# OWSG GENERAL MEETING

October 3, 2023

8:00 am CDT Start Time

Jonathan Lightfoot

Sub-Committee Chair

# AGENDA


- OWSG Mission & Anti-Trust
- Combined Surveys Case Study – Mike Calkins
  - Quality Control Project Overview
  - Calculation Methods
  - Challenges in Implementation and Adoption
- Upcoming Events
  - API RP78 Ballot / Voting Roster Update
  - ISCWSA Mtg. 58
  - SPE ATCE (San Antonio)
  - IADD Annual Technical Forum (Abstract Call)
  - IADC TPC 2023 Annual Meeting
- Open Discussion Session

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# Our Mission

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

# Anti-Trust

*We are meeting to help develop and promote good practices in wellbore surveying necessary to support wellbore construction 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.*

# Surveying Quality Control of Overlapping Surveys Combined Surveys Case Study – Mike Calkins

- Quality Control Project Overview
- Calculation Methods
- Challenges in Implementation and Adoption

# Survey Uncertainty Quantification with R: Need for an Explicit Definition of the Chi-Square Tests

Mike Calkins – Three Sigma Well Design, LLC

# Overview

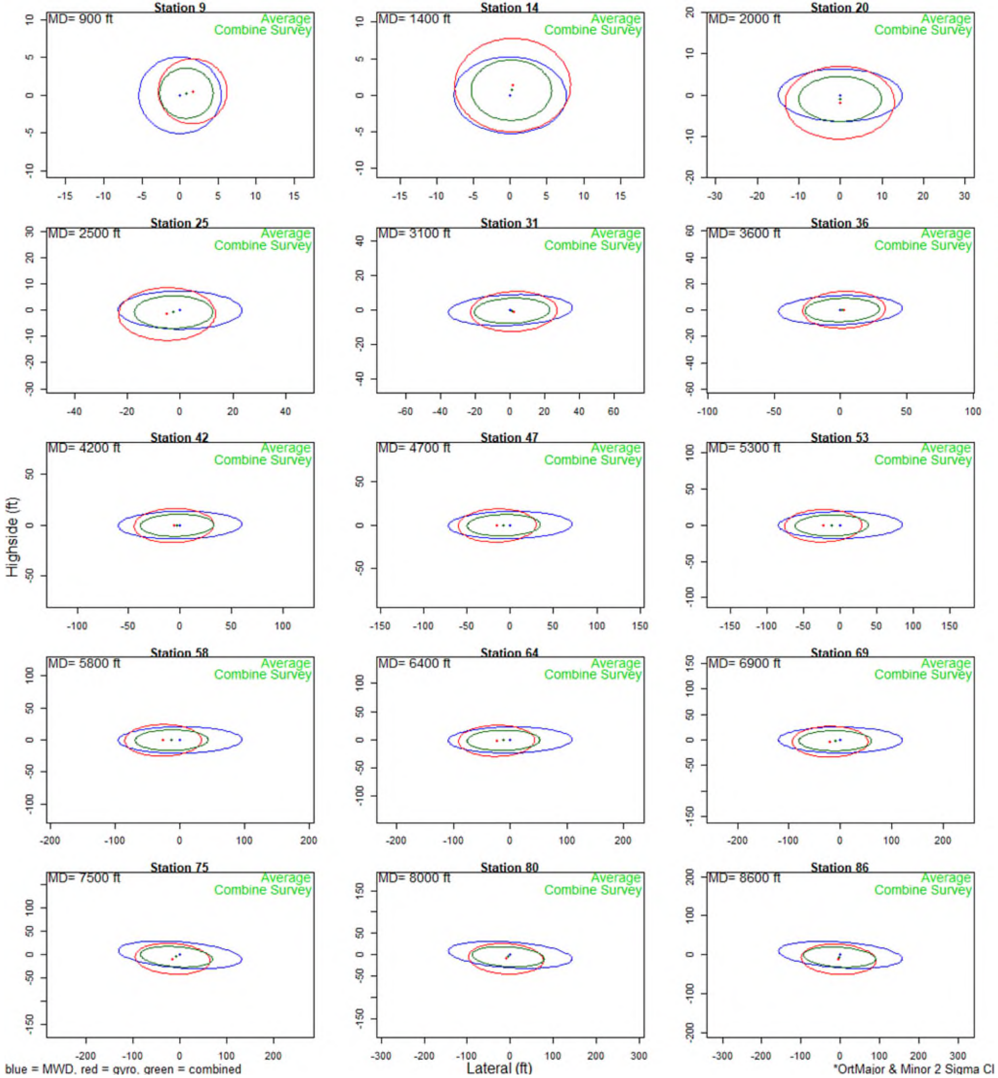
1. ***Why?***
2. Combined Survey Project
3. Common Survey QC Tests
   a. Qualitative Ellipse Visual Tests
   b. RIP Test
   c. Chi-Squared Tests
      1. One Sided for Individual Wells
      2. Two Sided for EM Validation & Refinement
4. Current Chi-Square Test Implementation per Ekseth *et al.*, 2007 (SPE-105558)
   a) Limitations, Assumptions, & Concerns
   b) Need to explicitly define all QC Tests so they can be run correctly and consistently
5. Overview of R and preview of current QC Report code(slides to be posted)

