Operator Wellbore Survey Group

September 25th, 2018

Omni Hotel, Dallas

Chair – Pete Clark, Chevron

Secretary – Jordan Meyer, Nobel Energy

Anti-Trust Statement

- We are meeting to help develop and promote good practices in wellbore surveying necessary to support oil and gas operations which enhance safety and competition.
- The meeting will be conducted in compliance with all laws including the antitrust laws, both state and federal. We will not discuss prices paid to suppliers or charged to customers nor will we endorse or disparage vendors or goods or services, divide markets, or discuss with whom we will or will not do business, nor other specific commercial terms, because these are matters for each company or individual to independently evaluate and determine.

OWSG Vision

- To promote practices that provide confidence that reported wellbore positions are within their stated uncertainty

Agenda

1. SPE WPTS Collision Avoidance Rule
    1. Need of standardized Collision Avoidance Rule & Practices
    2. SPE WPTS Collision Avoidance Rule k factor analysis
    3. Conclusion and CA rule in API RP78
    4. Open discussion
2. OWSG PU Model Set
    1. Access
    2. XCL terms
    3. Open discussion
3. API RP78 Update
    1. Need of standardized wellbore positioning practices
    2. Progress, Changes & Targets
    3. Open Discussion
4. Boundary lines
    1. Need of standardized Collision Avoidance Rule & Practices
    2. Outline ISCWSA Collision Avoidance Rule & Practices
    3. Relationship between ISCWSA Collision Avoidance Rule & Practices and API RP78
    4. Open discussion
5. Any Other Business

1. Collision Avoidance Practices Standardization

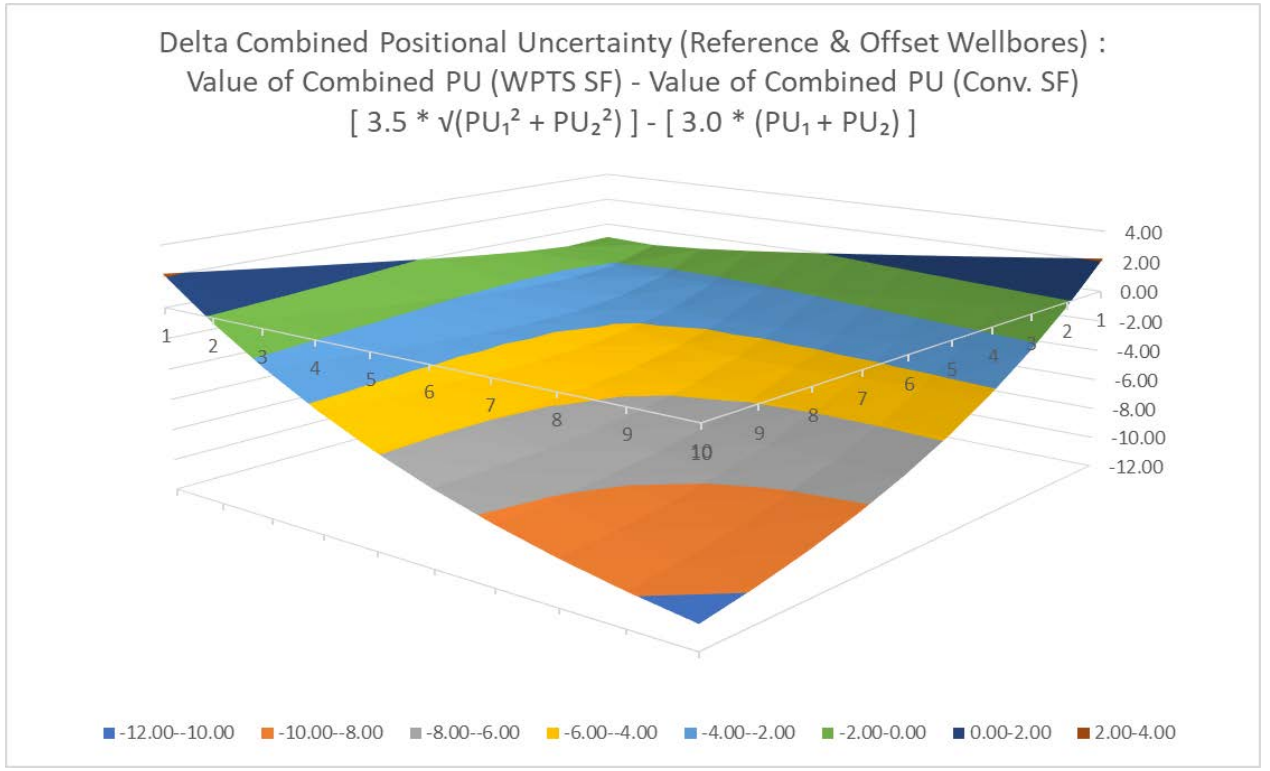
- Need for standardized of Collision Avoidance practices
  - Efficiency
    - Many DD business partners
  - Effectiveness
    - Operator’s meeting regulator’s standard
  - Ex-location
    - Remote center operation

