Collision Avoidance Sub-Group
Glasgow - 20th & 21st September 2016

Progress Report
Timeline

- September 2016: Candidate Agreed (PCM)
- March 2017: The Hague?
- September 2017:
  - 1 day event: Review
  - 1/2 day event: Publish

30 min Update

Document email exchange

SPE Paper 1

SPE Paper 2
Objective (Seems Familiar?)

By the end of the second day the intention is to be able to articulate the complete collision rule, with parameters and caveats together with written notes in sufficient detail to enable an individual / subgroup to elaborate and document the conclusions.

Clarity, Conciseness, Communication Documentation
Actions from Last Meeting

- Test the SF expression, starting with existing AC test wells – errors not currently consistent. Work with error model group use updated error models? As a starting point we will assume these values as a first pass ($K = 3.5$, $S_m = 1m$, $\sigma_d = 1.5m$).

- Description of Pedal Curve and link to probability.

- Management Practices

- Verification and Assurance:
  - Complete the flowcharts.
  - SPE Papers (2) will be the normative references:
    1. Management Practices
    2. Unified Collision Avoidance Rule / Assurance and Verification
SPE-184730-MS
Well Collision Avoidance - Management and Principles

2. The second is the collision avoidance model and its verification, the abstract of which needs to be submitted for the 2017 ATCE.
3. Much written before, so add focus on access to current information and subjects for which the emphasis has changed, e.g.:
   - Recommendations regarding dispensations.
   - Structure of company documentation.
   - Human factors.
   - Process flow (charts)
   - Underlying assumptions
   - etc.
4. Reinforce principles with real examples.
Meeting Focus Areas

Gaps
Model
Presentation
Flowcharts
Survey Interval
The Story
Gaps

1. 3D distance is referred to in the tests?
2. Update the Lexicon?
3. Precision of the calculations?
4. Update the Collision Avoidance paper references?
5. An HSE / non-HSE well is not defined in the Lexicon?
6. The use of ALARP (in USA)?
7. Elaborate on the special cases?
8. Limitations?
9. etc.
Survey Interval Recommendation

Assumptions

Appropriate error models, AC calculations, surveys tools will be used.

Surveying enough to assess wellbore position and BHA performance to meet well objectives and regulatory requirements.

All surveys pass QC.

For any steered section 100ft survey intervals recommended.

Following the plan closely enough to allow the AC scenario to be valid.

<table>
<thead>
<tr>
<th>Planned DLS (And/Or) Deg/100ft MD</th>
<th>SF</th>
<th>Recommended Maximum Survey Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>&gt;2</td>
<td>&lt;60m / 200ft</td>
</tr>
<tr>
<td>1-5</td>
<td>1.5 - 2</td>
<td>30m /100ft</td>
</tr>
<tr>
<td>&gt;5</td>
<td>&lt;1.5</td>
<td>10m /33ft</td>
</tr>
</tbody>
</table>
Offset 01: East 100 (Parallel)

\[
\text{(sum)} = \text{Ref} + \text{Offset} \\
\text{(RSS)} = \sqrt{\text{Ref}^2 + \text{Offset}^2} \\
\text{ISCWSA} = \text{RSS}
\]
Collision Avoidance Rule

\[ \Delta C - (R_r + R_o) - S_m \]

\[ SF = \frac{K (\sigma_s^2 + \sigma_d^2)^{1/2}}{K = 3.5} \]

... (1)

