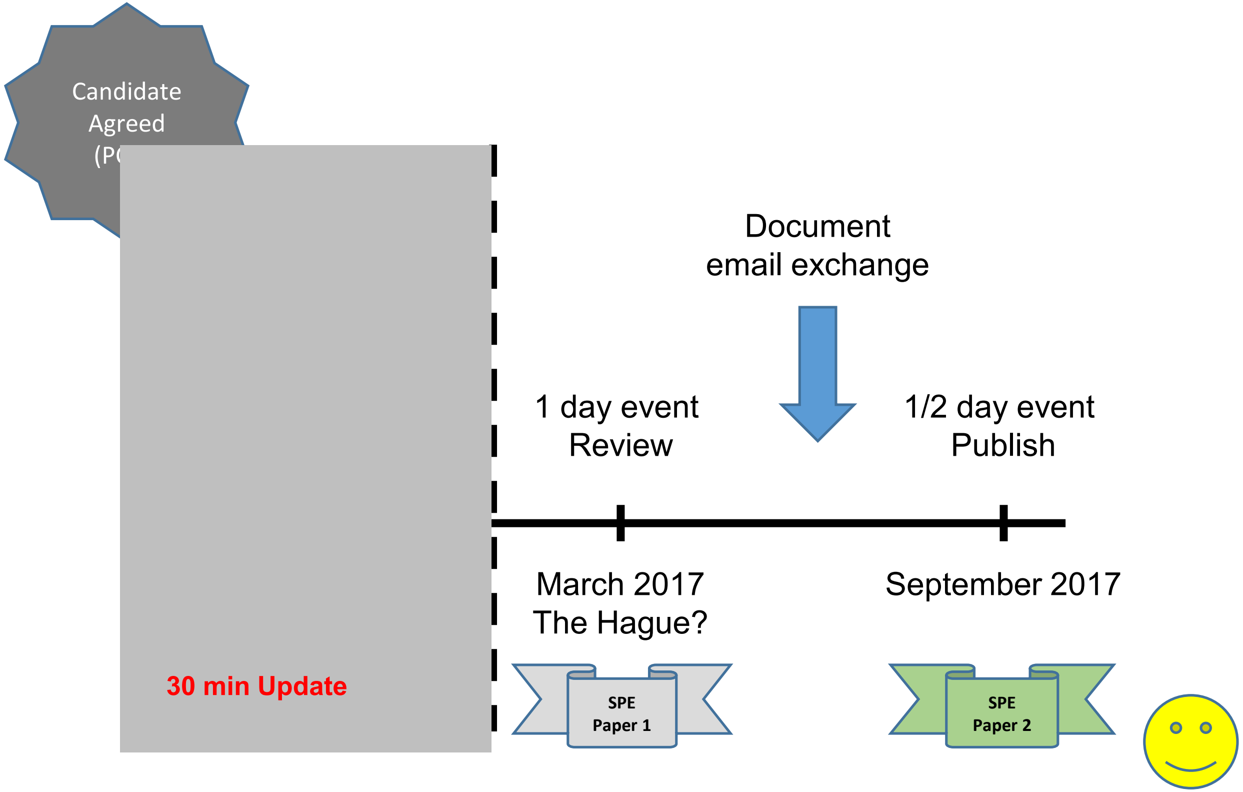
# Collision Avoidance Sub-Group

## Glasgow - 20th & 21st September 2016

Progress Report

# Timeline



Candidate
Agreed
(P

30 min Update

Document
email exchange

1 day event
Review

1/2 day event
Publish

March 2017
The Hague?