SPE WPTS Collison Avoidance Rule

- SPE187073
  - General rule
    - $SF=(D-R_1-R_2-SM) / (k* (SQRT(\sigma(s)^2+ \sigma(pa)^2))$
    - Imperial formulation
      - $SF=(D-R_1-R_2-1) / (\mathbf{3.5 * (SQRT(\sigma(s)^2} + 2.56))$
    - Metric formulation
      - $SF=(D-R_1-R_2-0.3) / (\mathbf{3.5 * (SQRT(\sigma(s)^2} + 0.25))$
  - Common Industry Practice
    - $SF=D / (3 * (\sigma(r) + \sigma(o)) + (R_1+R_2))$

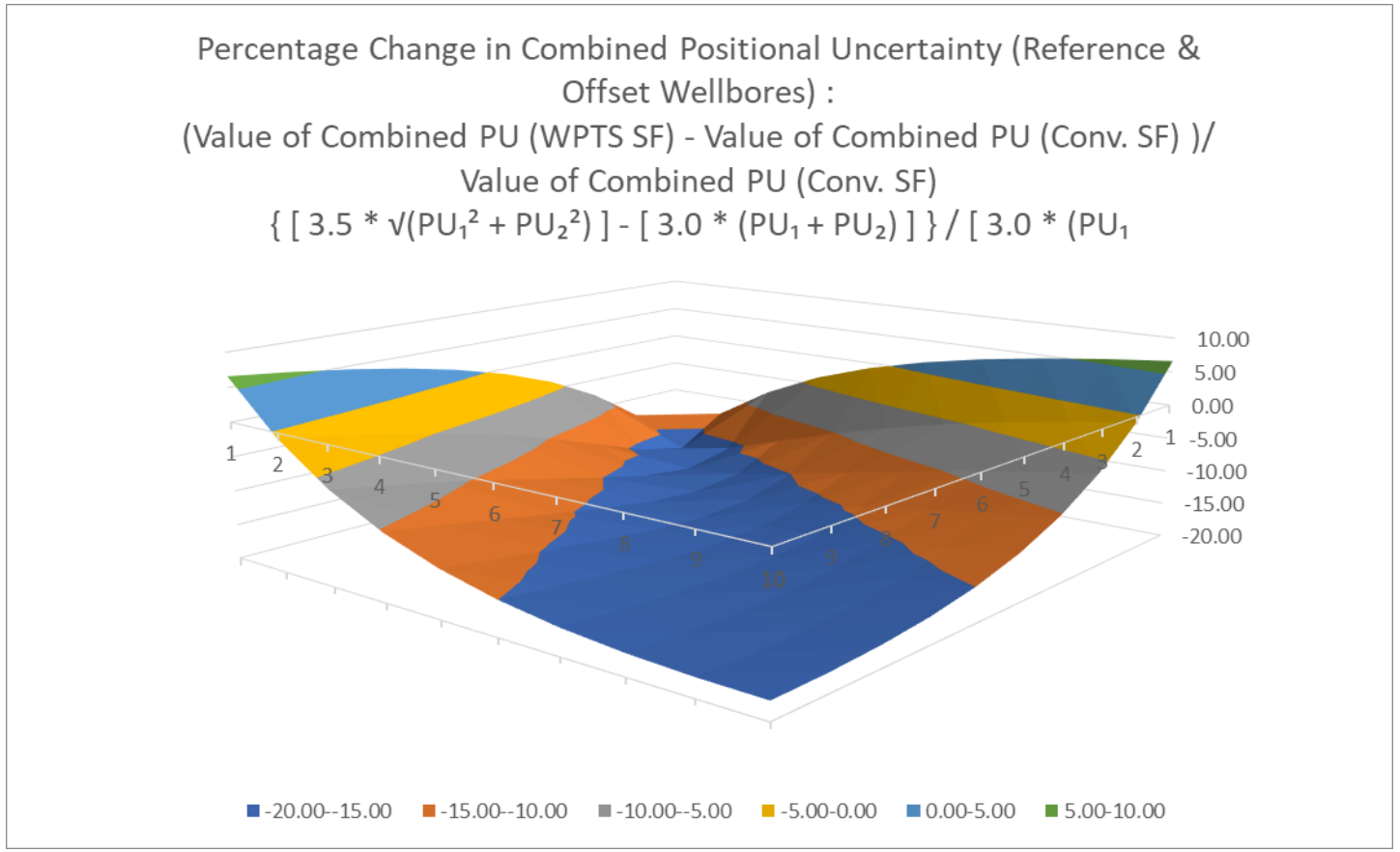
Change in Combined Positional Uncertainty 3.5 * SQRT(σ(s)² v. 3 * (σ(r) + σ(o))

