Distinguished Lecturer Program

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Distinguished Lecturer Program

Managed Pressure Drilling:

Drill the Un-Drillable

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Presentation Outlines

- Reservoir Engineering & Advanced Drilling Technology
- Advanced Drilling Technology Variations
- What is Managed Pressure Drilling?
- Optimal Redefined Time/Cost line
- Variables that can be Manipulated during MPD
- What Are the Main MPD Benefits?
- Managed Pressure Drilling Variations.
- Health, Safety and Environment Issues
- Case Histories obtained worldwide.
- Conclusions
- Acknowledgement

Advanced Drilling Technology® (ADT®) & **Reservoir Benefits**

How ADT® can increase reserves and improve recovery

- ✓ **Minimizes Formation Damage - UBD.**
- ✓ **Accesses Challenging Reservoirs - MPD.**
- ✓ **Improves Reservoir Characterization - UBD**
- ✓ **Identifies Missed Pay – UBD.**
- ✓ **Increases Production & Enhances Recovery - UBD / MPD**

How Managed Pressure Drilling – MPD Benefits the Reservoir?

By: Accessing Challenging Reservoirs

The single biggest reserve contribution of MPD is found to be access to reservoirs that could not be drilled conventionally.

In almost all cases, MPD is used in challenging or partially depleted reservoirs, only after conventional wells prove expensive, unsuccessful or un-drillable

Some reservoirs that could be difficult to access using conventional drilling techniques are:

1. Low pressure & depleted reservoirs
2. Vuggy/fractured carbonates where OB circulation is impossible
3. Reservoirs with a narrow margin between fracture pressure and pore pressure - kicks/losses cycles

Advanced Drilling Technology® (ADT®)

ADT® is an adaptive drilling process which enables a more precise control of wellbore pressures through the use of engineered equipment & processes.

ADT® Variations

Air Drilling

Improve Drilling Economics - *Intent is to invite surface flow*
Primarily non-liquid hydrocarbon formations

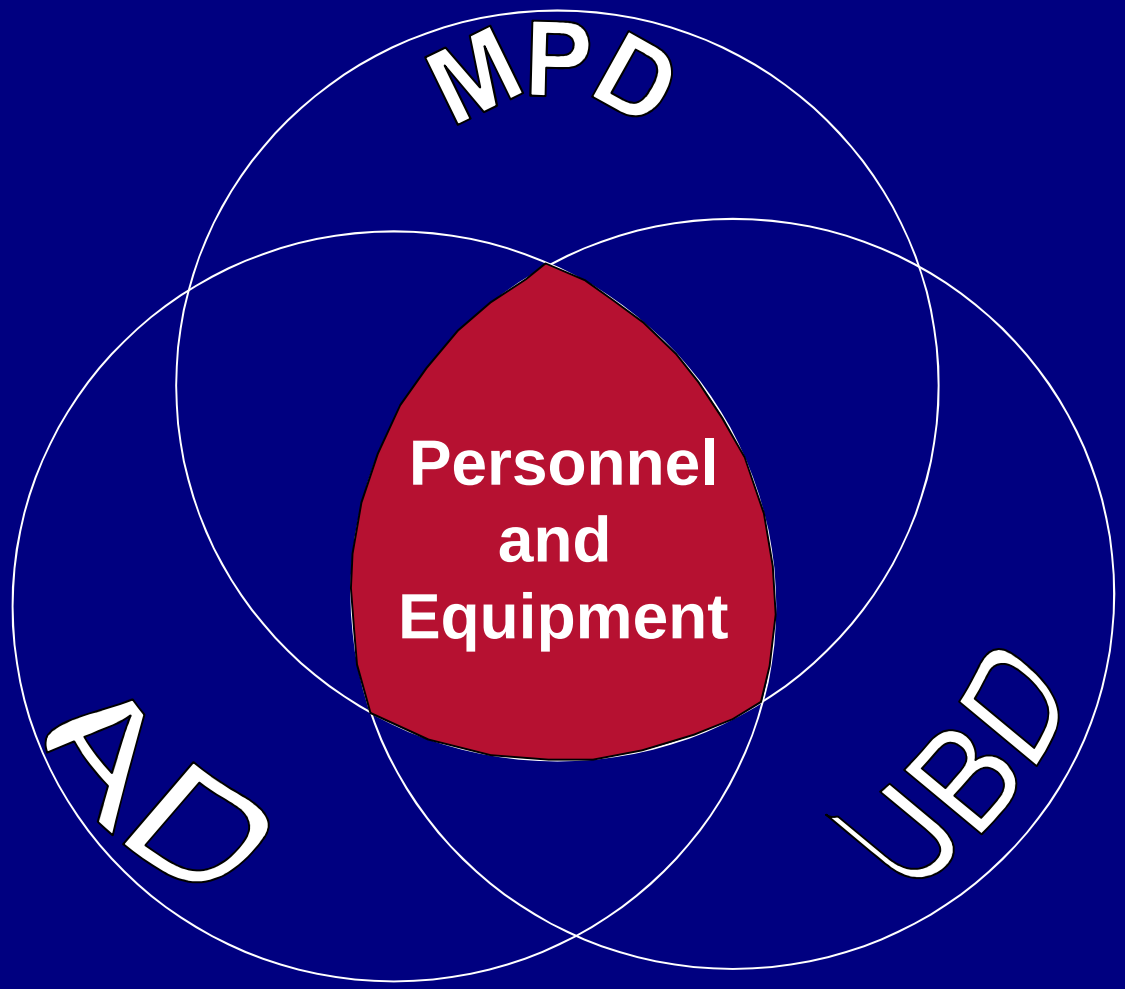
Underbalanced Drilling:

Maximize Reservoir Value - *Intent is to invite surface flow*

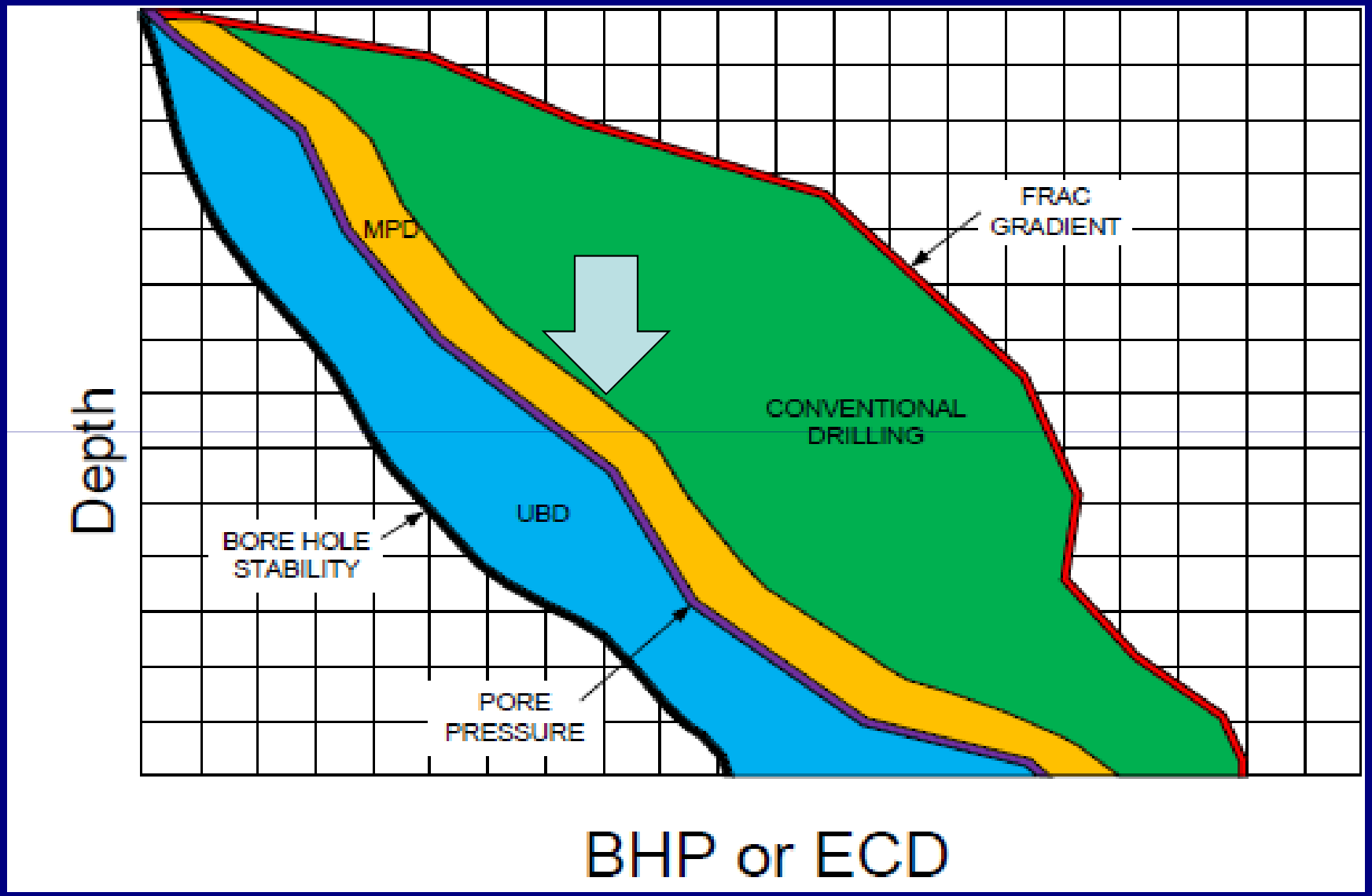
Managed Pressure Drilling:

Optimize Drilling Process **-** *Intent is not to invite surface flow*

What is common in ADT Variations?



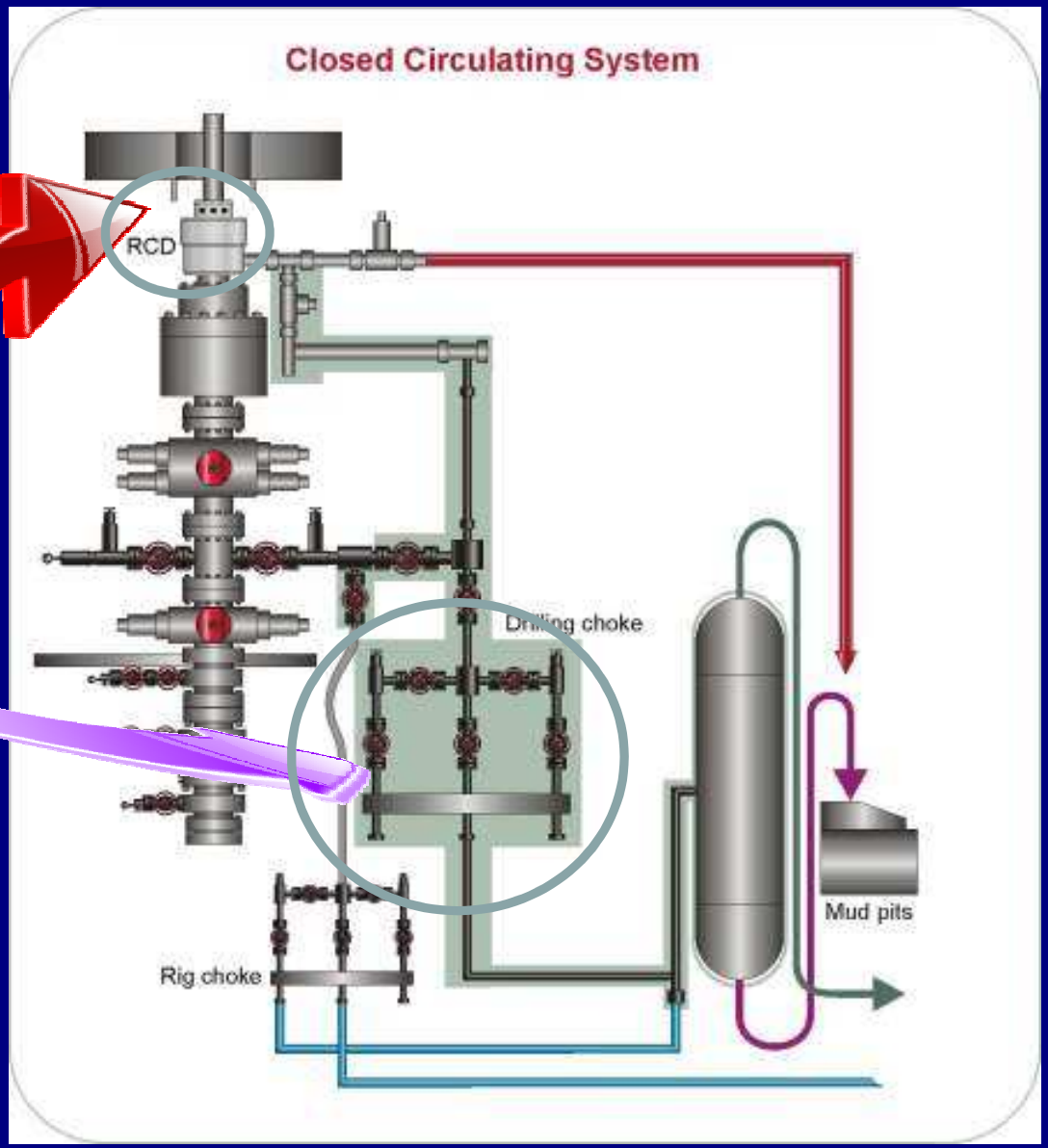
UBD , MPD & Conventional



What is Managed Pressure Drilling?

A closed and pressurizable mud-return system, a **Rotating Control Head**, and **choke.**

operations provide precise control of the wellbore pressure profile.