September 2017

SPE
Paper 1

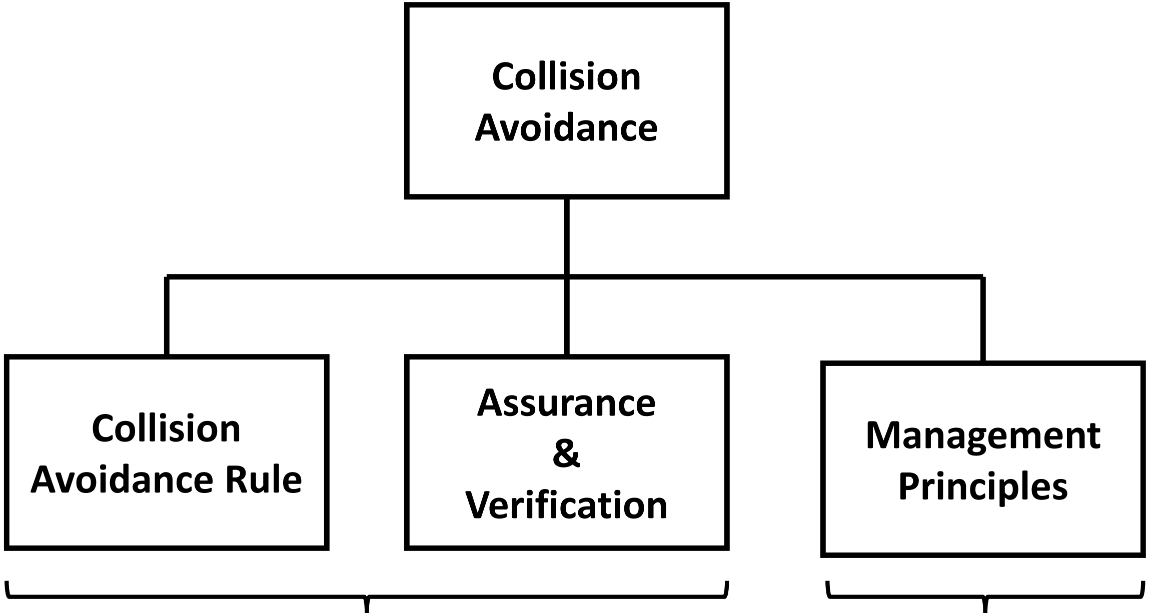
SPE
Paper 2

# 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

# Work Structure



Collision Avoidance

Collision Avoidance Rule

Assurance & Verification

Management Principles

SPE Paper 2

SPE Paper 1

# 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

1. The first of 2 papers, to be presented at the IADC / SPE Drilling Conference, The Hague in March 2017.
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

| Planned DLS (And/Or) Deg/100ft MD | SF | Recommended Maximum Survey Interval |
|---|---|---|
| <1 | >2 | <60m / 200ft |
| 1-5 | 1.5 - 2 | 30m /100ft |
| >5 | <1.5 | 10m /33ft |

## Assumptions

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

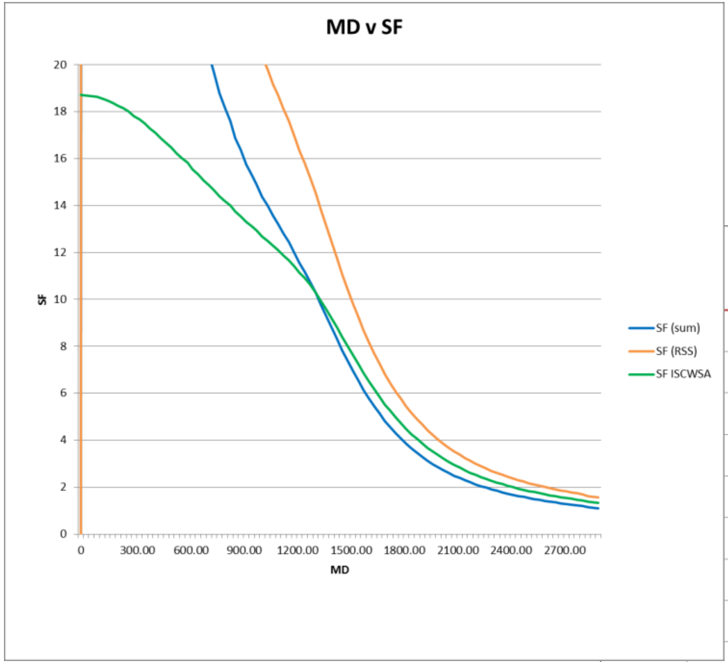
Surveying enough to assess wellbore position and BHA performance to meet well objectives and regulatory requirements