- In most cases $3.5 * \sqrt{(PU_1^2 + PU_2^2)} < 3.0 * (PU_1 + PU_2)$
- Z axis = $(3.5*\sqrt{(PU_1^2+PU_2^2)}-(3.0*(PU_1 + PU_2))$
- X axis = PU_1
- Y axis = PU_2



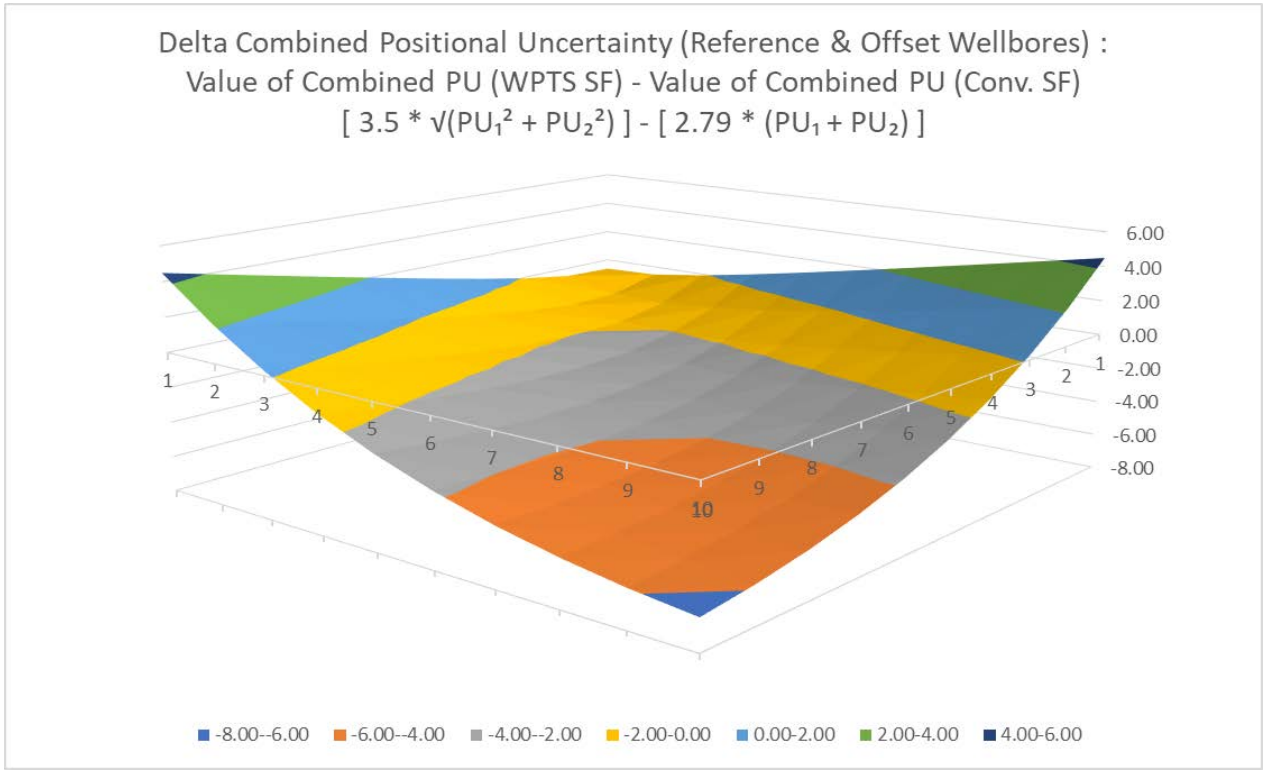
% Change in Combine Positional Uncertainty 3.5 * SQRT(σ(s)² v. 3 * (σ(r) + σ(o))

- Z axis = $100 *((3.5*\sqrt{(PU_1^2+PU_2^2)}-(3.0*(PU_1 + PU_2)))/(3.0*(PU_1 + PU_2))$
- X axis = PU_1
- Y axis = PU_2



