Anticollision and Risk Management Offshore Qatar: A Successful Collaboration

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Factors Driving Anticollision Development

- More complex drilling programs
- Densely populated subsurface environments
- Missing or inaccurate legacy data
- High cost of catastrophic failure
Typical Subsurface Environments
The Challenge of Collaboration

No industry-wide anticollision standard

Different standards define risk differently
  – Differ in methods for evaluating/reducing risk
  – Differ in amount of risk deemed acceptable

A hybrid approach requires
  – Careful planning
  – Integration/bridging of methodologies
  – Effective communication
  – Team work
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Operator’s Drilling Environments

- Wells drilled in close proximity
- 20-in conductors, vertical and deviated
- Uncontrolled conductor direction/inclination
- Risk of tophole collisions increased
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Challenges

- Different directional databases
- Different anticollision procedures and error models
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Different databases, software
- Contractor – proprietary software
- Operator – commercial software

Advantage in catching potential errors
- Incorrect survey entered
- Missing survey
- Incorrect sidetrack point
- Incorrect rotary table elevation
- Incorrect survey tool model assigned
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Resolving Differences in Anticollision Standards

- Extensive pre-job planning to identify potential issues
- Established plan to meet both companies’ standards
- Followed both company and operator’s rules for exemptions
- Independent calculations performed throughout execution
- No actions that would pose HSE risks
Key Differences in Calculating Risk

Operator ‘s Minimum Acceptable Clearance (MAC)

- Results are less conservative than company’s OSF
Key Differences in Calculating Risk

MAC = \( E_R + E_O + R_O + R_c \)

Where:

- \( E_R \) = Projection of the Error Ellipse (subject well) on line of closest approach
- \( E_O \) = Projection of the Error Ellipse (offset well) on to the line of closest approach
- \( R_O \) = Bit radius (reference well)
- \( R_c \) = Casing radius (offset well)
- \( X \) = Additional clearance beyond MAC

MAC factor =

\[
\frac{(MAC + X)}{MAC} = \frac{(MAC + X)}{(E_R + E_O + R_b + R_c)}
\]
Key Differences in Calculating Risk

Company’s Oriented Safety Factor (OSF)

<table>
<thead>
<tr>
<th>OSF</th>
<th>Probability</th>
</tr>
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<tbody>
<tr>
<td>2.0</td>
<td>750,599,937,895,083</td>
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<tr>
<td>1.5</td>
<td>660,669,956</td>
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<tr>
<td>1.2</td>
<td>954,910</td>
</tr>
<tr>
<td>1.1</td>
<td>146,076</td>
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<tr>
<td>1.0</td>
<td>25,959</td>
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<tr>
<td>0.8</td>
<td>669</td>
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<tr>
<td>0.5</td>
<td>42</td>
</tr>
<tr>
<td>0.3</td>
<td>9</td>
</tr>
</tbody>
</table>
## Key Differences in Calculating Risk

### Comparison of Methods

<table>
<thead>
<tr>
<th></th>
<th>Operator Procedure</th>
<th>Contractor Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Separation factor</strong></td>
<td>Minimum Acceptable Clearance (MAC) Factor</td>
<td>Oriented Separation Factor (OSF)</td>
</tr>
<tr>
<td><strong>Minimum separation</strong></td>
<td>( E_R + E_O + R_b + R_c )</td>
<td>Minimum Allowable Separation (MAS) at OSF = 1.5</td>
</tr>
<tr>
<td><strong>Drill ahead with precautions</strong></td>
<td>1.5&gt; Factor&gt;1.25</td>
<td>1.5&gt;OSF&gt;1.0 (Exemption required as per contractor standard)</td>
</tr>
<tr>
<td><strong>Drill ahead</strong></td>
<td>Factor&gt;1.5</td>
<td>OSF&gt;1.5</td>
</tr>
<tr>
<td><strong>Tool error model</strong></td>
<td>ISCWSA 2( \sigma ) 74% confidence level (3D)</td>
<td>ISCWSA 2.79( \sigma ) 95% confidence level (3D)</td>
</tr>
</tbody>
</table>
Traveling Cylinder Plot
Well Design Phase

Hazard and Risk Control
Well Execution Phase

Prespud Meeting

- Held prior to commencement of drilling
- Includes discussion of:
  - Well objectives
  - Well plan
  - Anticollision issues
    - Preventive and Mitigation actions
Well Execution Phase

MOQ – SLB Anti-Collision Communication Plan – Drilling Phase

OSF < 1.0; MAC < 1.25
Major Risk zone
Drilling stops. Rig notifies town as per chart, and discussion held between MOQ SLB project manager and MOQ Head of Drilling Operations with mandatory analysis from MOQ and SLB Drilling Engineering. If an acceptable technical solution is found then exemption is given by MOQ Head of Drilling Operations and SLB Operations Manager to proceed.