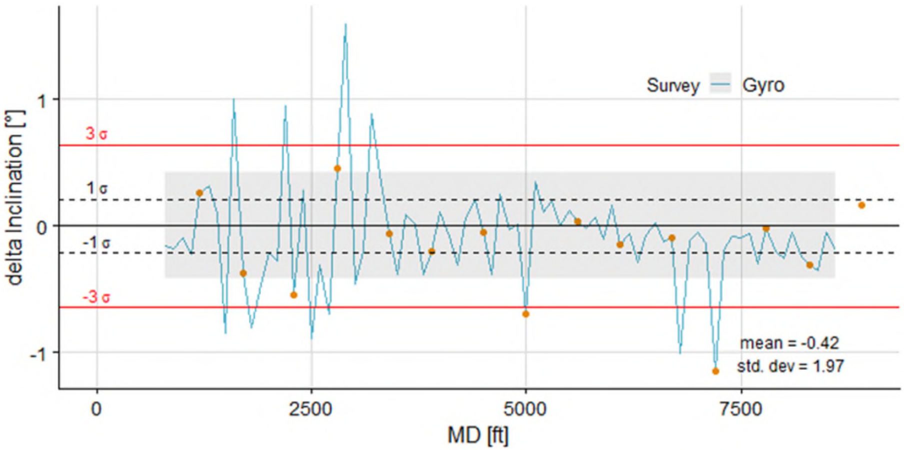
# Why?

1. To **explicitly define uncertainty expectations** for survey data and the **means to determine** when a tool is not performing as assumed by the EMs
   - **ISCWSA OWSG Mission Statement**: To promote practices that provide confidence that reported positions are within their stated uncertainty

2. "To **obtain the maximum amount of useful information from the data on hand** without being able to repeat the experiment with better equipment or reduce statistical uncertainty by making more measurements"

   - Bevington, Data Reduction and Error Analysis for the Physical Sciences




*Shaded area = Tolerance, orange dots = 15 stations used for the Chi-Square Test*

***Table 2: Result of all Chi Square ($X^2$) tests***

| | $X^2$ Test Value | Test Limit | Test Conclusion |
|---|---|---|---|
| IDT | 60.19 | 34.4 | Fail |
| ADT | 27.88 | 34.4 | Pass |
| CODT (HLA) | - | - | Pass |
| $X_L$ | 1.01 | 34.4 | Pass |
| $X_H$ | 0.97 | 34.4 | Pass |
| $X_W$ | 0.29 | 34.4 | Pass |

# QC Test Overview – SPE-212492

- Ellipse Test
- RIP Test
- **Chi-Square Tests (IDT, ADT, CODT)**

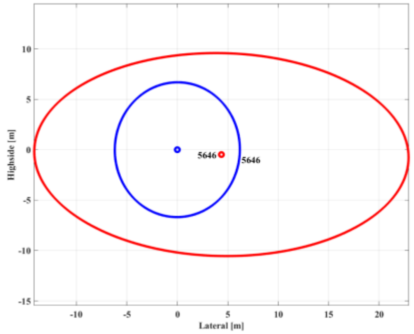



Figure 3—Comparison of GWD OMM (blue) and MWD (red) uncertainty ellipses at 5646m.

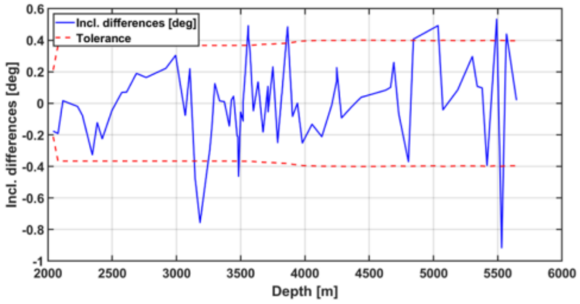



Figure 1—Inclination RIP test between GWD OMM × MWD

$$\chi = \sum_{i=1}^{n} \frac{\Delta x_i{}^2}{(\sigma_{1,i}{}^2 + \sigma_{2,i}{}^2)} \leq Z_{\gamma,n}$$

*x: inclination, azimuth, or CODT (highside/ lateral/ or along-hole)*

# What is an Explicit Definition? – STDEV.P

Excel Definition and Function:

- Calculates standard deviation based on the entire population given as arguments (ignores logical values and text)
- The standard deviation is a measure of how widely values are dispersed from the average value (the mean).
- Assumptions: Arguments are the entire population (n).
    - If data is for a sample use (STDEV.S)
- For larger sample sizes, STDEV.P and STDEV.S can return ~ equal values
- Calculated using "n" method

$$\sqrt{\frac{\sum(x-\bar{x})^2}{n}}$$

***Excel STDEV.P function***

| Formula | Description | Result |
|---|---|---|
| =STDEV.P(A3:A12) | Standard deviation of breaking strength, assuming only 10 tools are produced. | 26.05455814 |

| | | | | |
|---|---|---|---|---|
| 1345 | 1301 | 1368 | 1322 | 1310 |
| 1370 | 1318 | 1350 | 1303 | 1299 |

***Using the above data results in a standard deviation (p) of 26.05***

**https://support.microsoft.com/en-us/office/stdev-p-function-6e917c05-31a0-496f-ade7-4f4e7462f285#:~:text=P%20function,-**

