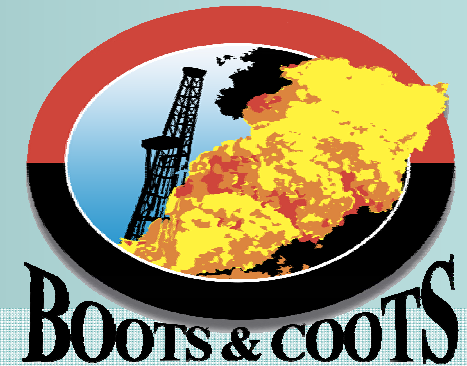


Drilling Technology Past & Future



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The Past 25 Years.....

- Drilling Fluids
- Drilling Equipment
- Evaluation Tools
- Drilling Methods

The Past 25 Years.....

- ***Drilling Fluids***

- Oil Based Muds (Diesel)
 - Temperature Resistant +300°F (+150°C)
 - Shale Inhibition
 - Enhanced PDC Penetration Rates

The Past 25 Years.....

- ***Drilling Equipment***

- Sub-Sea Wellheads
- Top Drives
- Multi-Bowl Heads
- Rotating Heads



The Past 25 Years.....

- ***Drilling Equipment (cont)***

- Bottom Hole Assemblies (BHA)
- PDC Bits
- Bi-Center PDC
- Bent Housing Drilling Mo
- Measurement While Drilling (MWD)



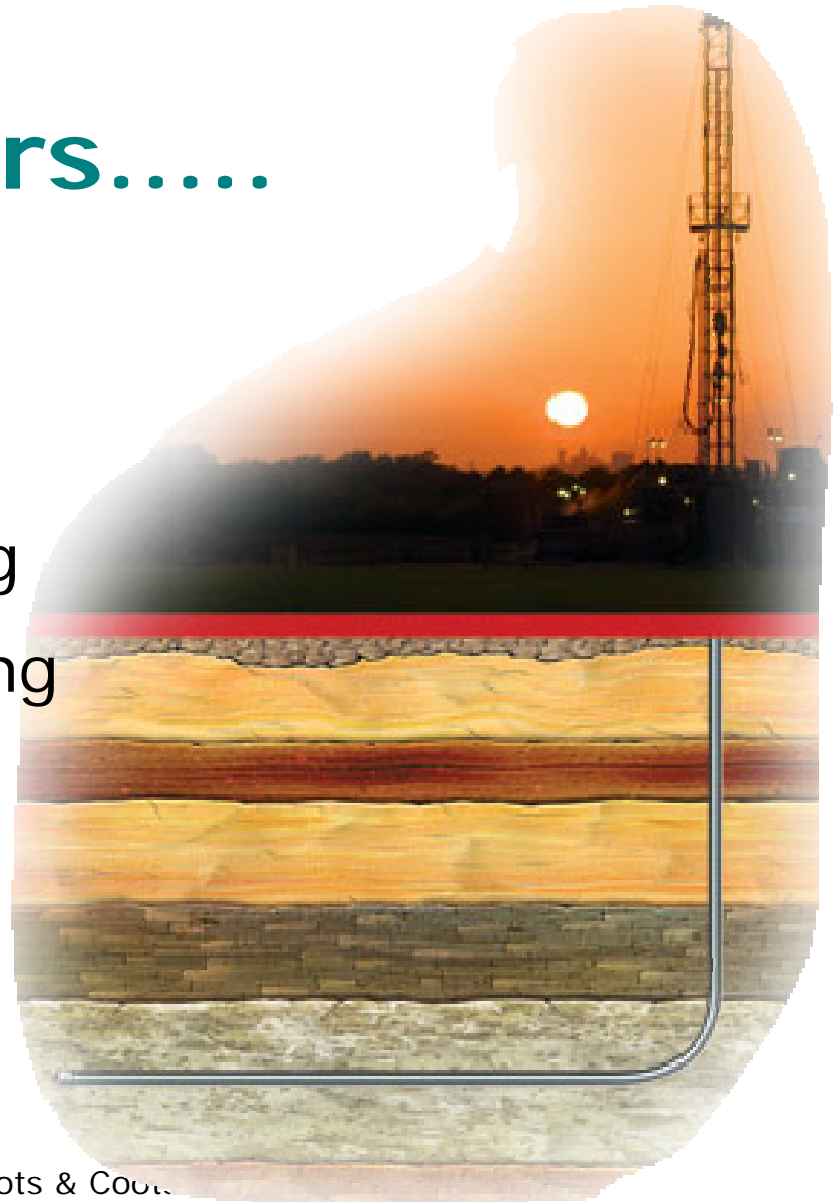
The Past 25 Years.....

