

36th CA Subcommittee  
6<sup>th</sup> of March 2025  
Stavanger, Norway



Wellbore Positioning Technical Section



The Industry Steering Committee on  
Wellbore Survey Accuracy (ISCWSA)

# Collision Avoidance Subcommittee Update

CA Meeting #36 06-Mar-2025  
11:30 pm – 1:30 pm ~2hrs

Darren Aklestad - SLB  
07 Mar 2025



- Darren Aklestad
- 34 yrs Schlumberger/SLB
- Wellbore positioning, well planning, anti-collision, cartographic systems, survey corrections
- Aklestad@slb.com



## Attendees summary

- 44 Attendees (18 Online) (62 total)
  - 31 companies (14 Operators, 41 Service Providers, 7 Software vendors)
  - Online, probably higher



# Agenda

1. Quick Review of the previous activities
2. Jerry Codling HAL – PC Made Easy – Update presentation (details)
  - Adoption recommendation?
3. Pending Items – plan forward
4. New Business



# Previous activities review

1. Surface Margin – White Paper Recommendation
  1. Still needs formal publication
2. Reporting minimum-standards – columns / header items
  1. No additions – needs publication
3. Current activity of SC members – CA benchmarking
4. Focus on PC methods/usage/recommendations



## SPE-189654-MS Probability Of Wellbore Intercept Made Easy

- Full Presentation will be posted and made available
- Full formulation for others to implement in software
- Inputs are readily available now
- Software vendors will be continuing effort to validate against each other



# Formulation

Projected Vector

$$AOI = \cos^{-1}(V_r \cdot V_o)$$

$$V = |V_r \times V_o|$$

Where  $V_r$  is Vector direction on reference  
 $V_o$  is vector direction on offset well

Mahalanobis Distance

$$\sigma = \sqrt{V^{-1} C V}$$

Where  $\sigma$  = Relative Error  
 $V$  = Vector direction (3x1 matrix)  
 $C$  = Covariance Matrix (3x3 matrix)

Mod Laplacian

$$P = \frac{1}{2} \left[ e^{-1.5 \left( \frac{S-R}{\sigma} \right)^{0.8}} - e^{-1.5 \left( \frac{S+R}{\sigma} \right)^{0.8}} \right]$$

Normal/Gaussian

$$P = \frac{1}{2} \left[ \operatorname{erf} \left( \frac{S-R}{\sigma\sqrt{2}} \right) - \operatorname{erf} \left( \frac{S+R}{\sigma\sqrt{2}} \right) \right]$$

Separation is 3D distance between points of interest  
Sum Casing is Ref Hole Radius + Off Casing Radius

```

SIntercept TempIntercept = Intercept;
double dotrprod = RefStation.vi * OffStation.vi
* RefStation.vj * OffStation.vj + RefStation.vk * OffStation.vk;
if (fabs(dotrprod) < 0.999047695) // this is 1 deg tolerance
{
    TempIntercept.vi = RefStation.vj * OffStation.vk - RefStation.vk * OffStation.vj;
    TempIntercept.vj = -(RefStation.vi * OffStation.vk - RefStation.vk * OffStation.vi);
    TempIntercept.vk = RefStation.vi * OffStation.vj - RefStation.vj * OffStation.vi;
    CPlan::normalize(TempIntercept.vi, TempIntercept.vj, TempIntercept.vk);
}

double ellref = EllipseBoundary(RefCov, TempIntercept);
double ellobj = EllipseBoundary(OffCov, TempIntercept);
double signal = _hypot(ellref, ellobj);

double dRisk = JerrysRiskFunction(Intercept.distance, signal, dSumCasing, bUseLaplacian,

// ellipse boundary calculation for collision calculation
double EllipseBoundary(const SCovarianceMatrix &cov, const SIntercept &ref)
{
    if ( cov.xx == 0.0 && cov.yy == 0.0 && cov.zz == 0.0 ) return 0.0;
    double icx = cov.xx*ref.vi + cov.xy*ref.vj + cov.xz*ref.vk;
    double icy = cov.xy*ref.vi + cov.yy*ref.vj + cov.yz*ref.vk;
    double icz = cov.xz*ref.vi + cov.yz*ref.vj + cov.zz*ref.vk;
    double rc = ref.vi*icx + ref.vj*icy + ref.vk*icz;
    return sqrt(fabs(rc));
}

// Jerrys risk based rule function provides risk level, enhanced to give Laplacian results
double JerrysRiskFunction(const double &dSeparation, const double &ELLSize,
const double &dSumCasing, bool bUseLaplacian=false, bool bUseOneSided=false )
{
    double ProbAng = 1e16; // large enough number
    if ( ELLSize > 0.0 && SumCasing > 0.0 )
    {
        double X1 = (dSeparation + SumCasing) / ELLSize;
        double X2 = (dSeparation - SumCasing) / ELLSize;
        double R1 = 0.0, R2 = 0.0;
        if ( bUseLaplacian && X1 > 0.0 && X2 > 0.0 )
        {
            R1 = 1.0 - 0.5*exp(-pow(X1,0.8)+1.5);
            R2 = 1.0 - 0.5*exp(-pow(X2,0.8)+1.5);
        }
        else
        {
            R1 = NormSDist(X1);
            R2 = NormSDist(X2);
        }
        if ( R1 > R2 )
        {
            ProbAng = 1.0 / (R1 - R2);
            if ( bUseOneSided )
                ProbAng = 1.0 / (1.0 - R2);
        }
        return ProbAng;
    }
}
    
```