# Chi-Square Test

- A Statistical Measure of ***Goodness-of-Fit***
- **Hypothesis Testing** – Does the survey disagreement exceed our EM expectation
- A normally distributed **measurement and uncertainty** is transformed into a **Chi-Square distributed measurement**
- **5 Tests Total**
  - Inclination – IDT
  - Azimuth - ADT
  - 3 CODTs in HLA reference frame
    - NEV can be tested too, but HLA is preferred
- Results are **compared with a test limit (Z)**
  - Z value = number of stations (n) [15 stations is recommended] and significance level (γ)

$$X = \sum_{i=1}^{n} \frac{x_i^2}{\sigma_i^2} \le Z_{\gamma,n}$$

where $Z_{\gamma,n}$ is the Chi-square test limit for $n$ degrees of freedom, at a significance level of $\gamma$. The significance level is, with one exception, fixed at 0.3% throughout this paper, in

**SPE-105558 Eqn referenced above**

**1.0 Sigma Uncertainty/Scaled Variance Expectation Interpretation**

***Table 2: Result of all Chi Square ($X^2$) tests***

| | $X^2$ Test Value | Test Limit | Test Conclusion |
|---|---|---|---|
| IDT | 27.98 | 34.4 | Pass |
| ADT | 18.39 | 34.4 | Pass |
| CODT (HLA) | - | - | Pass |
| $X_L$ | 1.23 | 34.4 | Pass |
| $X_H$ | 0.87 | 34.4 | Pass |
| $X_W$ | 0.25 | 34.4 | Pass |

**3.0 Sigma Uncertainty/Scaled Variance Expectation Interpretation**

*Table 2: Result of all Chi Square ($X^2$) tests*

| | $X^2$ Test Value | Test Limit | Test Conclusion |
|---|---|---|---|
| IDT | 3.11 | 34.39 | Pass |
| ADT | 2.04 | 34.39 | Pass |
| CODT (HLA) | - | - | Pass |
| $X_L$ | 0.14 | 34.39 | Pass |
| $X_H$ | 0.1 | 34.39 | Pass |
| $X_W$ | 0.03 | 34.39 | Pass |

Excel Test Limit Equation: CHISQ.INV.RT(0.003,15) = 34.4

# Uncertainty Expectation – Test Decision

- How should our expected Variance or Uncertainty(std dev=sqrt(Variance)) sigma be calculated?
- **Not Explicitly Defined!**
  - **1 sigma seems too pessimistic(Prone to Type One Error – False Negative) for reasonable discrepancies**
  - 3 sigma may be too optimistic(Prone to Type Two Errors – False Positive)
- **Column 3 in Table 2** appears to show the average discrepancy/uncertainty ratio required to equal the Selected Test Limit
- Does an Ellipse Test scaled at 1.5 sigma make sense with Poor/Bad actions??

SPE/IADC 105558

High-Integrity Wellbore Surveys: Methods for Eliminating Gross Errors

Roger Ekseth, SPE, Gyrodata; Torgeir Torkildsen, SPE, Statoil ASA; Andrew Brooks, SPE, Baker Hughes Inteq; John Weston, SPE, Gyrodata; Erik Nyrnes, SPE, Statoil ASA; Harry Wilson, SPE, Baker Hughes Inteq; and Kazimir Kovalenko, SPE, Gyrodata

***The Chi-square distribution statistical test.*** A Normally distributed measurement ($x$) with zero expectation and variance, $\sigma^2$, is transformed into an apparent one degree of freedom Chi-square distributed measurement by squaring the measurement and dividing by the variance. A given number ($n$) of one degree of freedom Chi-square distributed measurements, originating from $n$ independent (uncorrelated) measurements, can be added together into a common Chi-square distributed test variable ($X$) with $n$ degrees of freedom. The measurements can then be controlled against gross errors at a given confidence ($\gamma$) by testing if the following condition is fulfilled:

$$X = \sum_{i=1}^{n} \frac{x_i^2}{\sigma_i^2} \leq Z_{\gamma,n}$$

where $Z_{\gamma,n}$ is the Chi-square test limit for $n$ degrees of freedom, at a significance level of $\gamma$. The significance level is, with one exception, fixed at 0.3% throughout this paper, in order to harmonise with the significance level used for the Normal distribution tests.

The Chi-square distribution test may be presented in an alternative form, when all $n$ summed measurements have the same variance, $\sigma^2$.

**Table 2: Chi-square distribution test limits and standard deviation scaling factors at a 0.3% significance level**

| $n$ | $Z_{0.003,n}$ | $\sqrt{Z_{0.003,n}/n}$ |
|---|---|---|
| 1 | 8.8 | 3.0 |
| 3 | 13.9 | 2.2 |
| 5 | 18.0 | 1.9 |
| 15 | 34.4 | 1.5 |
| 100 | 143 | 1.2 |
| 1000 | 1127 | 1.1 |

# Summary: Chi-Square Test Items to Address

- **Explicitly *define* sigma/scaled variance**
  - ~~What is our expected uncertainty?~~ **Confirmed at 1.0 sigma**
- **Is *n* selection appropriate at 15 stations for CODT?**
  - **Prone to Type 1 error** relative to RIP Mean and Ellipse Test Limits?
  - Would n=5 make more sense for CODT?
- 0.003 significance *or* 3 sigma?
- Should we *switch* to the term *"Discrepancy" to* refer to "*measurement differences*"?
- How to run the CODT on a lower Survey Leg?
  - Zero Error Tie in and start ~500' out f/ TIP to avoid small error sensitivity
- 0.1 **or** 0.05 **or** 2 sigma for 2 sided test?
  - Mistake made in paper or appendix?
  - Same Test Values referenced as created in single sided test?

