Supporting Rig Site Operations with Real-Time Monitoring

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Primary control of our drilling and well activity is at the well site. The responsibility for drilling operations always stays on the rig. Real-time monitoring is one of many tools that support drilling operations. The DSC leverages technology and provides additional resources to collaborate on wells Chevron classifies as complex.
Decision Support Center
2014 Deployment Snapshot

- 28 rigs currently live data collection
- All ~15 Chevron Complex Wells examined daily
- 9 rigs Decision Support Center supported
NAS question 1: Parameters that Chevron currently monitors remotely in drilling operations

**Process Collaboration**

Collaborate with Business Units to ensure operations are executed within Basis of Design limits

- Mud Weights
- Hole Depths
- Casing/Liner Shoe Depths
- Casing Test Pressures
- Casing Seat Tests (FIT & LOT)
- Barrier Pressure Tests

**Decision Support**

Provide engineering support by modeling and comparing to real-time data

- Equivalent Circulating Density
- Surge & Swab
- Fluid Displacement
- Leak Off Test Results
- Kick Tolerance *(In Development)*
- Torque & Drag *(In Development)*
- Cementing Operations *(In Development)*
- Well Kill Operations *(In Development)*

**Real-Time Monitoring**

Utilize experienced people to enhance early kick detection

- Trip Volume Schedule
- Connection Flow Back Profiling
- Positive & Possible Kick Indicators:
  - Pit Volumes
  - Flow Out vs. Flow In
  - Gas
  - SPP
  - ROP
  - Erratic torque
  - Temperature
  - Pore Pressure Monitoring
Predictive Software Tools

NAS Question 2: Chevron currently uses automation at the rigsite and is developing conditional alarm tools to remotely monitor real-time Drilling Operations

- ‘Physical’ automation at rig-site is owned by the rig contractor or service provider
  - Focused on automating equipment and reducing personnel exposure
  - Extensive personnel oversight and interaction
- Newer generation rigs have enhanced automation systems that allow better reliability, maintenance and safety systems
  - Chevron works closely with rig owners during the design and construction stages
- Chevron is developing intelligent, multi-parameter alarms for drilling operations
Role of Condition Based Monitoring (CBM)

NAS Question 3: Chevron monitors drilling processes using Subject Matter Experts and clearly defined protocols

- Drilling processes are dynamic
  - Inherently more difficult to monitor than individual pieces of equipment
  - Knowledgeable people and clearly defined protocols are required

- Drilling contractors use CBM for preventative maintenance of their surface equipment

- Operators (including Chevron) have used RTM on-site for decades to monitor dynamic drilling processes:
  - Surface measurements (WOB, RPM, torque, etc.)
  - Downhole tool readings (pressures, temps, orientations, etc.)
  - Geologic sensors (gamma, resistivity, sonic, etc.)
Real-time Monitoring Recommendations

NAS Question 4: Recommendations for BSSE Regarding Real-time Monitoring

- RTM happens today on the rig to support operations and comply with regulations
- Remote RTM is not a panacea or a substitute for competency on rig
- Final operational control should be maintained at the rig site
- Should not be universally required; rather purpose built and business driven
To reduce BSEE field trips if certain operations can be reviewed and monitored remotely:

- Pressure tests, casing setting depths, etc.
- This requires high confidence in rig-site configurations and key sensors
- Technology developments may be required (BOP testing)

Archived data could be available for incident investigations.
## Remote Monitoring Challenges

<table>
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<tr>
<th>Situational Awareness</th>
<th>Transmission Challenges</th>
<th>Data Quality</th>
<th>Stakeholder Engagement</th>
<th>Communications</th>
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<tbody>
<tr>
<td>- Not having the complete picture of rig operations</td>
<td>- Satellite reliability (mobile drilling units)</td>
<td>- Data is received from multiple sources</td>
<td>- Behavioral Change Management</td>
<td>- Language</td>
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<td>- Weather</td>
<td>- Specification requirements are not consistent</td>
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<td>- Message Interpretation</td>
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<td></td>
<td>- Data Languages</td>
<td>- Sensor quality drift and disruption</td>
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<td>- Operating/Escalation Protocols</td>
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<td>- Converting to universal protocol</td>
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**Pilot Period was 27 months and we’re still learning**
Current Uses of Remote Real-Time Monitoring for Production Operations

- Remote RTM is driven by business need and is primarily used for:
  - Production optimization (Well Reliability Optimization, Reservoir Management, Facility Process Optimization)
  - Remote troubleshooting of equipment (rotating equipment monitoring)
  - Enables collaboration with onshore Operations Specialist (Monitoring and Production Reporting only)
  - Used in support of certain operations
  - Not universally applied everywhere

Note: In contrast to dynamic drilling operations, production operations are typically steady state.