- ***Evaluation Tools***
 - 3D Seismic
 - Logging While Drilling (LWD)

The Past 25 Years.....

- ***Drilling Methods***

- Horizontal Drilling
- Underbalanced Drilling
- Extended Reach Drilling



And Now.....

The Future

And where it leads us...

The Future.....

- **Deeper Water**
 - **Frac Gradient/Pore Pressure Window Shrinks**
- **Deeper Depths**
 - **Higher Pressures**
 - **Higher Temperatures**

The Future.....

- ***Drilling Fluids***
 - Synthetic Based Muds (low Toxicity)
 - Enhanced Water Based Mud Performance

The Future.....

- ***Drilling Equipment***
 - Casing Drilling
 - Casing Running Eqpt
 - Expandable Casing
 - Downhole Isolation Valve
 - Rotary Steerable BHA's

The Future.....

- ***Evaluation Tools***
 - 3D Seismic Enhanced & 4D Seismic
 - MWD/LWD Radio Frequency
 - Pressure While Drilling
 - Passive Ranging

The Future.....

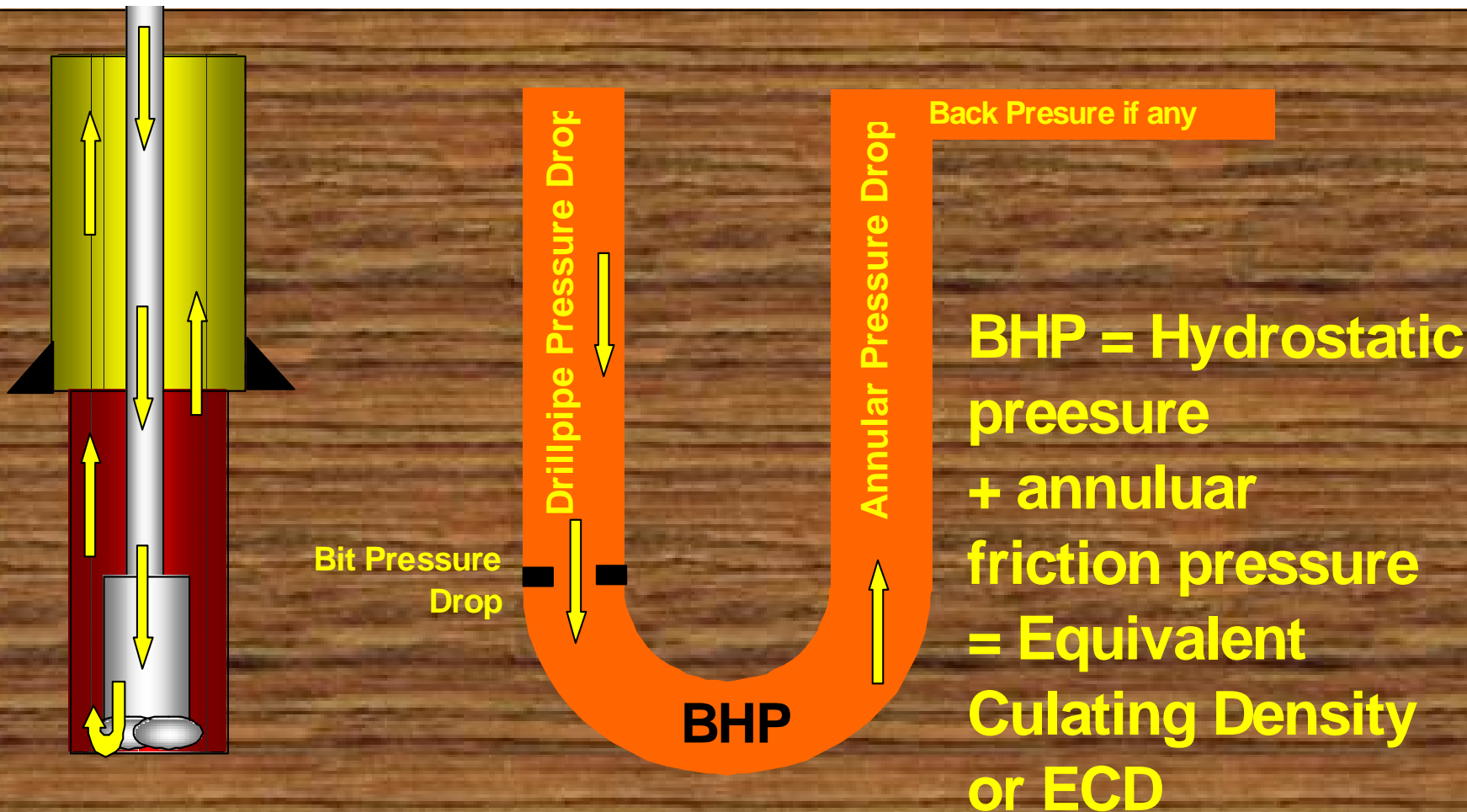
- ***Drilling Methods***
 - Mud Cap Drilling – Closed Hole Circulating Density (CHCD)
 - Continuous Circulation
 - Managed Pressure Drilling (MPD)