**Table 2: Chi-square distribution test limits and standard deviation scaling factors at a 0.3% significance level**

| $n$ | $Z_{0.003,n}$ | $\sqrt{Z_{0.003,n}/n}$ |
|---|---|---|
| 1 | 8.8 | 3.0 |
| 3 | 13.9 | 2.2 |
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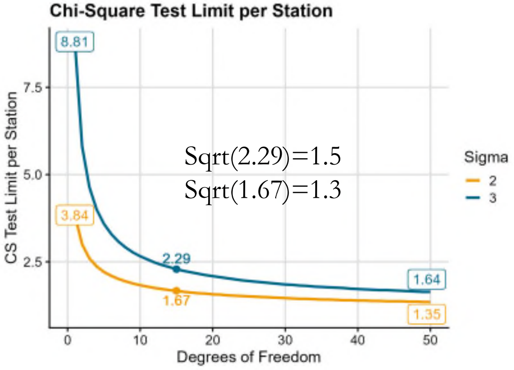


**Table 6.2** Confidence limits associated with various $\Delta\chi^2$ contours for one degree of freedom.

| | | | | | |
|---|---|---|---|---|---|
| $\Delta\chi^2$ contour | 1.00 | 2.71 | 4.00 | 6.63 | 9.00 |
| Measurements within range | 68.3%<br>$1\sigma$ | 90.0% | 95.4%<br>$2\sigma$ | 99.0% | 99.7%<br>$3\sigma$ |

*Hughes and Hase, Measurements and their Uncertainties – A Practical Guide to Modern Error Analysis*

# Questions?

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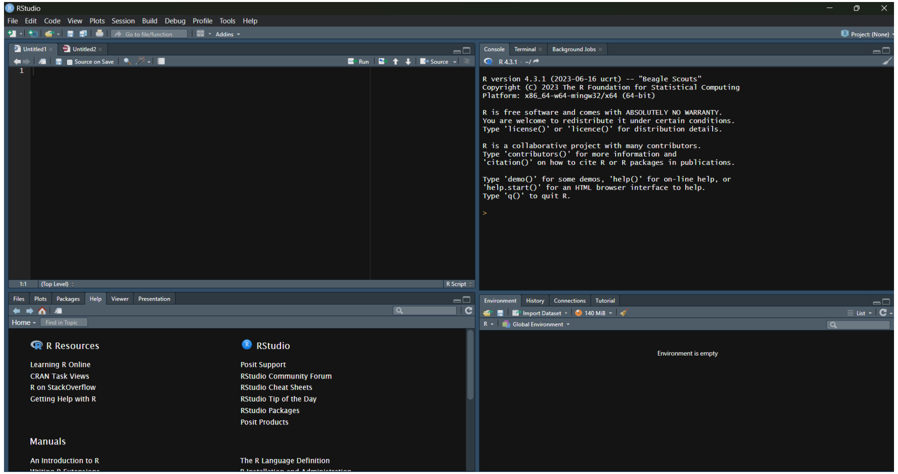
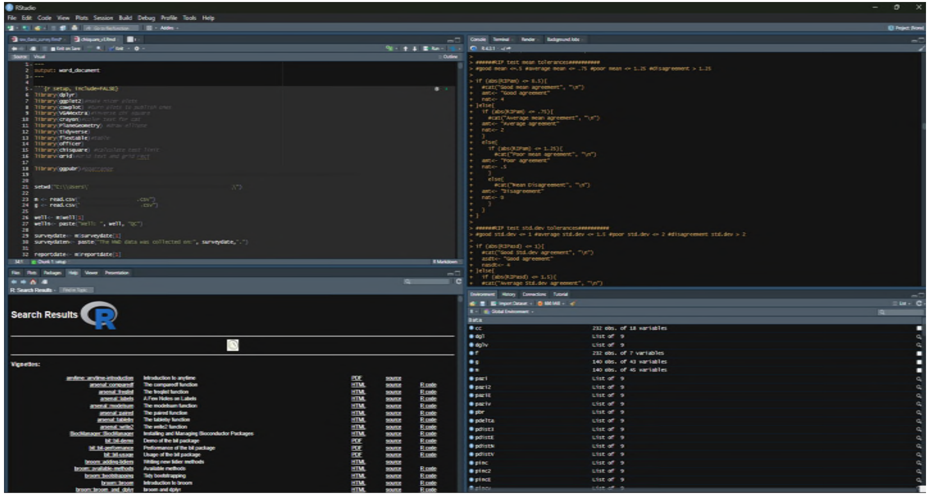
# What is R?

- An open-source statistical computing and graphic coding program
- Handles and stores data
- Computes large data and operations
- Functions not available in base package can be easily added by importing other created packages, or you can create your own functions.
- Most users use R studio as it is a more user-friendly interface than R.