Reactive vs Proactive MPD

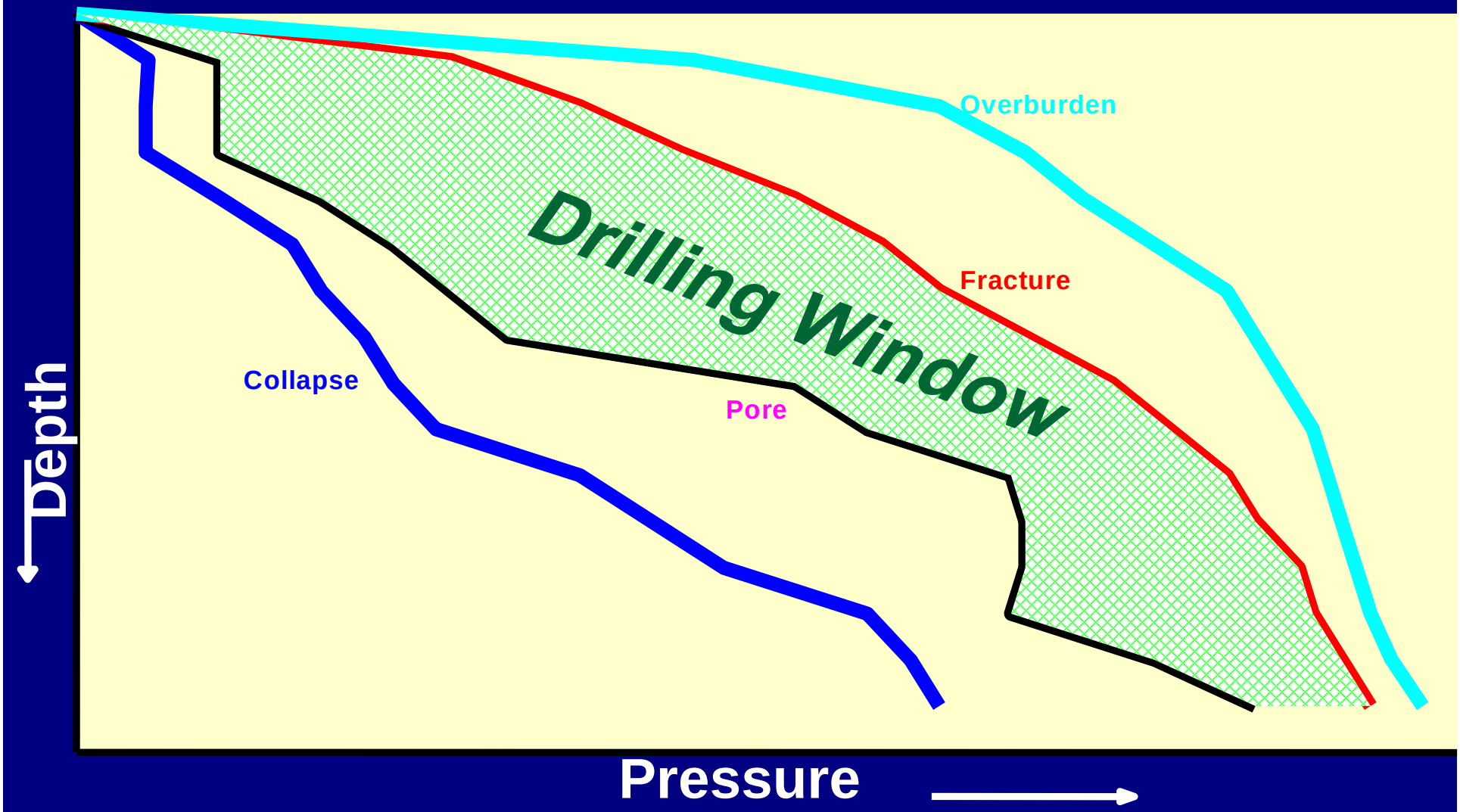
Reactive

Effective on “standby” basis as an enhanced form of passive well control to help manage unexpected downhole pressure.

Proactive

Used to mitigate drilling hazards and reduce NPT by changes to fluid, casing and open-hole programs