- **SF** - Separation Factor, a ratio related to the probability of the reference well colliding with or crossing the offset well over the next drilled interval.
- **ΔC** - The distance between the point of interest on the centreline of the reference well and a point on the centreline of the offset well. The point on the offset well is determined by the 3D closest approach or Travelling Cylinder plane method, dependent on the application of the rule.
- **R_r** - The radius of the reference wellbore at the point of interest.
- **R_o** - The radius of the offset wellbore at the point of interest.
- **S_m** - The Surface Margin, a fixed value intended to avoid contact between the reference and offset wells at near surface.
- **K** - The scaling factor applied to the 1 sigma position uncertainty estimate to define a MASD that represents a suitably low probability of collision or crossing. Initial recommendation for HSE risk offset wells is 3.5, based on the range of current Industry practice (this may be redefined to relate to a specified probability of collision).
- **σ_s** - The magnitude of the pedal vector of the relative uncertainty of the surveyed positions of the points of interest on the two wells, along the C vector, assuming a normal distribution and specified at 1 sigma. (See diagram.) The calculation of relative uncertainty should account for correlation of errors.
- **σ_d** - The estimate of position uncertainty associated with the projection of the current surveyed position in the reference well to the point of interest at the end of the next drilled interval. Applies to both planned and actual wellpaths.
Separation Factor (SF)

Compares actual distance $D$ between wells to a statistically determined limit $k\sigma_D$.

$D$ and $\sigma_D$ must be measured in the same direction.

Commonly, SF is a ratio:

$$SF = \frac{\text{physical, measured lengths}}{\text{statistical dimensions}} = \frac{D}{k\sigma_D}$$

Condition $SF \geq 1$:
1. ISCWSA Collision Avoidance has been asked to contribute
2. It is recognised that collision avoidance touches most (if not all) other sections.
3. API RP78 has an equations sub-group
Planning Phase Work-Flow

Well Collision Avoidance

Options Found

Unable to Create Well Path

Yes

Plan Engineered Well Path

Select & Classify All Appropriate Offsets

Wellbore Proximity Analysis

SF Acceptable?

Manage Allowable Deviation
- Re-plan well path
- Revise survey program
- Resurvey offset
- Resurvey relative wellhead position

AND/OR
- Re-evaluate Offset Classification
- Consider Ranging
- Other Compliant Options

No

Consider Operational Improvements

Control well plan revision and prepare to execute plan

No

Yes
Principles

• The standards may only refer to existing methods and algorithms, described in a recognised, publicly available paper (preferably peer reviewed).

• We will recognise that future improvements are likely and we will be open to evolving the standard in a controlled manner, through peer review and management of change.

• The adopted method will distinguish between HSE and non-HSE collisions and be risk-sensitive.

• We will address rule(s) for both planning and for execution.

• Qualify first, then quantify.

• We will test the feasibility and practicality of execution of any proposal.

• We commit to developing and adopting the minimum set of rules that satisfies existing operating envelopes.

• We will define the limitation of the stated standards, or algorithms.

• The output generated by the attendees will be compiled into a draft standard by a group of 5 or so members endorsed by the wider group.
1. The ACR relates to probability of collision or well crossing, not just collision.

2. The use of the pedal point with a simplistic definition of “crossing” results in an over conservative and inappropriate no-go zone in some geometries.

3. Inclusion of the surface margin ($S_m$) term means that probability relates to collision with the exclusion zone defined by the term (or crossing) rather than the offset wellbore (or crossing).

4. The ACR is unsuitable for situations where relative position and relative uncertainty are determined by methods other than directional survey data, unless the uncertainty can be defined in terms of $\sigma_s$. Examples may be use of magnetic ranging or geosteering to position the reference well.

5. The ACR is unsuitable for situations in which the HSE risk is represented by a volume other than, or in addition to the offset wellbore, although modification of $S_m$ or $R_o$ may be a solution in some circumstances. Examples may be faults, shallow gas pockets and formations that might allow hydraulic communication.
**Error Models**

**Ellipsoids of Uncertainty**

**Examples of Uncertainty**

- Lateral Uncertainty
- Vertical Uncertainty
- High-Side Uncertainty
- Along Hole Uncertainty
- Semi-Major Axis Uncertainty
- Semi-Minor Axis Uncertainty
- Azimuth Uncertainty
- Inclination Uncertainty
- Surface Location Uncertainty

![Diagram of 3D ellipse](http://www.uhi.ac.uk/en/research-enterprise/energy/wellbore-positioning-download)

Conclusion