UNDERBALANCED DRILLING (UBD)

- A CASE STUDY IN INDIAN OFFSHORE
AGENDA

- Drivers for UBD Technology
- Introduction to UBD Pilot Project in India
- UBD Design and Process Flow Diagram
- UBD Project Highlights
- Recommendation's for Technology Implementation
- Why Halliburton
- Question and Answer
Underbalance Drilling Technology

Drivers for UBD

Drilling Improvement

- Reduce mud losses
- Improve ROP
- Eliminate differential sticking

Production Improvement

- Access residual reserves in mature fields
- Minimise Formation Damage
- Early Production Recovery (while drilling)
- Reduce well cleanup time
- Increase production rates

Reservoir Characterization

- Testing While Drilling
Introduction to UBD Pilot Project

- **Project**: 6 Wells Pilot Project at ONGC Western Offshore
- **Scope of Work**: To Drill & Complete 6” Drain-holes Underbalanced
- **Fields/Wells**: 3 Wells on Heera Field & 3 Wells on Mumbai High Field
- **Basis Of Design**: Technical Feasibility & FEED
  - Well/Platform Selection, Rig Selection And Survey
  - Equipment, Requisite Chemicals And Personnel As Defined In SOW
  - Base Oil as Primary Drilling Fluid (Through Drill String)
  - Concentric Casing Gas Injection (N2) Method - 7” Tieback To Surface
Project Execution Timeline

RigUp / Interwell / RigDown Days
UBD
Simplified Flow Schematic
Concentric Casing N2 Injection Methodology
It is critical that 7” liner is landed inside target carbonate layer to case off overlying shale & avoid borehole instability during UBD (HK#6H & N22#8H).

Consider geomechanical study to assess and predict borehole stability risk:

- inadvertently drilling into overlying or underlying shales
- Encountering pinch-out/lateral stratigraphic changes
- Intentionally cutting through several carbonate/shale layers to optimize layer drainage

It may be possible in some cases to utilize Managed Pressure Drilling (MPD) techniques to exceed shale collapse pressure while staying below fracture gradient.

- MPD & UBD Technologies use similar equipment and can be complementary.
UBD PROJECT HIGHLIGHTS

- First UBD project in India by any Operator.

- Vast scale of the project covering FEED, Engineering/Modelling, HAZID-HAZOP, Project Planning and Execution.

- One of the biggest setup ever used in UBD covering 4 Phase Separation System, Nitrogen Membrane Injection through Concentric Casing, HT-400 Pump, Tank Farms, Solid Waste Management, Push Pull Machine and Lower Completions using FIV.

- No HSE or SQ incident during entire preparation and execution phase.
UBD PROJECT HIGHLIGHTS

- **Drain Holes length** in the range of 190m-250m drilled in underbalanced condition in 3 Wells of Heera Field and 2 Wells of Mumbai High field.

- **Total Operating time** for Drilling Five Drain hole sections and running Lower Completion: 43 days.

- Average **ECD maintained between 3.8 and 4.5** for UB Drilling and Completions.

- Able to **identify water ingress real time** and thus place the well.

- **Consistence and Sustainable incremental Production** as per latest update.
Recommendations for Technology Implementation

- Dedicated UBD Rig – Offshore
  - Reduce multiple Rig Up/Rig Down Time
  - One time modifications required, if any
- Turnkey Project model comprising:
  - Fluids Management
  - Downhole Tools for Reservoir steering and Evaluation
  - Bits Selection
- Long Term Contracts for Onshore Economic feasibility
Recommendations for Technology Implementation on Pilot Basis

- Implement UBD in Onshore assets – Use Trailer Mounted Package
- Implement Managed Pressure Drilling (MPD) in wells with Loss/Gain Scenarios.
- Implement Pressurized Mud Cap Drilling (PMCD) in Exploration wells with severe Loss scenarios.
- $$$ Savings in terms of:
  - High Cost Drilling Mud - eliminating Mud Losses
  - High Day Rate of Drilling Rigs - reduce the Non-Productive Time
  - Complete the wells in all scenarios.
  - Smaller setup required for MPD/PMCD required
# Job History for Optimized Pressure Drilling Services

## GEOBALANCE - Testing & Sub Sea

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<thead>
<tr>
<th>Technique</th>
<th>No. Wells</th>
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<tbody>
<tr>
<td>MPD</td>
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<tr>
<td>UBD</td>
<td>175</td>
<td>13%</td>
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<tr>
<td>PMCD</td>
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<tr>
<td>COMBINED TECHNIQUES</td>
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<tr>
<td>N2</td>
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<td>RCD?</td>
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## Onshore/Offshore

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<tr>
<td>Offshore</td>
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<td>Other (i.e. manmade island)</td>
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## Region

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<th>HPHT % **</th>
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<td>23%</td>
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</tr>
</tbody>
</table>

* % Based on all wells drilled Globally

** % Based on all wells drilled in each Region
THANK YOU