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Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl
Drilling Vibration Management

Lecturer’s Name: Alan Clarke, SPE
Company Name: National Oilwell Varco,
Director of Advanced Drilling Solutions
Agenda

• Impact on our Industry
• Overview of Drilling Dysfunctions
• Vibration 101
• Industry solutions
• What about my rig?
• Vibration Event, and Solution
• Conclusion
Industry Impact

Distribution of Causes for Major Dull Conditions

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Vibration</th>
<th>Hydraulics</th>
<th>Structural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>71.1%</td>
<td>25.3%</td>
<td>7.2%</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

**Vibration Related**

- Normal
- Vibration
- Hydraulics
- Structural

25.3%
Industry Impact
Industry Impact
Drilling Dysfunctions

Categories

• On bottom events
• Tagging bottom procedures
• Reaming activity
• Directional impact
• Hole quality
On and Off Bottom Drilling Dysfunctions

On Bottom Vibration increase

Impact damage. Increased vibration during connection
### Reaming Activity & Directional Impact

**Torque Spike**

**Bit Torsional / Lateral**

Picked Up Slightly

Periodic
Hole Quality

Animation is based on actual downhole data.

* Used with permission from National Oilwell Varco
Drilling Dysfunctions

Why do we care?

• Safety
• Failed tools
• Poor performance
• High costs
• Learning
Vibration 101

Primary modes
- Lateral
- Axial
- Torsional

Mode Coupling
- Combined motion of 2 or more primary modes
Vibration 101

Animation is based on actual downhole data.

* Used with permission from National Oilwell Varco

* Used with permission from Schlumberger
Industry Solutions

Predictive harmonic bottom hole assembly modeling
<table>
<thead>
<tr>
<th>Run 3 Formation Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOB (klbf)</td>
</tr>
<tr>
<td>Full Run 3</td>
</tr>
<tr>
<td>Oligocene</td>
</tr>
<tr>
<td>Eocene</td>
</tr>
<tr>
<td>Paleocene</td>
</tr>
<tr>
<td>Maastrichtian</td>
</tr>
</tbody>
</table>

**Industry Solutions**
What About My Rig?

Room for Improvement

- Gather data
- Overview
- Look for specifics
- Solve for the easiest
- Test the solution
- Keep learning
Vibration Event and Solution

Increase energy available to the drillstring
Conclusion

Why was ROP so poor?

High Coupled Vibration is driver for ROP loss

Formation effect for Lateral Vibration

Torsional Vibration coupled to Lat Vibration

WOB dependency evident

Poor bit selection?

Surface parameters must vary per vibration zone
Acknowledgements

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• National Oilwell Varco
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Alan Clarke, Director of Advanced Drilling Solutions, National Oilwell Varco