We like prospects with big drilling windows…

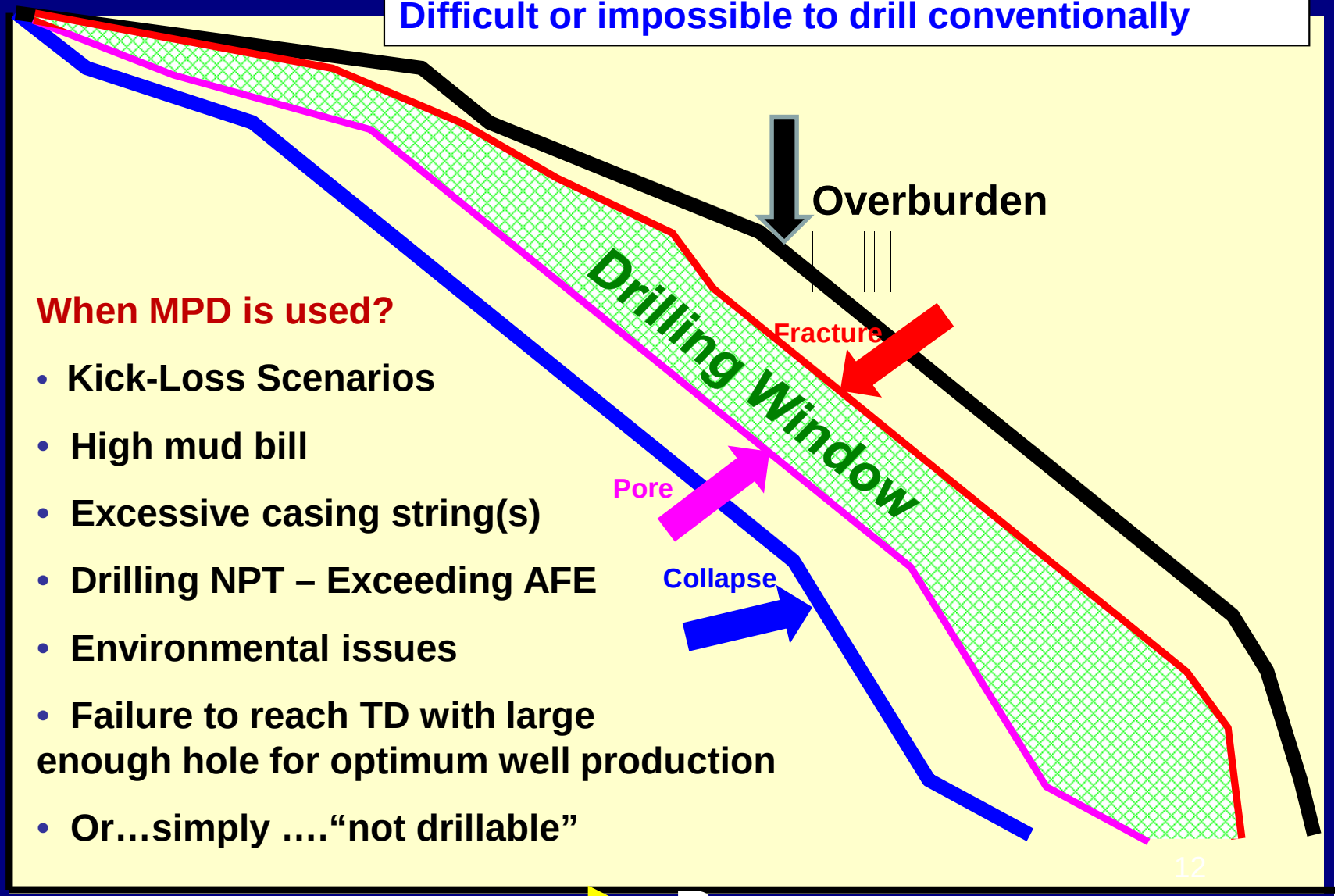


EMW Must Stay Within Drilling Window For Drilling To Progress

Remaining prospects not cooperating very well

Very narrow or relatively un-known margins

Difficult or impossible to drill conventionally



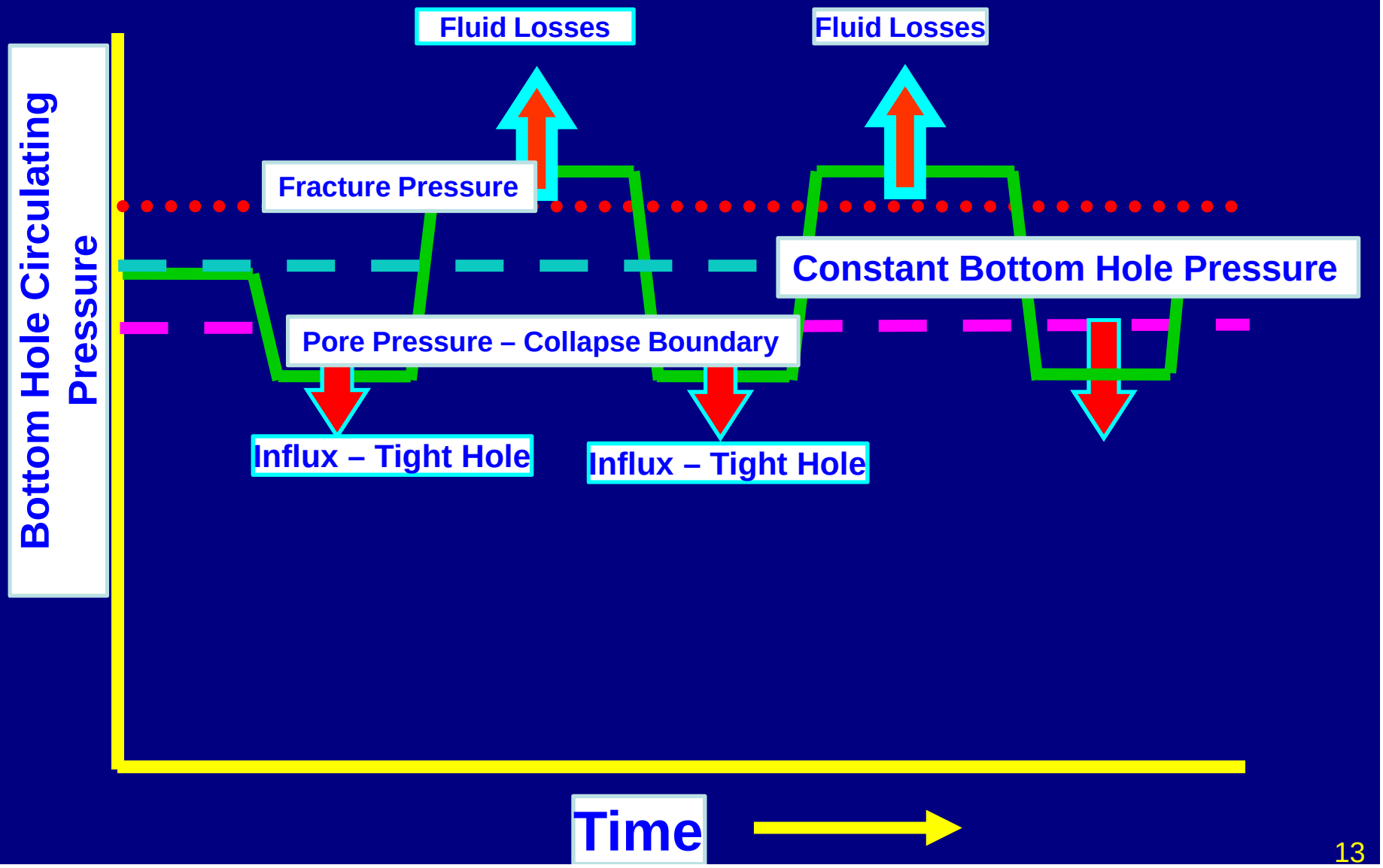
When MPD is used?

- **Kick-Loss Scenarios**
- **High mud bill**
- **Excessive casing string(s)**
- **Drilling NPT – Exceeding AFE**
- **Environmental issues**
- **Failure to reach TD with large enough hole for optimum well production**
- **Or…simply ….“not drillable”**