The Future.....

- ***The Big Window Problem***
 - How to Keep Bottom Hole Pressure (BHP) in between
 - Pore Pressure
 - Frac Pressure
 - All usually described by pressure gradient
 - Pressure/Depth (usually PPG or SG)

The Future.....

- ***Bottomhole Pressure***
 - BHP used to be controlled solely by the density of the mud and depth
 - $BHP = \text{Constant} \times \text{Mud Density} \times \text{Depth (TVD)}$
 - BHP can also be increased by adding surface pressure

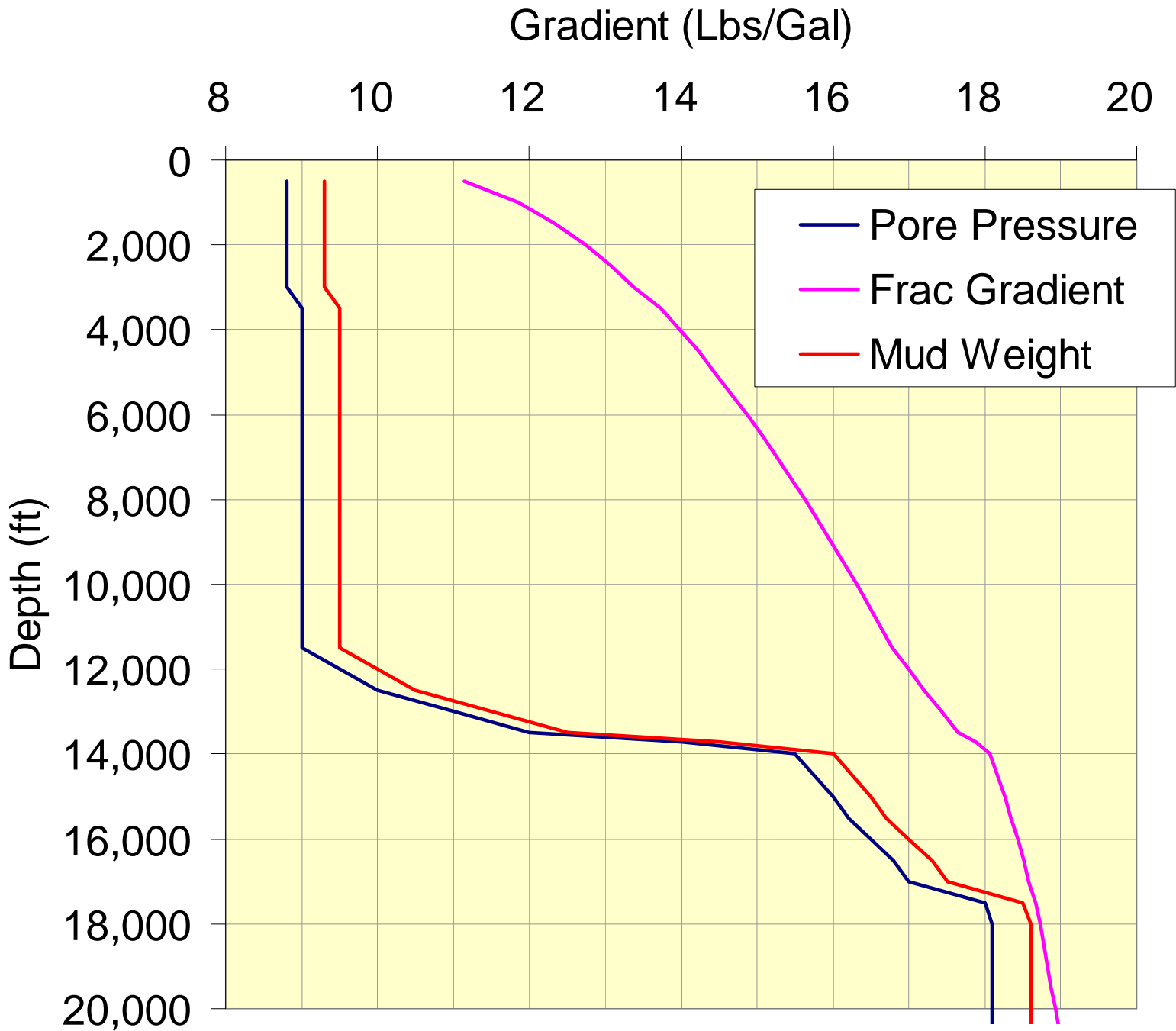


The Future.....

- ***Pore or Formation Pressure***
 - Pressure at which the fluid in the pore space exists
 - If Pore Pres > Bottom Hole Pres the well will flow

The Future.....