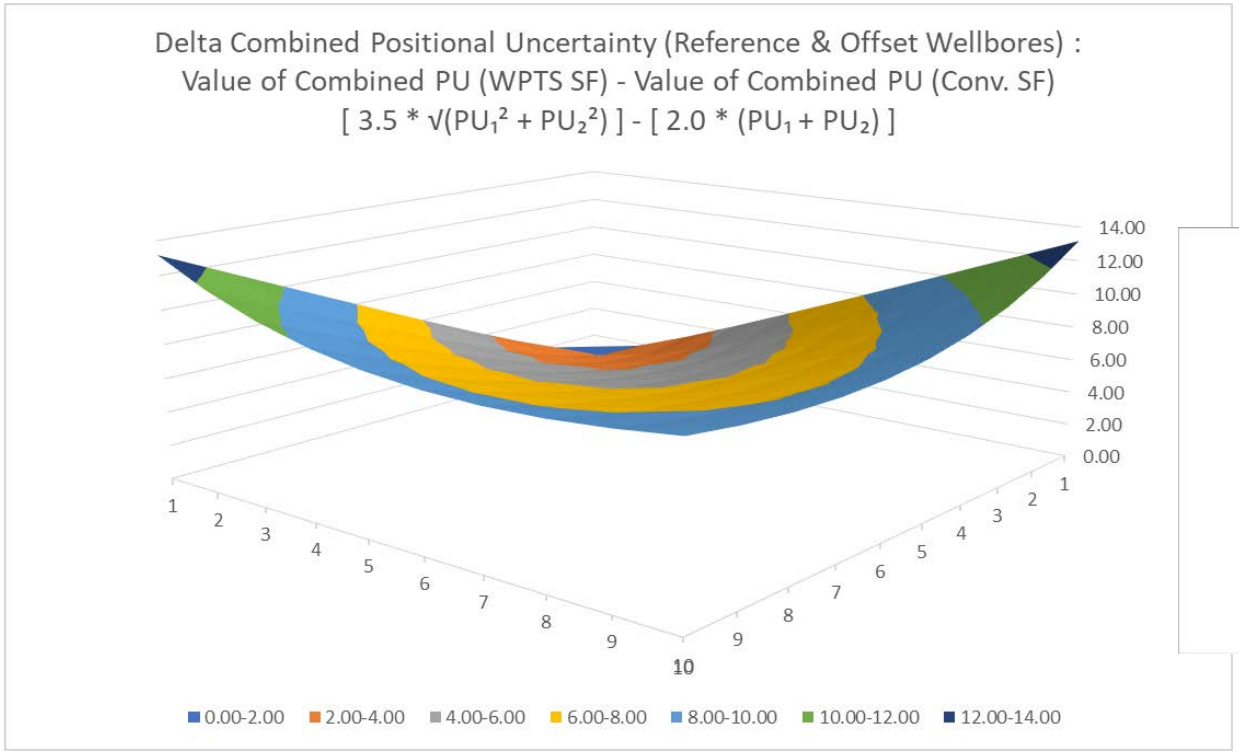
Change in Combined Positional Uncertainty 3.5 * SQRT(σ(s)² v. 2.79 * (σ(r) + σ(o))

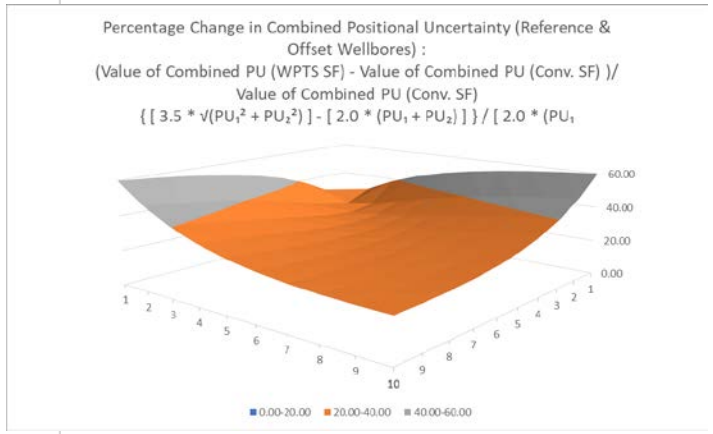
- In most cases $3.5 * \sqrt{(PU_1^2 + PU_2^2)} < 2.79 * (PU_1 + PU_2)$
- Z axis = $(3.5*\sqrt{(PU_1^2+PU_2^2)}-(2.79*(PU_1 + PU_2))$
- X axis = PU_1
- Y axis = PU_2