All surveys pass QC

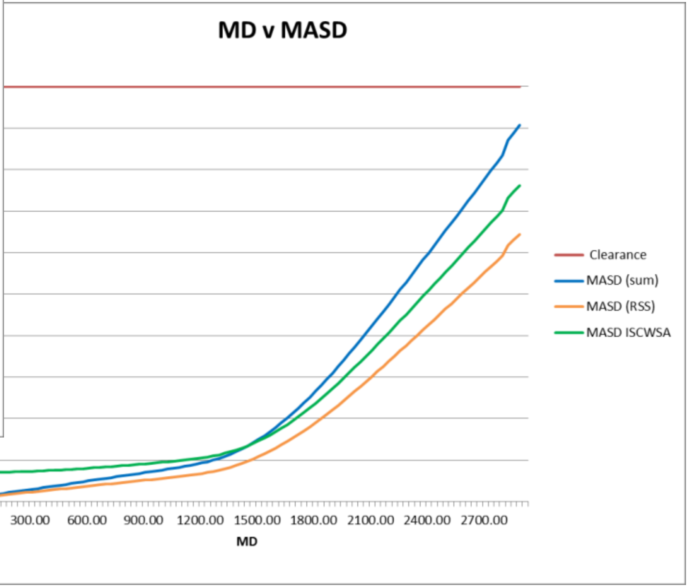
For any steered section 100ft survey intervals recommended

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

# Offset 01: East 100 (Parallel)



(sum) = Ref + Offset
(RSS) = sqrt(Ref^2 + Offset^2)
ISCWSA = RSS



$$SF = \frac{\Delta C - (R_r + R_o) - S_m}{K(\sigma_s^2 + \sigma_d^2)^{½}}$$

# Collision Avoidance Rule

$$SF = \frac{\Delta C - ( R_r + R_o ) - S_m}{K ( \sigma_s^2 + \sigma_d^2 )^{½}} \qquad ( K = 3.5 ) \qquad \ldots (1)$$

Negligible Effect

Adjust?
= 0.5

- *SF* - Separation Factor, a ratio relate 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).
- $\sigma_s$ - 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.
- $\sigma_d$ - 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)

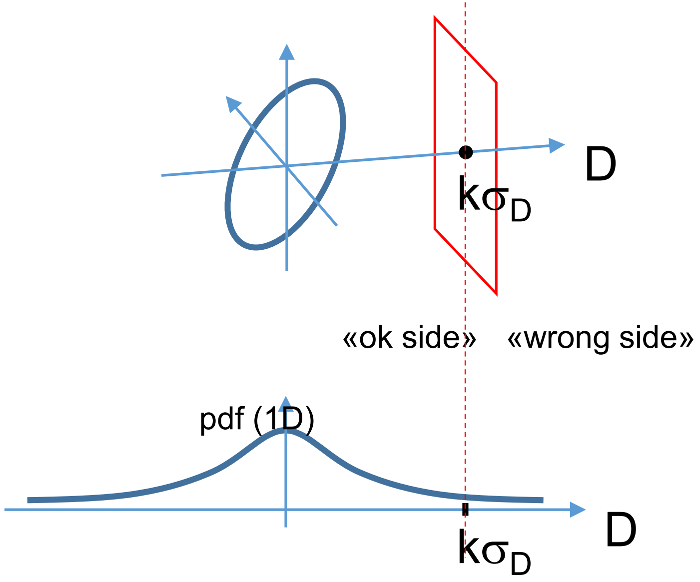
Compares actual distance *D* between wells to a statistically determined limit $k\sigma_D$.

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

Commonly, *SF* is a ratio:

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

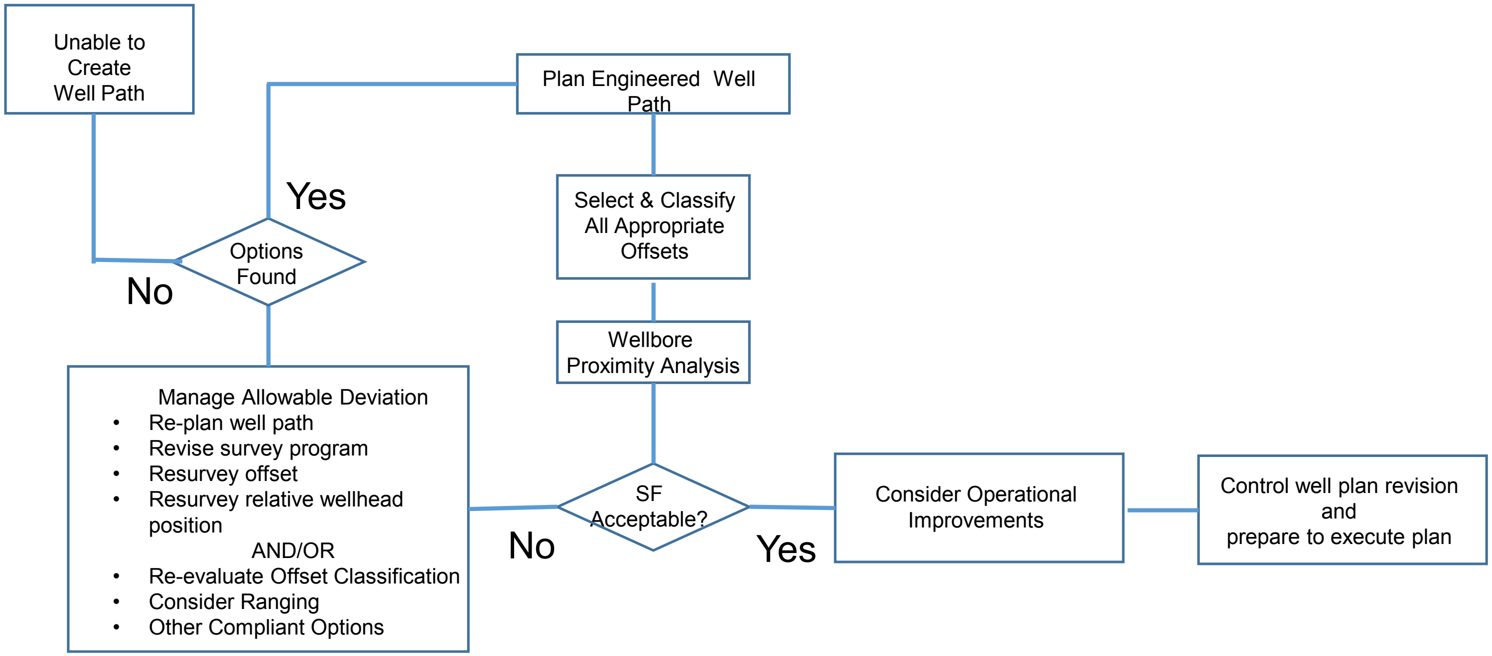
Condition *SF* >= 1 :



# API RP78

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



Unable to Create Well Path

Plan Engineered Well Path

Select & Classify All Appropriate Offsets

Wellbore Proximity Analysis

Options Found

Yes

No

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

SF Acceptable?

No

Yes

Consider Operational Improvements

Control well plan revision and prepare to execute plan

# Principles

- The standards may only refer to existing methods and algorithms, described in a recognised, publically 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.

# Special Cases

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

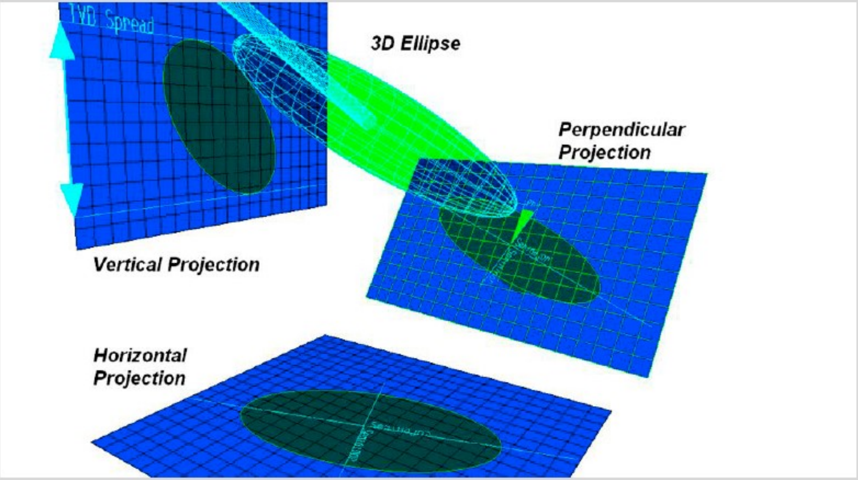
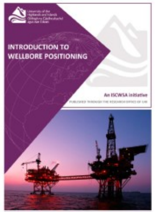


Figure 83: The ellipse of uncertainty mapped in 3D software.

Source: http://www.uhi.ac.uk/en/research-enterprise/energy/wellbore-positioning-download



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# Conclusion