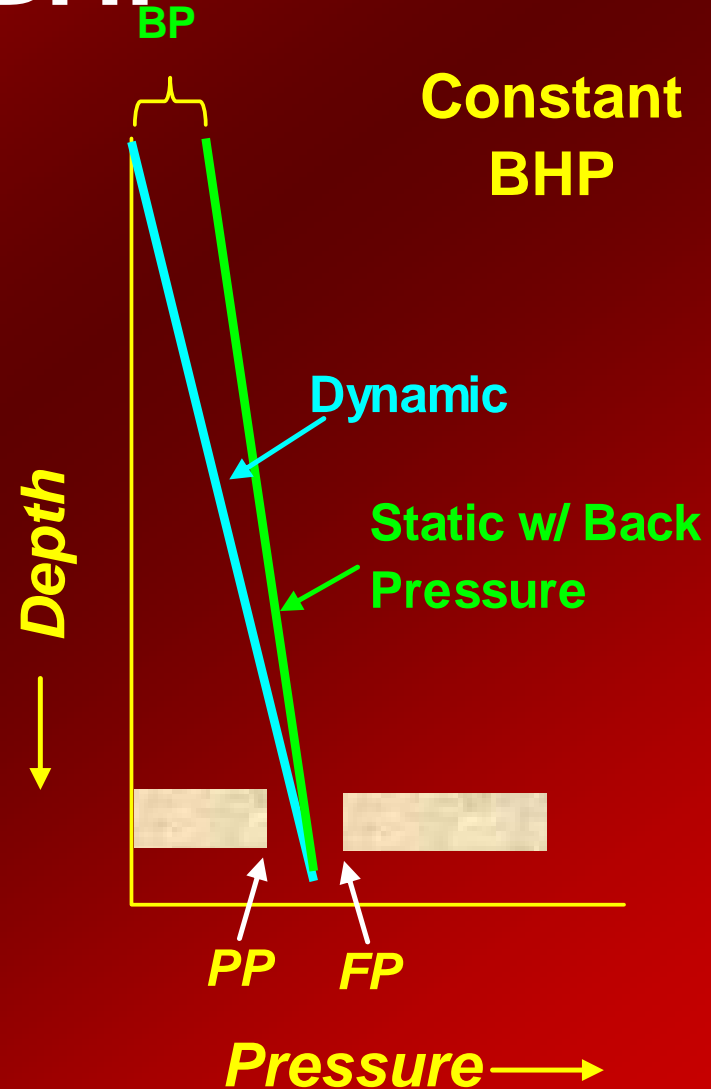
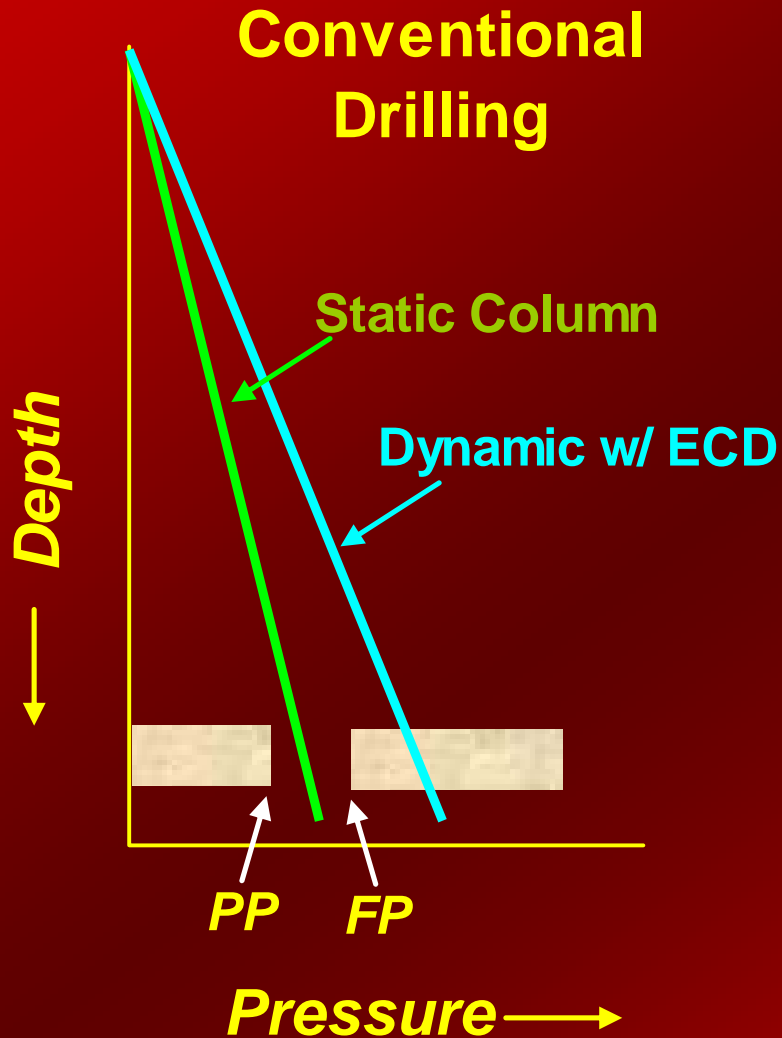
- ***Frac Pressure or Gradient***
 - Pressure at which the rock physically splits open and will accept wellbore fluids
 - Frac strength (pressure) determined by
 - Mechanical strength of rock
 - Overburden Weight (pressure)
 - Formation Pore Pressure