# Ellipse Test Improvement?

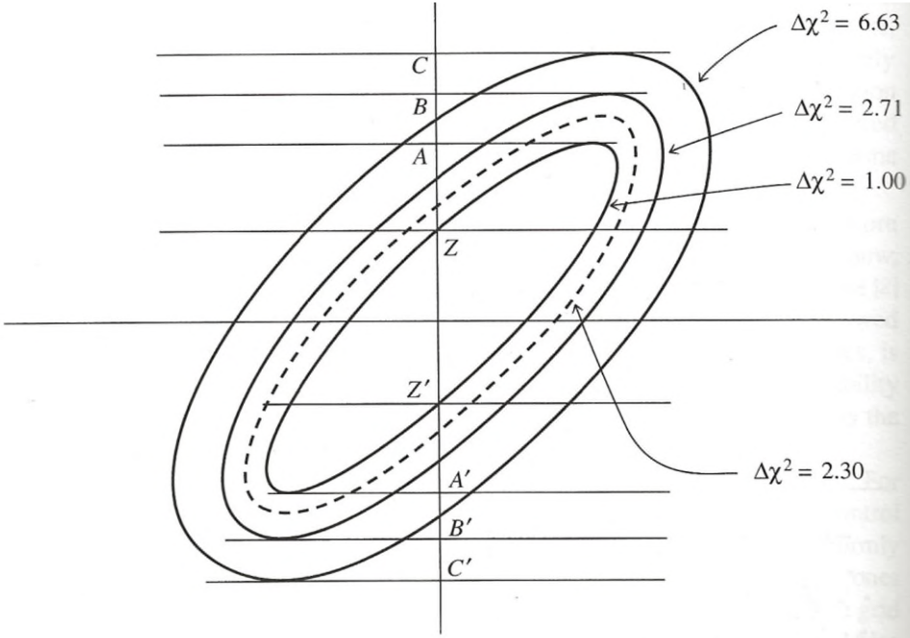
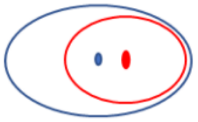
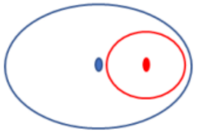
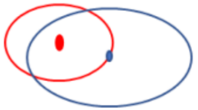
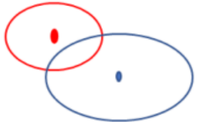
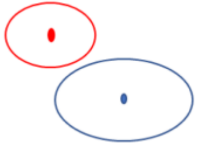



Figure 15.6.4. Confidence region ellipses corresponding to values of chi-square larger than the fitted minimum. The solid curves, with $\Delta\chi^2 = 1.00, 2.71, 6.63$ project onto one-dimensional intervals $AA'$, $BB'$, $CC'$. These intervals — not the ellipses themselves — contain 68.3%, 90%, and 99% of normally distributed data. The ellipse that contains 68.3% of normally distributed data is shown dashed, and has $\Delta\chi^2 = 2.30$. For additional numerical values, see accompanying table.

Press, W. H., B. P. Flannery, S. A. Teukolsky, and W. T. Vetterling, *Numerical Recipes, The Art of Scientific Computing*, Cambridge University Press, New York (1986).

**Table 5—Ellipsis of Uncertainty for Survey Quality Analysis**

| Level Agreement | Description of Agreement level | Action | Pictorial Description of Agreement Level |
|---|---|---|---|
| **Very Good** | MWD ellipse fully encompasses gyro ellipse, and gyro ellipse encompasses centre of MWD ellipse. | No further investigation needed. |  |
| **Good** | MWD ellipse fully encompasses gyro ellipse, but gyro ellipse does not encompass centre of MWD ellipse. | No further investigation needed. |  |
| **Average** | MWD ellipse dows not fully encompass gyro ellipse but overlaps with it. The center of the gyro ellipse lies inside the MWD ellipse. | No further investigation needed. |  |
| **Poor** | MWD ellipse dows not fully encompass gyro ellipse but overlaps with it. The centre of the gyro ellipse lies outside the MWD ellipse. | Investigate – if unresolved consider re-survey. |  |
| **Unacceptable** | Ellipses do not overlap. | Probably re-survey immediately and investigate. |  |

*SPE-212492*

# American Society for Quality(ASQ) – Control Chart

## Out-of-control signals

- A single point outside the control limits. In Figure 1, point sixteen is above the UCL (upper control limit).
- 2 out of 3 successive points are on the same side of the centerline and farther than 2 σ from it. In Figure 1, point 4 sends that signal.
- 4 out of the 5 successive points are on the same side of the centerline and farther than 1 σ from it. In Figure 1, point 11 sends that signal.
- A run of 8 in a row are on the same side of the centerline. Or 10 out of 11, 12 out of 14, or 16 out of 20. In Figure 1, point 21 is $8^{th}$ in a row above the centerline.
- Obvious consistent or persistent patterns that suggest something unusual about your data and your process.

*When you start a new control chart, the process may be out of control. If so, the control limits calculated from the first 20 points are conditional limits. When you have at least 20 sequential points from a period when the process is operating in control, recalculate control limits.