Vector Product

Mahalanobis Distance

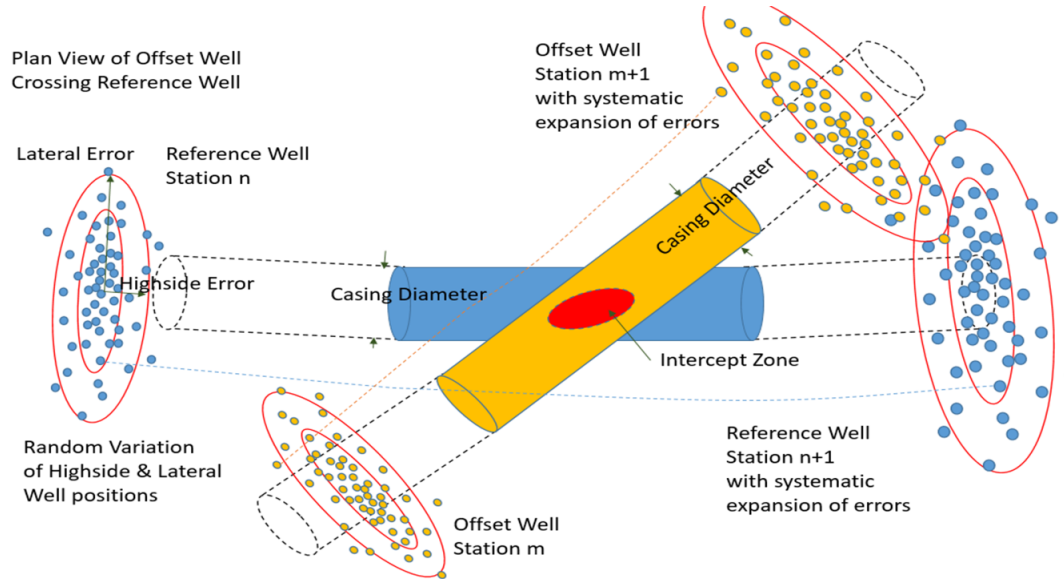
Compute Probability

Mod Laplacian

Normal/Gaussian

# SPE-189654-MS Probability Of Wellbore Intercept Made Easy

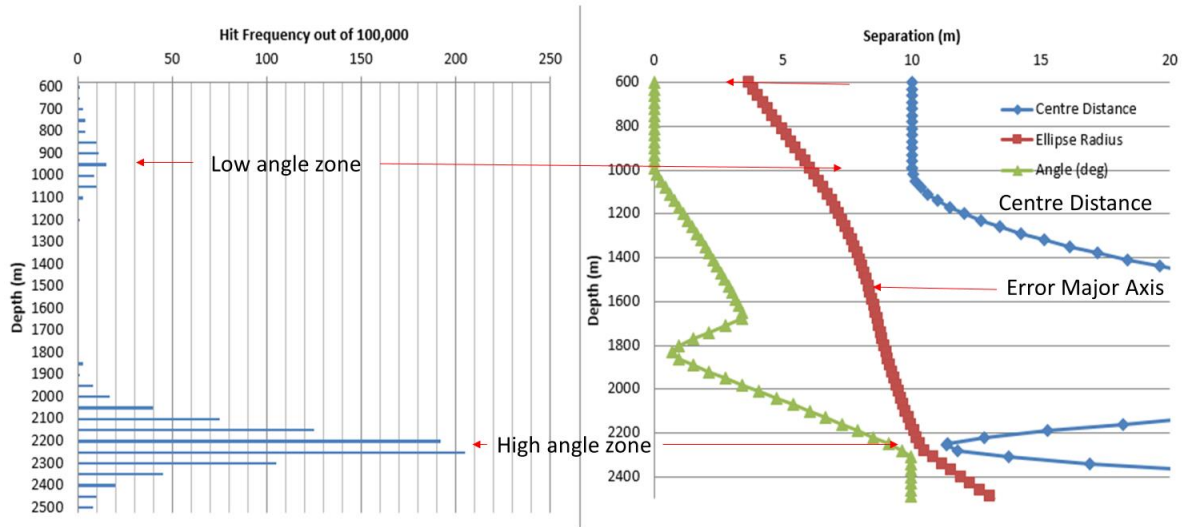
## Illustration of Monte Carlo Simulator for Well Intercept