The Future

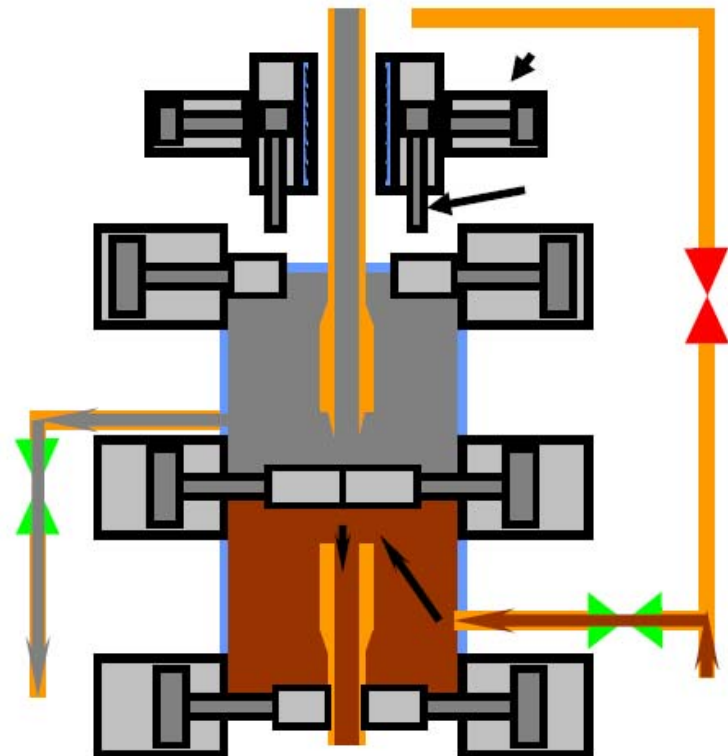
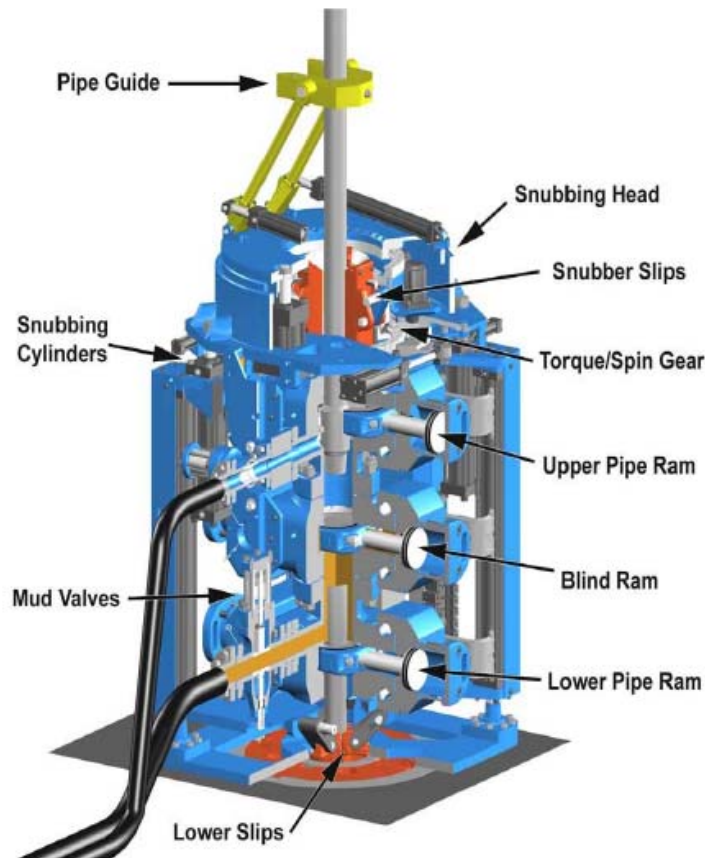
- **Constant Bottom Hole Pressure**
 - Balancing ECD with Choke Backpressure
- **Continuous Circulation**
 - Varco – Maintains Circulation during connection
- **Manage Pressure Drilling**
 - Secure Drill - Measures Mass Flowrate, Density in closed loop system

Constant BHP



What is the CCS?

A system to allow leaving the pumps on and maintaining continuous down hole circulation while making connections with jointed pipe.