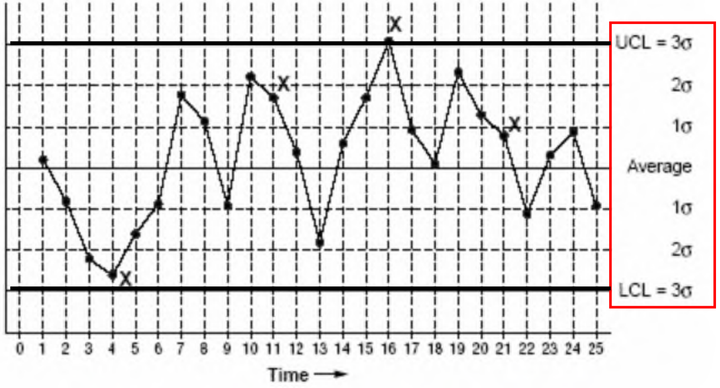
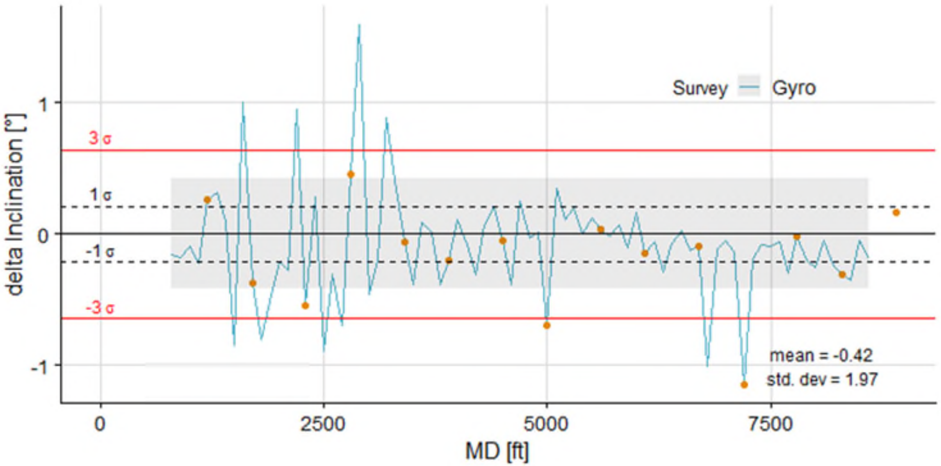



Figure 1 Control Chart: Out-of-Control Signals

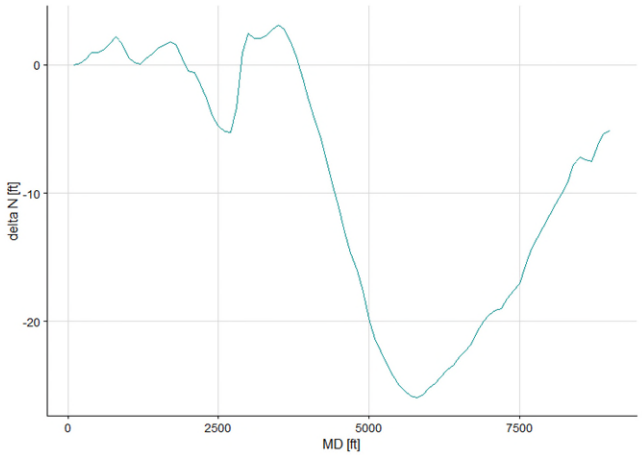
### Current RIP/Control Chart Option from R

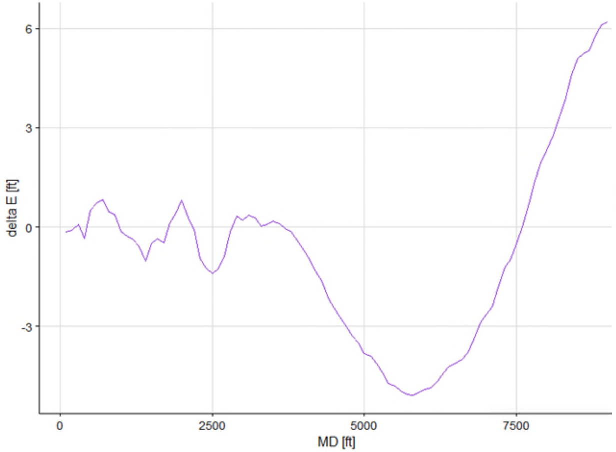


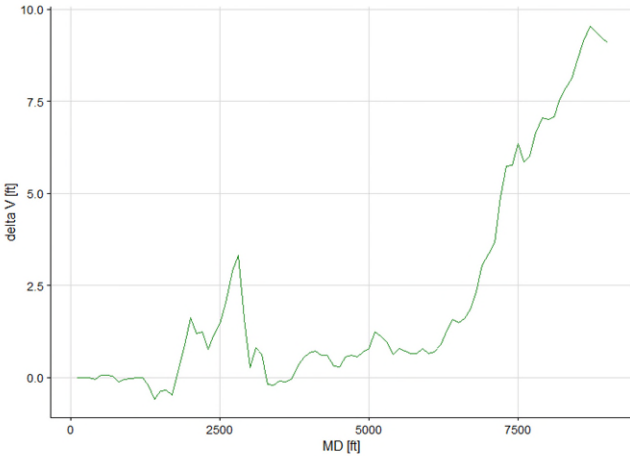

*Shaded area = Tolerance, orange dots = 15 stations used for the Chi-Square Test*

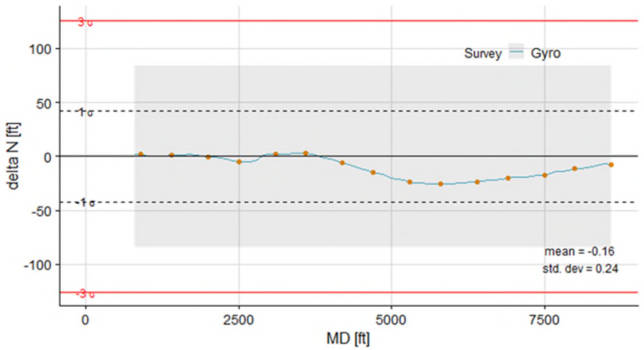
https://asq.org/quality-resources/control-chart