Depth

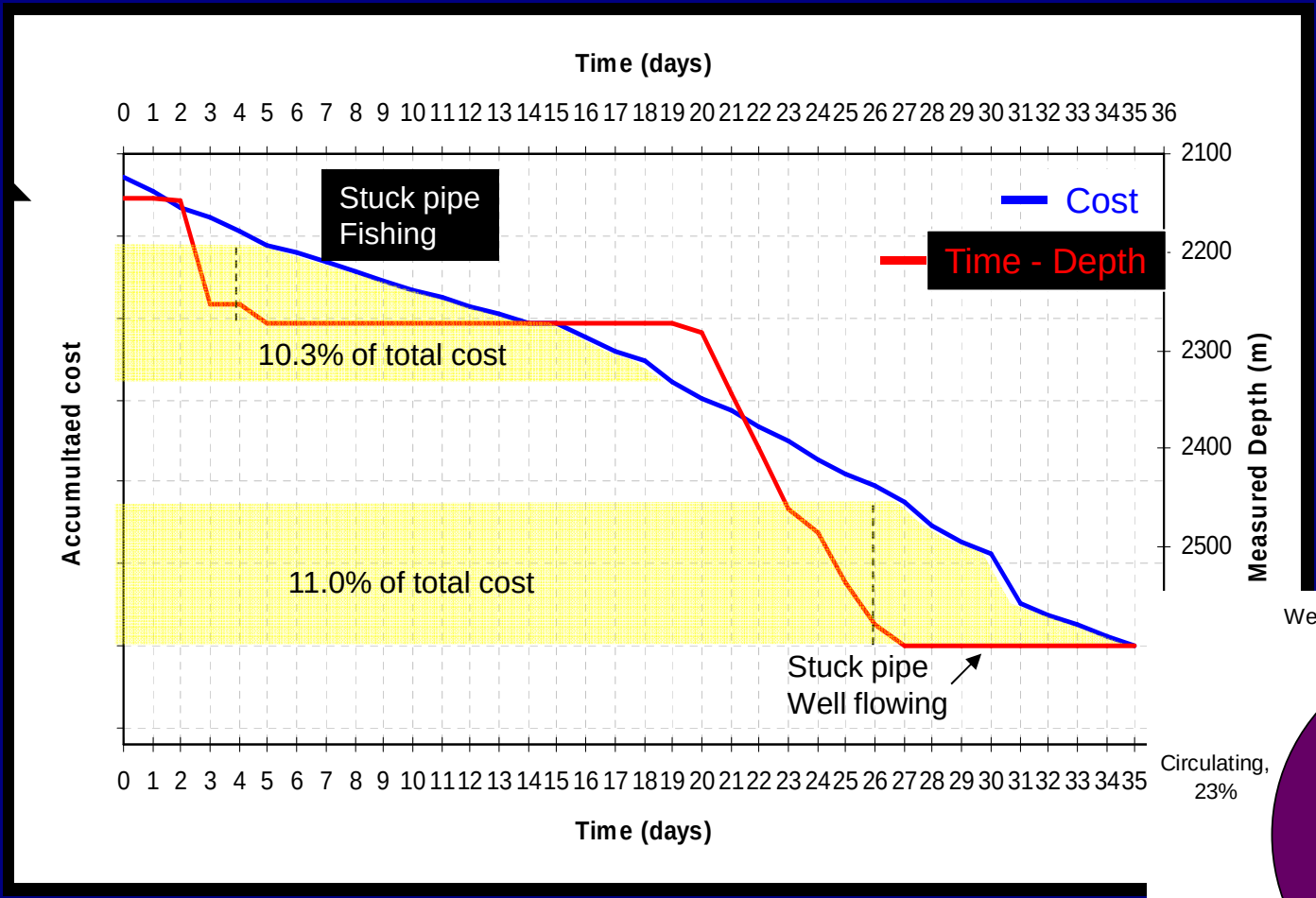
Pressure

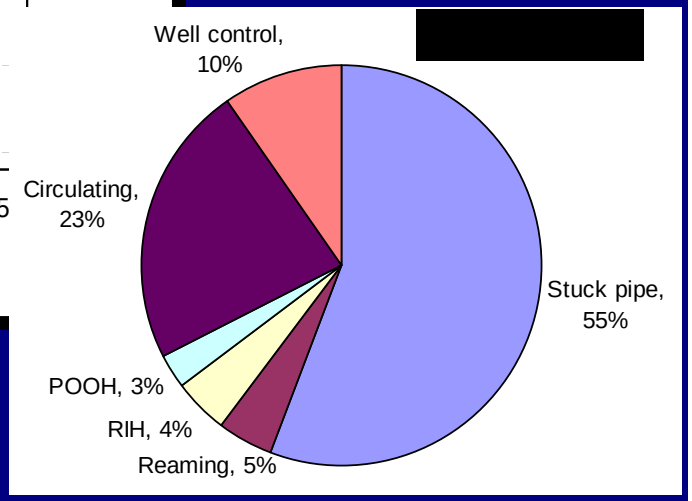
Small Drilling "Window"