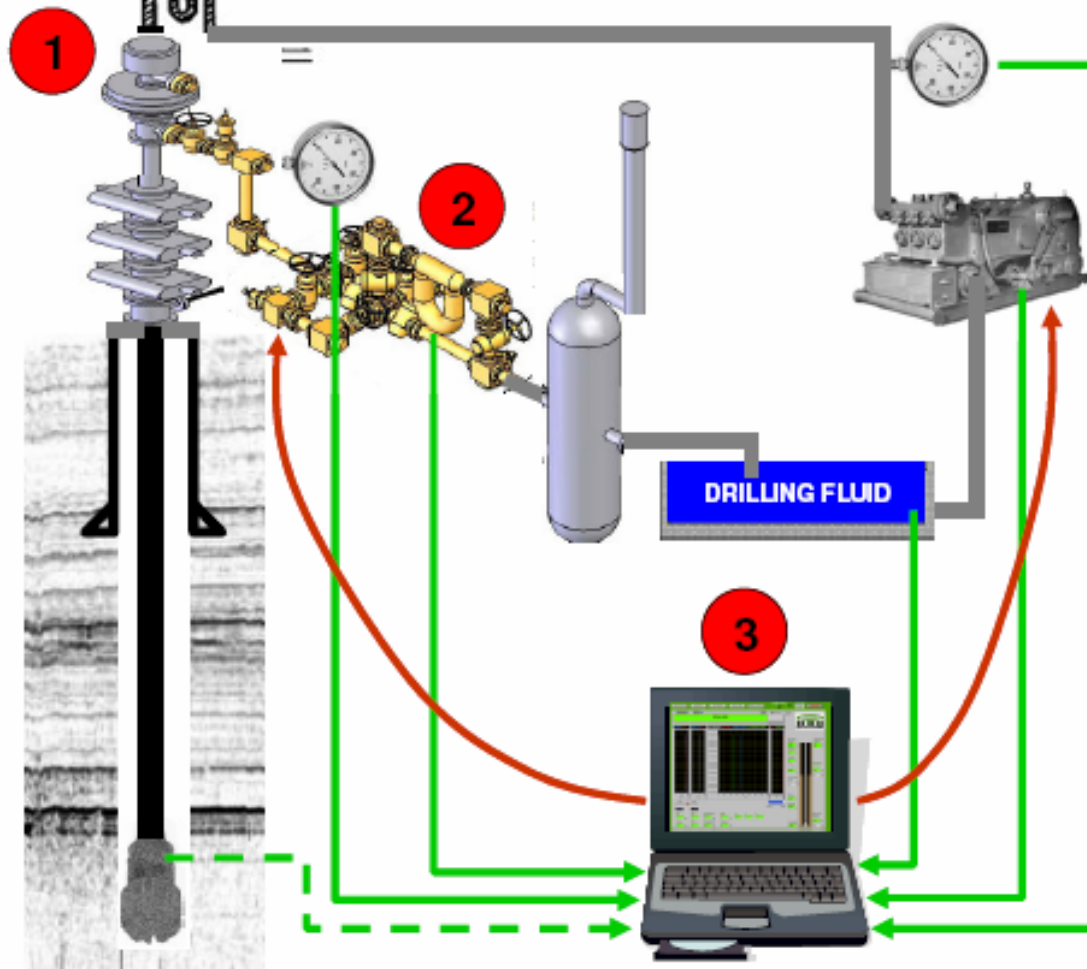


Manage Pressure Drilling

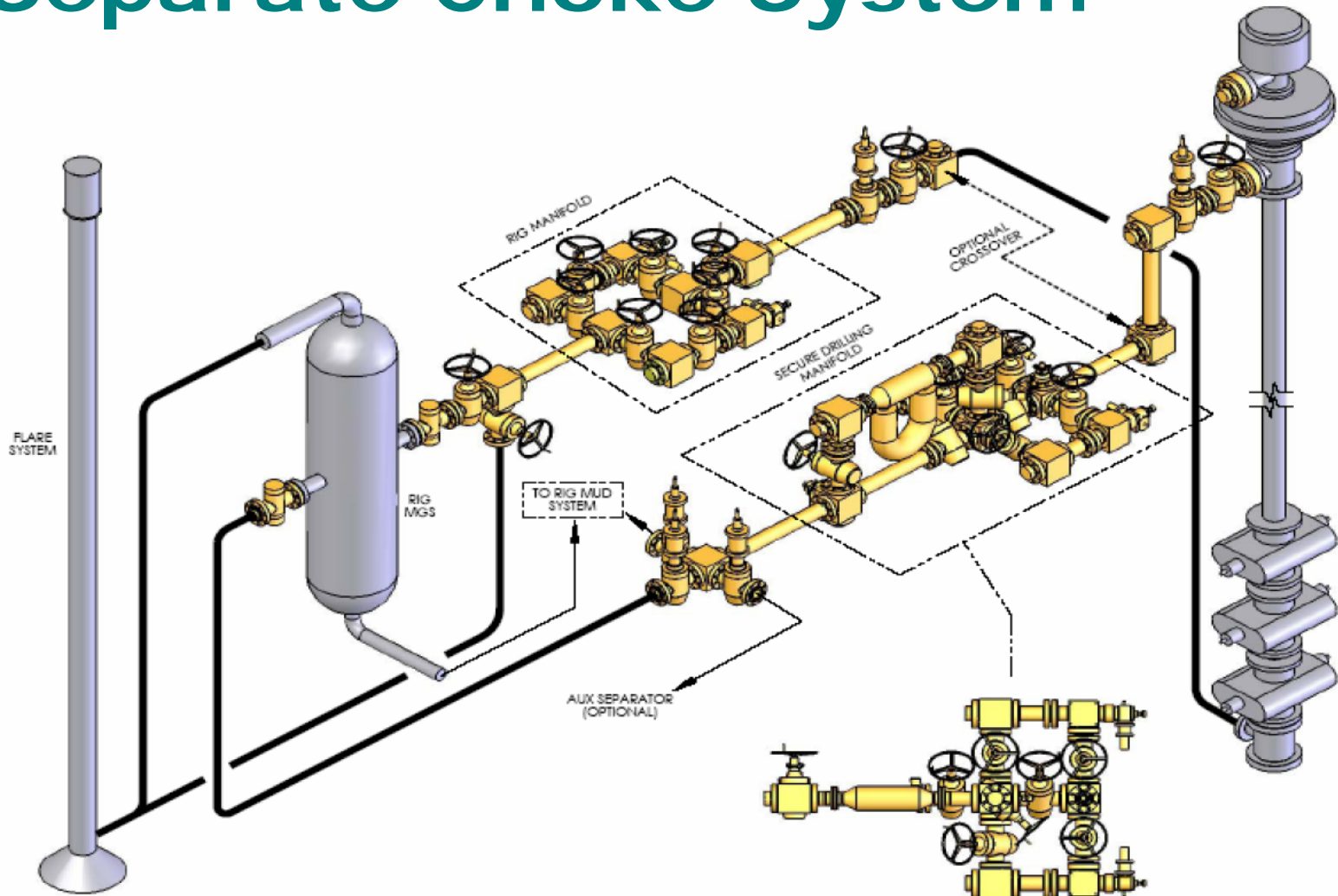
- **Secure Drill**
 - Closed Loop
 - Detect small influx: < 1 bbl
 - Detect small losses: $< \frac{1}{2}$ bbl
 - Detect Ballooning formations
 - Can be used on Floaters to eliminate heave gain

Simple Rig Upgrade for Secure Drilling™

1. Rotating Control Device
2. Compact and Integrated Secure Manifold
 - a. Two drilling chokes
 - b. Mass flow meter
 - c. Electronic and choke controls
 - d. Data acquisition
3. Remote Control and Display



Separate Choke System



Where do we go from here....

- Deeper Water Needs....and how deep will we go
- + 10,000 ft water depth
- > 30,000 ft TD
 - High Pressure Risers
 - Weight, Strength, Cost
 - Subsea Pumps

Questions?

And Thank You