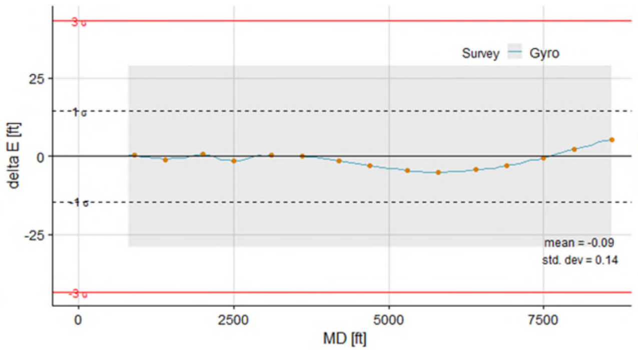
# Distance RIP Plots – Improvement Idea

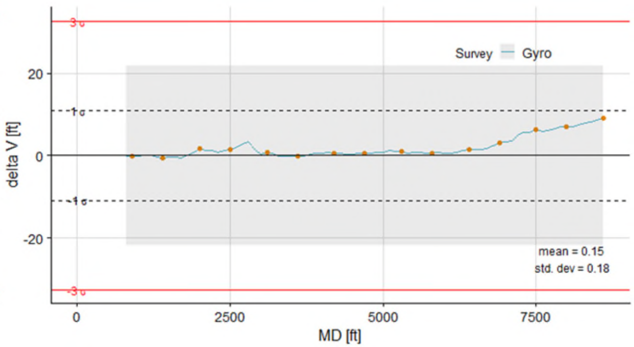


# Chi Squared References

SPE/IADC 105558

**High-Integrity Wellbore Surveys: Methods for Eliminating Gross Errors**
Roger Ekseth, SPE, Gyrodata; Torgeir Torkildsen, SPE, Statoil ASA; Andrew Brooks, SPE, Baker Hughes Inteq; John Weston, SPE, Gyrodata; Erik Nyrnes, SPE, Statoil ASA; Harry Wilson, SPE, Baker Hughes Inteq; and Kazimir Kovalenko, SPE, Gyrodata

Published: February 20, 2007 (Peer Reviewed)

**IADC/SPE-199554-MS**

**Validation of Error Models – A Key Component of Risk Mitigation in Wellbore Collision Challenges**

Tarig Ali, Adrián Ledroz, and John Weston, Gyrodata; William Allen, BP

Published: February 25, 2020 (Peer Reviewed)

# Upcoming Events

# API RP 78 Wellbore Positioning and Surveying

- 4th Technical Draft Complete & Posted on RP78 TG SharePoint
- Balloting Roster Being Prepared / Confirmed
- API RP78 Task Group Program Manager (Assigned)


- **Katie M. Burkle, AStd**
- **Senior Program Manager**
- Standards Department
- **o:** 202.682.8507
- **e:** burklek@api.org
- 200 Massachusetts Ave NW
- Washington, DC 20001