MPD VALUE - VISUALIZATION

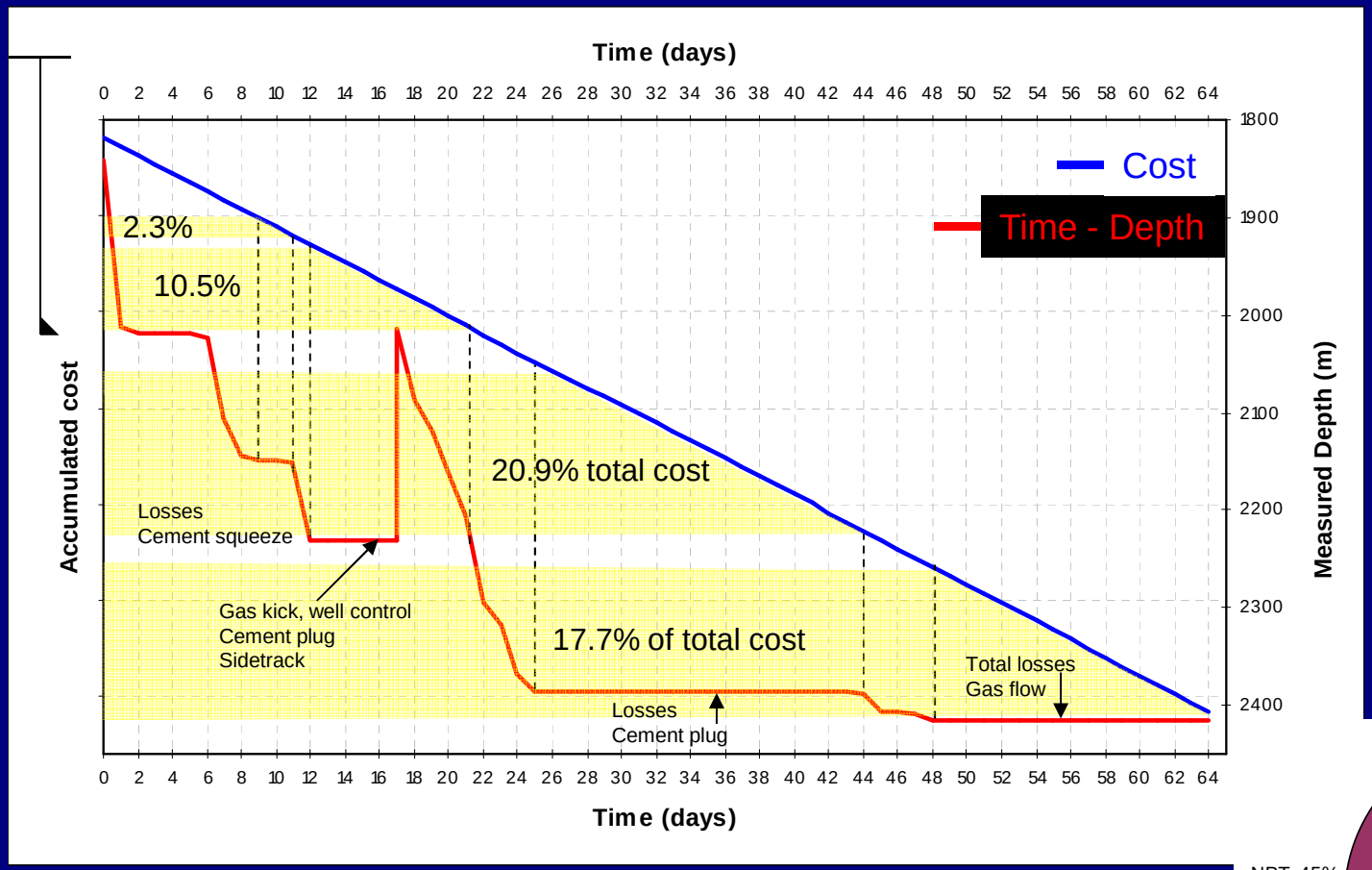
Real Well – Case 1

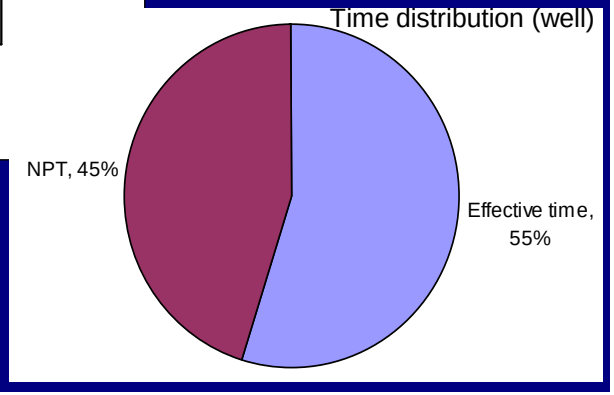




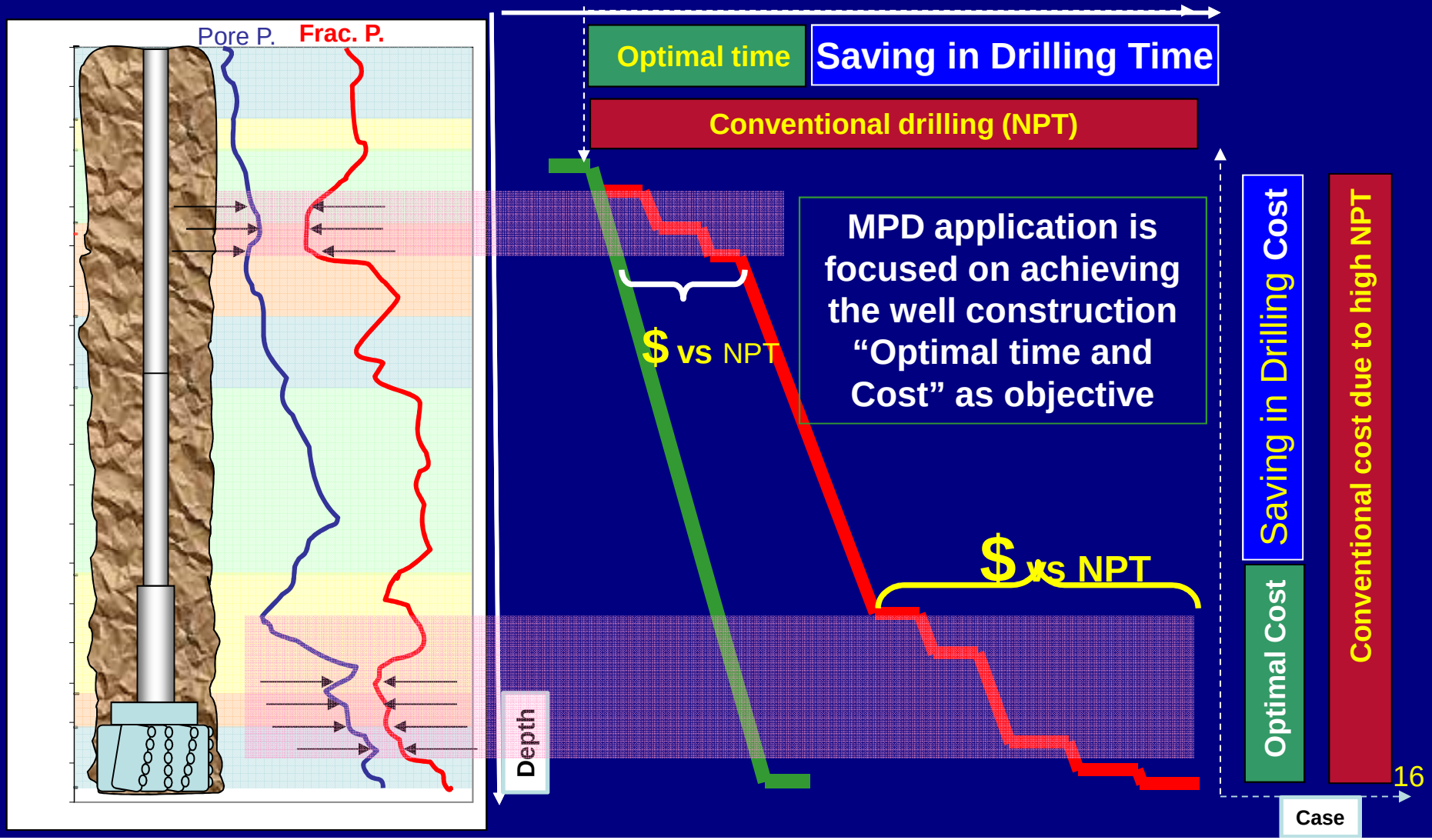
MPD VALUE - VISUALIZATION

Real Well – Case 2





Optimal Redefined Time/Cost line



Conventional Drilling

Bottom hole circulating pressure is manipulated by only two variables.

$$BHCP_{conventional} = \text{Hydrostatic Pressure}$$

Affected by Density

$$+ \Delta P_{friction}$$

Affected by density and flow rate

Managed Pressure Drilling

.

$BHCP_{MPD}$ = Hydrostatic Pressure

Affected by density

+ $\Delta p_{friction}$

Affected by density and flow rate

+ Choke

Manipulated from surface

Variables that can be Manipulated

Variable	Equipment
Mud density	Rotating Control Head
Mud viscosity	Choke Manifold
Flow rate	Mud pumps
Trapped Pressure	Downhole pump
Friction Pressure	

In what cases can MPD add value?

Drill to the target

- Drilling Exploratory, Appraisal or Challenging Development wells

- Drill conventionally "Un-drillable" tight Pore /Collapse /Fracture pressure gradients

- Drill "Un-drillable" vuggy/ fractured carbonates where Over Balanced circulation is impossible

What Are MPD Benefits?

Cost Saving

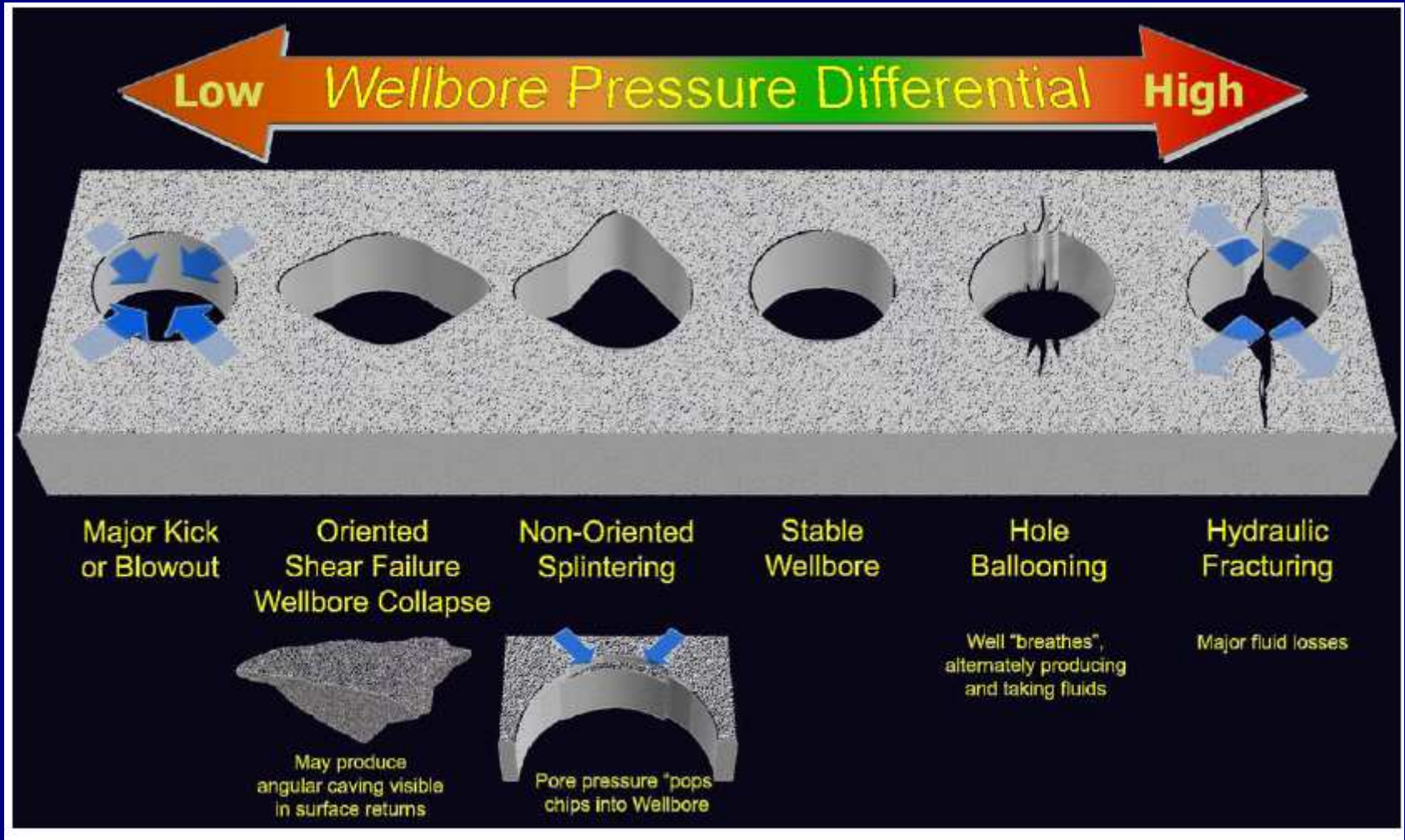
- Reduced number of loss/kick occurrences
- Reduced time spent dealing with well control events
- Earlier kick / losses detection
- Optimized number of casing strings