OSF > 1.5
Minor Risk zone
Directional Driller notifies Company man and DD Coordinator. Company man notifies Drill Sep. in town for MOQ DE to start calculating MAC factors. MOQ DE communicates MAC factors to rig. SLB DE monitors high risk operations (advised by DD Coordinator or DE Mgr). Directional Driller will not cross tolerance line.

OSF > 2.0
Alert zone
Directional Driller notifies Company man of approaching wells. Traveling cylinder plots are updated offshore at every survey.

OSF > 5
No collision risk
Drilling proceeds as normal
Well Execution Phase

Management of Change Request

Request Date: May 03, 2009 17:58 (UTC)

Requestor: Isevan Effan

KRM Client: MAERSK OIL QATAR AS

Location: SLM Qatar

Management of Change Number: 2009003173045 (1821.61)

STATUS: Approved

Final Approver: Merad Mohamed

Next Approver: Merad Mohamed

Expert Approvers: Walker John

Classification: QAQE

Potential Likelihood: Medium

Potential Severity: Catastrophic

Potential Risk: High

Residual Likelihood: Medium

Residual Severity: Light

Residual Risk: Low

Approved Management of Change Period: May 03, 2009 00:00 to May 04, 2009 00:00

Request Details:

Management of Change related to which contractual terms and conditions, work scope, historical norms, procedures, work instructions?

S&M Standard 002

Management of Change requested from what exact section and text of the contract actual terms and conditions, work scope, historical norms, procedures, work instructions?

Relate to Well A/B Collision

Well Name: DA 10

As new: 00Q-00440

Summary of Situation (Include the description of the additional/increased risk caused by the deviation):

Deviation from plan resulted of having incorrect expectation factor -1.5 and Max Factor = 1 due to conductor placement 90 degrees off target. Conductor with DA-12 will go down to 1.2 ft at 120 ft.

DA-12 is expected to shut in.

Risk Reduction/Minimization Plan - Prevention Measures:

- Contact Maersk drilling superintendent and drilling engineer

- Exempt: Quest #2009043093058

- Take a survey every 30 ft with gtm0 from the conductor shoe with 1st clean out BHA

- Take a survey every 30 ft with gtm1 with the 2nd pendulum BHA, whenever is necessary take more frequent surveys.

- Project ahead to bit 300, 100ft, and 200ft.

- Use the up-to-date electronic TCI plot.

- Have OSC calculate MAC for survey and projections and compare the values with MOQ.

- MOQ surveys specialist to monitor the well in Real Time.

- Use MMO/SLB AIC chart

- Communicate with FSM/OSC and SSL Drilling Engineer

- FSM and DE to communicate Maersk Survey Specialist & DE

Drilling Parameters:

- RPM 40

- OB: -Cool

- mud: 10000ppm
Well Execution Phase

Gyro survey of subject well conductor e-mailed to:

- Operator’s
  - Drilling superintendent
  - Drilling Engineer
  - Survey specialist
- Contractor’s
  - Drilling service manager
  - Drilling engineer
  - Survey specialist
  - OSC personnel
Well Execution Phase

MAC factor calculations sent from OSC to Operator:

![Image of MAC calculations table]
Well Execution Phase
Well Execution Phase

Contractor DSM confirms drill-ahead decision

Failing confirmation:

- Additional meetings may be planned to analyze options
- Agreement is reached on prevention/mitigation strategies
- Well is re-planned to minimize well collision risk
Preventive Actions While Drilling:

- Monitor indications such as high/erratic torque, ROP change, bit vibration, etc.
- Monitor object well at wellhead for indications of bit in contact with casing.
- Monitor returns for cement.
- Install magnet in flow line to monitor for metal cuttings/shows.
- Check MWD surveys for magnetic interference.
- Take survey when bit $\leq 5$ ft from critical point.
Well Execution Phase

When to shut in wells:

– Critical offsets shut in as specified by drilling program.
– Additional wells shut in, bled off, when:
  • Deviation results in MAC factor < 1.25 (actual or projected)
– Drilling ceases, object well plugged back, when:
  • Object well falls within MAC factor < 1.0 toward any well
Post-Drilling Evaluation

Key personnel meet to:
- Identify problem areas
- Identify good practices
- Document and share lessons learned
Conclusion

Keys to success:

- Comprehensive planning
- Good communication strategy
- Multidisciplinary collaboration
Conclusion

Advantages of an Industry-wide Standard

- Enhanced interoperability among project participants
- Reduction of risks due to:
  - Miscommunication
  - Different terminologies
  - Different methods of calculating risk
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