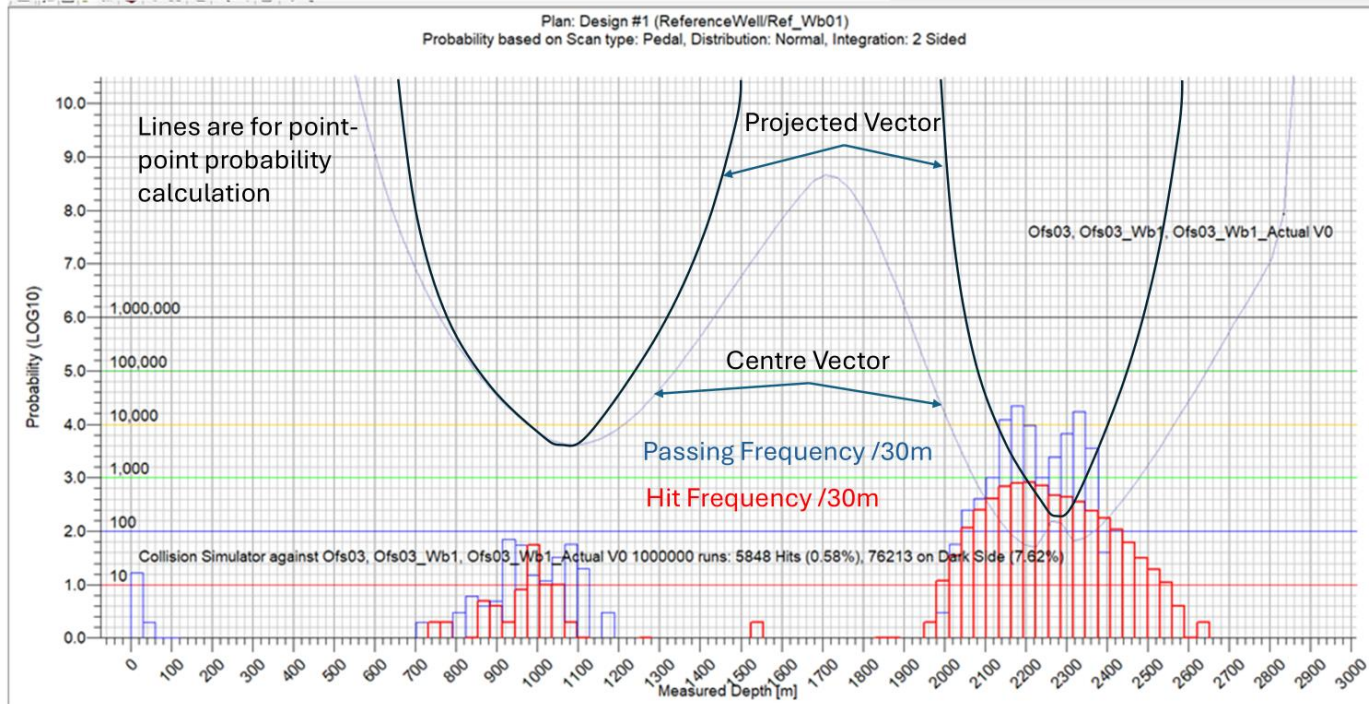




### Results of Monte-Carlo Simulator for Offset 03



## MC Simulation – Offset 03 - Native Application





## PC Discussion

- Lively debate concerning “what” PC is being computed
  - Shortcuts are inherent for convenience – shown do be adequate as a first step
- Focus is on getting a “common” tool available as a starting point
  - (just the beginning) a chance for everyone to learn more
  - Opportunity to change when shown to be inadequate
  - Has published limitations
  - Need to publish recommendations of when/how to be used
- Another tool in the toolbox for risk evaluation
  - Help make decisions on what to do next when SF has failed



# Continued Working

1. Benchmarks Update Rev5 & WPTS & Sidetrack
  - Work in progress – post results from all major software vendors
  - Include PC results – Projected Vector / Direct Vector?
  - Include rev4/5 w/wo inter-well geomag reference correlations
  - Update to give test trajectories as simplified paths un-interpolated
  - Add expanded “setup” details – specific error models
2. Post Surface Margin – White Paper Recommendation
3. Finalize CA Reporting minimum content standard



# New Initiatives

1. CA-Survey Database Management – Recommendations (Hans Dreisig – TotalEnergies)
  - Expansion with details of other components of competent CA system
2. Recommendations on Graphics systems for CA and combined covariance representation
3. \* Coordination on analysis of operators “Exemption” process. Common elements?
  1. Possibly coordinated within the OWSG
4. \* Update benchmarks to include “utility” error models

\* Newly added



# Thank You – Questions? Corrections?

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