Improved Safety

- Trip safely
- Remove H_2S hazard from rig floor
- Drill HPHT wells safely

MPD – Added Drilling Performance Value

Geo-mechanical Issues



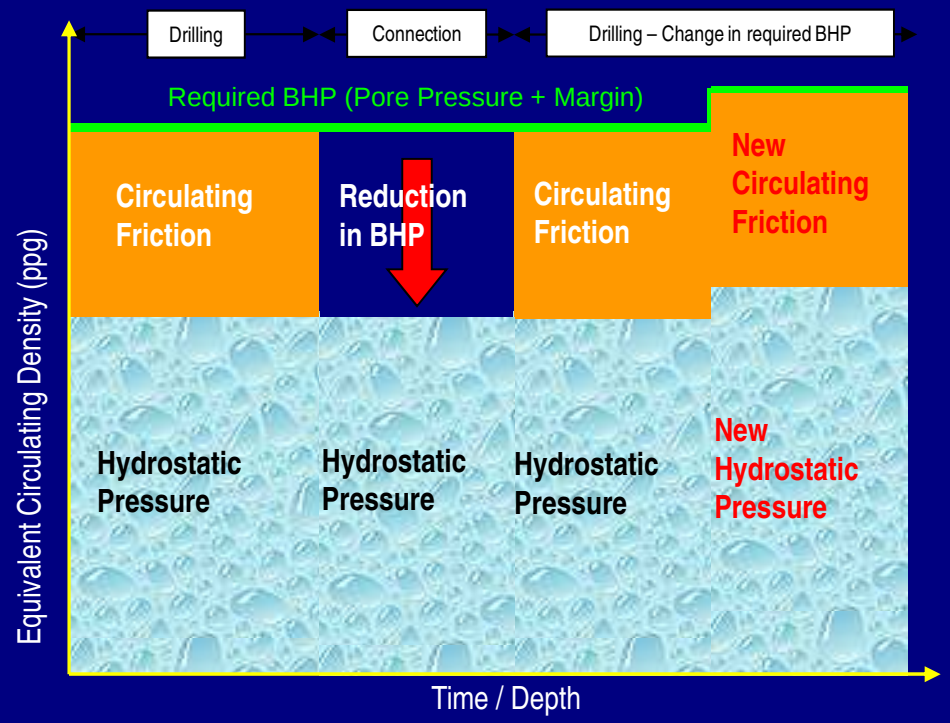
MPD Variations – Visualization

MPD

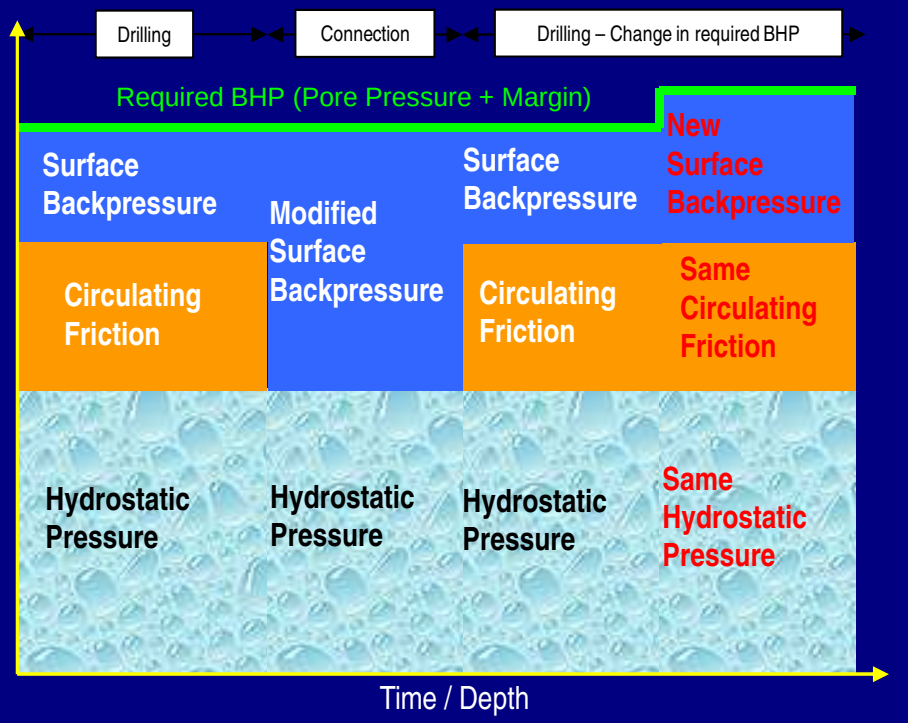
- Returns-flow-control (HSE)
- Constant Bottom Hole Pressure (CBHP)
- Pressurized mud-cap drilling
- Dual gradient MPD

MPD Official Definition

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. MPD is intended to avoid continuous influx of formation fluids to the surface. Any influx incidental to the operation will be safely contained using an appropriate process.



Conventional Drilling Practices



Managed Pressure Drilling

Risk Management

With all MPD operations a detailed risk assessment as well as a HAZID and HAZOP should be carried out with the rig crew supervisors and the relevant service providers and operator staff.