Change in Combined Positional Uncertainty 3.5 * SQRT(σ(s)² v. 2 * (σ(r) + σ(o))

- In most cases $3.5 * \sqrt{(PU_1^2 + PU_2^2)} < 2.0 * (PU_1 + PU_2)$
- Z axis = $(3.5*\sqrt{(PU_1^2+PU_2^2)}-(2.0*(PU_1 + PU_2))$
- X axis = PU_1
- Y axis = PU_2





SPE WPTS Collison Avoidance Rule - Conclusions

- Proposed & adopted by ISCWSA / SPE WPTS
  - OWSG is sub-committee of ISCWSA
- Despite k factor being a larger number than common practice confidence level the resulting combined positional uncertainties will generally reduce as long as the confidence level in use is greater than ~2.5
- SPE WPTS CA rule is proposed for industry adoption in API RP78

2. OWSG PU model sets

- Described in SPE178843
- In common use with DD business partners
- Models with XCL terms available pending Error Model Maintenance Sub-committee meeting
- In need of a home
  - Spreadsheet description & diagnostic files had been on Copsegrove.com
  - Options
    - ISCWSA website
    - IOGP

3. API RP78 Update

- Initial draft complete
  - Available to contributors from API SharePoint site
- Several sections being actively worked
  - Software
  - QA/QC to slim down
  - Process; 5.1 – 5.4
  - 6.1 Plots or Outputs, ….
- Next steps
  - Review & revise
  - Target 1st draft for general review end ‘18

API RP78 Table of Content

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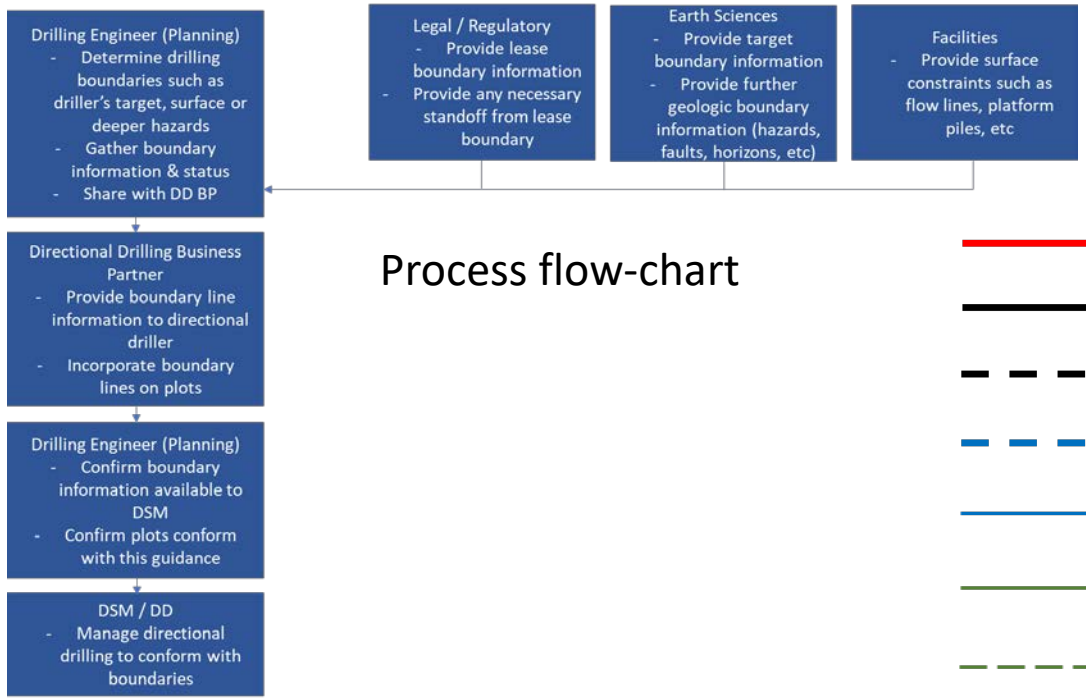
4. Boundary Line Identification & Notification Guidance

- May benefit from common approach by DD business partners & Operators
- Draft offered for review & comment



Process flow-chart

Boundary Line key

- Do not cross (any limiting boundary); red, bold, solid
- Lease boundary, advisory; black, bold, solid
- Regulatory boundary, advisory; black, bold, dashed
- Geologic boundary, advisory; blue, bold, dashed
- Geologic target boundary, advisory; blue, normal, solid
- Driller's target boundary, advisory; green, normal, solid
- Other type of boundary, advisory; green, bold, dashed

5. AOB & Thank You