American
Petroleum
Institute

# RP78 Roster (Update in Progress): Email Changes to Jonathan_Lightfoot@oxy.com

| Member | Company | Is Voting Member? | Interest Category | Primary Email (Member) (Person) | Confirm/Delete / Add | Group Count | Edited |
|---|---|---|---|---|---|---|---|
| Stuart Sargeant | Agilis Software Solutions, Inc. | Yes | General Interest | agilis@shaw.ca | Confirmed | 1 | |
| Steve Grindrod | Copsegrove Developments Ltd. | Yes | General Interest | steve@copsegrove.com | Confirmed | 2 | |
| Ed Dew | EG Dew Consulting, LLC | Yes | General Interest | ed.g.dew@gmail.com | Confirmed | 3 | |
| John Connor | ensoco, Inc. | Yes | General Interest | jconner@ensoco.com | Confirmed | 4 | |
| David Gibson | Gibson Reports | Yes | General Interest | david@gibsonreports.com | Confirmed | 5 | |
| Harald Bolt | ICT Europe, Ltd. | Yes | General Interest | harald@depth.solutions | Confirmed | 6 | |
| Neil Bergstrom | Independent Consultant | Yes | General Interest | nbergstrom.pe@gmail.com | Confirmed | 7 | |
| Shaun St. Louis | IPM Magnetics | Yes | General Interest | shaun.stlouis@ipmmagnetics.com | Confirmed | 8 | |
| Angela Mathis | ThinkTank Maths Limited | Yes | General Interest | a.mathis@thinktankmaths.com | ? | 9 | ?? |
| Mike Calkins | Three Sigma Well Design, LLC | Yes | General Interest | tswd@threesigmawelldesign.com | Added to be a Voting Member | 10 | Add |
| Nasikul Islam | AI Driller | Yes | Manufacturer-Service Supplier | nasikul@aidriller.com | Confirmed | 1 | Add |
| Ron Deady | APS Technology, Inc. | Yes | Manufacturer-Service Supplier | rdeady@aps-tech.com | Confirmed | 2 | |
| Jamie Stewart | Baker Hughes | Yes | Manufacturer-Service Supplier | Jamie.Stewart@bakerhughes.com | Confirmed | 3 | |
| Aubrey Holt | Bench Tree Group | Yes | Manufacturer-Service Supplier | Aubrey.Holt@benchtree.net | Confirmed | 4 | Changed |
| Michael Kuhlman | Cougar Drilling Solutions | Yes | Manufacturer-Service Supplier | Mkuhlman@cougards.com | Confirmed | 5 | Add |
| Maria French | Halliburton | Yes | Manufacturer-Service Supplier | maria.french@halliburton.com | Confirmed | 6 | |
| Andy McGregor | Helmerich & Payne, Inc. | Yes | Manufacturer-Service Supplier | andy.mcgregor@hpinc.com | Confirmed | 7 | |
| Mariya Kucherenko | MWDPlanet and Lumen Corp. | Yes | Manufacturer-Service Supplier | mariya@mwdplanet.ca | Confirmed | 8 | Update |
| Mike Attrell | Pacesetter | Yes | Manufacturer-Service Supplier | mattrell@pacesetterdirectional.ca | Confirmed New Email | 9 | Update |
| Mike Long | roundLAB Inc. | Yes | Manufacturer-Service Supplier | mlong@roundlabinc.com | Confirmed | 10 | Update |
| Julie Cruse | Scientific Drilling | Yes | Manufacturer-Service Supplier | julie.cruse@scientificdrilling.com | Confirmed | 11 | Update |
| Ross Lowdon | SLB | Yes | Manufacturer-Service Supplier | RLowdon@slb.com | Confirmed | 12 | |
| Chad Hanak | Superior QC, LLC | Yes | Manufacturer-Service Supplier | chad@superiorqc.com | Confirmed | 13 | |
| Ross Bremner | THREE60 ENERGY | Yes | Manufacturer-Service Supplier | Ross.Bremner@three60energy.com | Confirmed New Email | 14 | Update |
| William T. Allen | BP | Yes | Operator-User | William.Allen@bp.com | Confirmed | 1 | |
| Sareddy Escobar Gonzalez | Cenovus | Yes | Operator-User | sareddy.escobargonzalez@cenovus.com | Confirmed - Note the New Emai | 2 | Update |
| Kevin Sutherland | Chevron | Yes | Operator-User | kevin.sutherland@chevron.com | Confirmed | 3 | Add |
| Dalis Deliu | ConocoPhillips | Yes | Operator-User | Dalis.Deliu@conocophillips.com | Confirmed | 4 | |
| Heather Vannoy | EOG Resources | Yes | Operator-User | heather_vannoy@eogresources.com | Confirmed | 5 | eeking approv |
| Marianne Houbiers | Equinor ASA | Yes | Operator-User | mhou@equinor.com | Confirmed | 6 | |
| Ayush Raj Srivastava | ExxonMobil | Yes | Operator-User | ayush.r.srivastava@exxonmobil.com | Confirmed | 7 | |
| James Franks | Hunt Oil Company | Yes | Operator-User | jfranks@huntoil.com | Need to confirm email | 8 | ?? |
| Bruce Gatherer | Iceland Drilling | Yes | Operator-User | bruce@iceland-drilling.com | Confirmed | 9 | |
| Zim Okafor | Nexen Energy ULC | Yes | Operator-User | zim.okafor@nexencnoocltd.com | ? | 10 | ?? |
| Will Tank | Occidental Oil & Gas Corporation | Yes | Operator-User | Willard_Tank@oxy.com | Confirmed | 11 | |
| Matthew Weber | Shell | Yes | Operator-User | Matthew.Weber@shell.com | Confirmed and Add | 12 | Update |
| Hans Dreisig | Total Energies | Yes | Operator-User | hans.dreisig@totalenergies.com | Confirmed | 13 | |

- SPE Annual Technical Conference and Exhibition 2023
  - San Antonio, Texas, USA
  - 16-18 October 2023
- ISCWSA Sub-Committee Mtgs – Wednesday October 18th
- ISCWSA Meeting 58 – Thursday October 19th

OCT. 18 - OCT. 19, 2023

ISCWSA #58 - San Antonio, Texas

San Antonio

San Antonio, Texas
United States of America

DESCRIPTION

The 58th General Meeting of the ISCWSA will be held in San Antonio, Texas in conjunction with the SPE ATCE.

The General Meeting is planned to take place on Thursday October 19th, with Sub-committee workgroup meetings on Wednesday October 18th. Please communicate with the appropriate Subcommittee Chair to volounteer.

If you would like to make a presentation, please submit your Abstract to the Program Chair using the link in the top bar of this webpage.

We are also looking for SPONSORS for this event. Please contact us directly if you would like further information on how to sponsor this event which will showcase your commitment to best practices in Wellbore Positioning, to the most important people in the world - YOUR customers.

Return here for more details as they become available.

DATE AND TIME

Wed, Oct. 18

-

Thu, Oct. 19, 2023

LOCATION

San Antonio

San Antonio, Texas
United States of America

Event - ISCWSA #58 - San Antonio, Texas

IADD Annual Technical Forum
(2-Day Event)
Call for Presentation Abstracts
October 25th & 26th

Oxy Woodlands Tower Conference Center
Steering Committee Participation
Exhibition (Limited Space)

Program Chair: Samaa Saif Salim Al Adawi
samaa_aladawi@oxy.com

# IADC Technical Publications Committee (TPC) 2023 Annual Meeting

San Luis Resort
5222 Seawall Blvd.
Galveston, TX 77551
Thursday – Friday, October 12th & 13th

Seeking Volunteers
Contact Mary Dimataris if you would like to attend,
mdimataris@outlook.com

# Open Discussion
# Future Topic Ideas
# Questions

# Thank you

Next OWSG Meeting: December 5, 2023

Pot-Luck Lunch Mtg