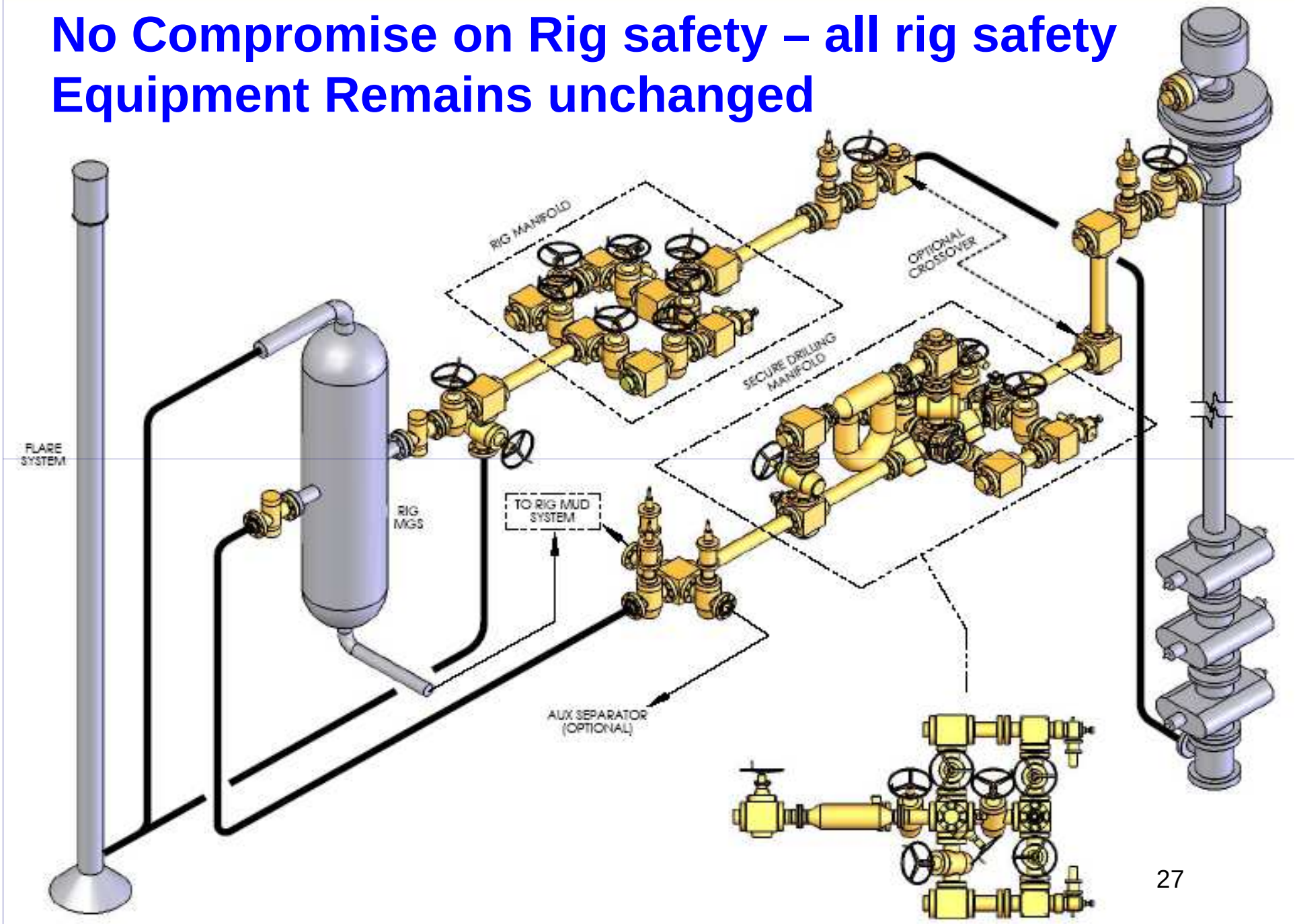
Understanding the sequence of events and when to initiate MPD operations and discussing the rig up, pressure testing and operational aspects of a job together with all of the procedures will help to ensure the maximum success for an MPD operation.

Health, Safety and Environment Issues

- **HAZOPs and HAZIDs are both systematic processes to identify hazards.**

- ***"You cannot manage what you don't know."***

No Compromise on Rig safety – all rig safety Equipment Remains unchanged



Case History 1 – Middle East

Objectives

- To reach the target depth with minimum NPT
- To avoid uncontrolled event by maintaining a constant bottom hole pressure

8 3/8" Section Performance	Offset Well	MPD Well
Total days spent on drilling the section	65	40
Total days spent on well control events (NPT)	7.6	1.1
Total days spent on tight hole/reaming	2.8 days	19 hours

Saudi Arabia (Onshore)

Case History 2 – North Africa

Algeria – drilling through high fractured zone

Un-drillable Reservoir Drilled

A total of 191 m were drilled with a very small drilling window.

Zero LTI's or near misses recorded on this well.

Avoided kick/loss cycles & Improved ROP.

Case History 3: Offshore India

MPD Added Value

NPT reduced to 1 day compared to 10 days experienced in the three previous wells drilled.

LOC & Fluid losses minimized to 290 BBL compared to 4000 BBL on previous wells.

Avoided kick/loss cycles & Improved ROP.

Case History 4 – South America

Petrobras Colombia Limited,

MPD Added Value

- **No Loss of Circulation**
- **significant cost savings**

Case History 5 – Canada

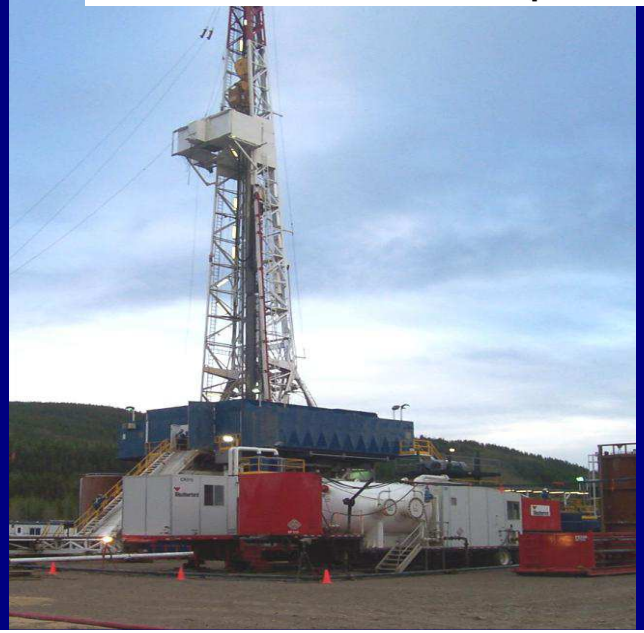
Northeastern British Columbia,

<u>MPD Added Value</u>

Reduced AFE by approximately 19% **(saving Can$ 2 Million).**

Drilling efficiency was improved by lowering the mud weight and doubling the ROP .

Considered MPD techniques to increase drilling effectiveness in this field.



MPD application in Vietnam

BIEN DONG POC HPHT Gas Condensate Development
BLOCK 05-2 & 05-3 Offshore -Vietnam

Why MPD on this project?

✓Narrow margin of PP/FG pressure in both fields.

✓Early kick detection & control.

✓Better well control in HPHT wells.

✓Drill wells to target depth and eliminate additional casing string.

✓Providing CBHP during static and dynamic conditions which mitigates stress caging (SC).

Project Overview

Phase-1: total sixteen (16) wells:

- 6 wells in block 05-3 (Moc Tinh)
- 10 wells in block 05-2 (Hai Thach)

Contract status: singed for 4.5 years + potential extension.

Conclusions

The challenging hydraulics of the world's remaining prospects indicate MPD will evolve to become a key enabling technology.

Managed Pressure Drilling technology is increasingly being applied in reservoirs that are difficult to drill conventionally (Un-drillable), deep water and High Pressure, High Temperature (HPHT) wells to access HC reserves, enhance operational safety and efficiency.

All "first adopters" of MPD offshore plan future wells.

Conclusions (cont'd)

Managed Pressure Drilling can reduce well costs as a result of;

- Reduced number of casings = Smaller casings = smaller rig
- Less consumables (mud and cement)
- Less materials and logistics cost

Additional Benefits of MPD:

- Faster drilling
- Reduced formation damage
- Improved productivity = improved recovery
- Reduced environmental impact

Wrap-Up

Proper candidate screening is a deliberate process, and is a critical step in the design of a successful ADT operation.

Detailed economic analysis is an important step to determine the benefit that MPD could provide compared to competing conventional drilling & completion technologies.

Poor screening and planning results in an over-enthusiastic misapplication of the technology, and possibly failure.

Proper Project management, engineering and execution is a key factor for a successful MPD operation.

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