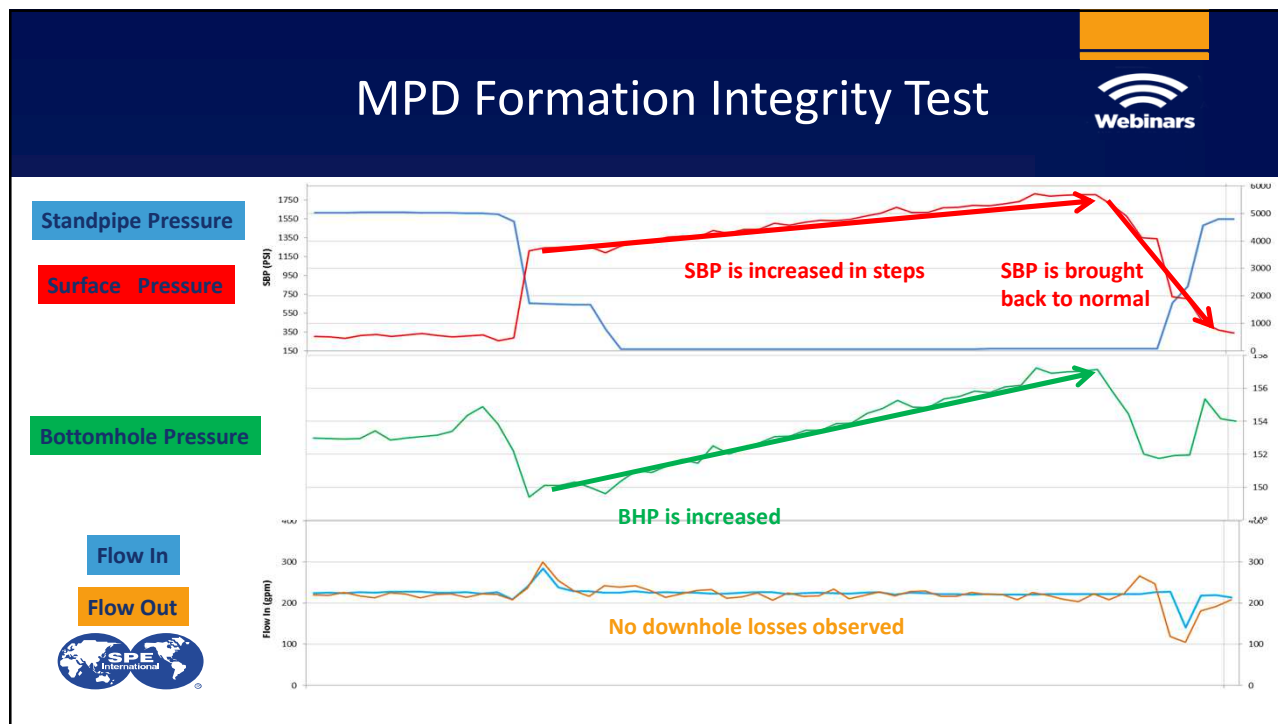
Includes the manipulation of the surface annular pressure to reduce the bottomhole pressure in steps until an increase in the flow out of the well (micro-influx) is observed.

MPD Formation Integrity Test:

Includes the manipulation of the surface annular pressure to increase the bottomhole pressure in steps until a predetermined value.







Influx Management -Continued



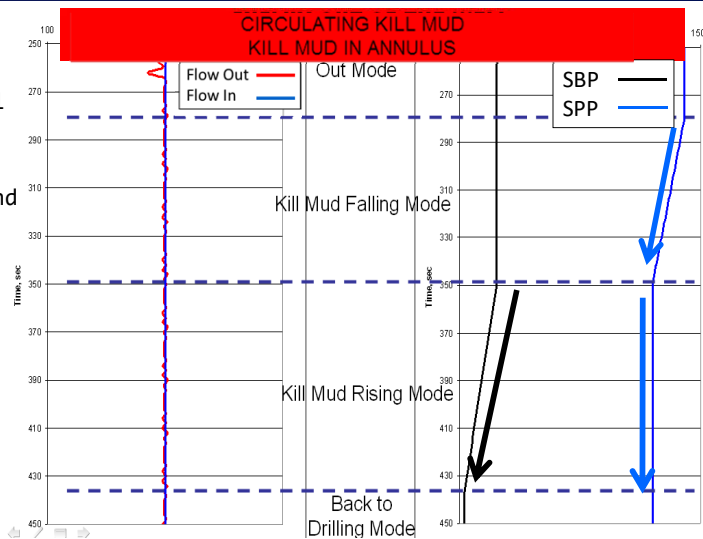
Influx is out of the Well

Kill mud is being pump and falling in drill string

Kill mud rises up in the annulus. SBP is adjusted to maintain CBHP



Drilling is resumed



Losses Detection and Mitigation

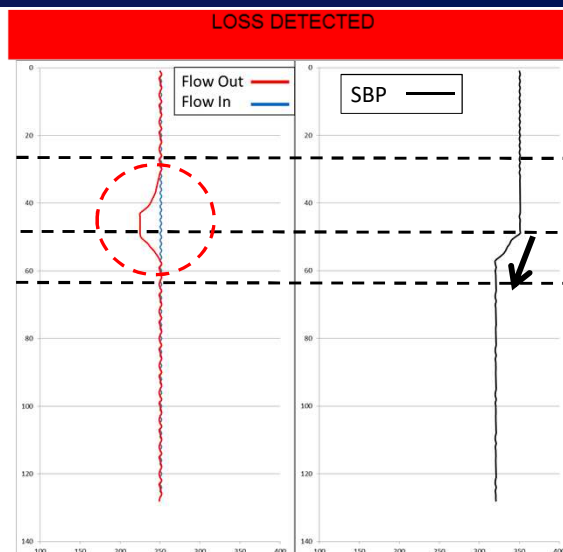


Drilling on MPD mode

Loss is detected by the MPD System

SBP is reduced by the MPD system to mitigate losses

Flow balance is restored.
Operation can be resumed



Summary



The use of an Intelligent MPD System can allow us to:

- ☐ Determine the upper and lower limits of the drilling window
- ☐ Adjust the BHP based on the window limits
- ☐ Quick detection and mitigation of unexpected events like kicks and losses



Thank you!

Questions?

