OWSG GENERAL MEETING

January 25, 2022

Jonathan Lightfoot

Sub-Committee Chair

AGENDA

- OWSG Mission & Anti-Trust
- WITS-LEVEL 7 Survey (J. Lightfoot)
- Intro to Sustained Inclination Calculation (Pete Clark)
- Measure of Lateral Straightness (Pete Clark)
- Cone of Uncertainty Error Models (J. Lightfoot)
- Open Discussion Session
- Focus Areas and Future Goals

Last Meeting Action Items

- Share Meeting Slides & Minutes with Nov. Attendee Group
- Post slides & minutes on the OWSG Sub-Committee section of ISCWSA
- Share Naming Spreadsheet & request feedback
- Case Study Topics for the January Meeting
- RP-78 Roster and Invite Operators to the 2022 OWSG Meetings
- Develop a 2022 Operator Poll to prioritize topics and focus areas

Attendance & Introductions

Operators

1.	Jonathan Lightfoot	Oxy
2.	Will Tank	Oxy
3.	Pete Clark	Chevron
4.	Kevin Sutherland	Chevron
5.	Ryan Carlson	XTO | ExxonMobil
6.	Knut Johannes Ness	ADNOC
7.	Dalis Deliu	ConocoPhillips
8.	Marianne Houbiers	Equinor
9.	Nick Robertson	BP
10.	Hans Christian Dreisig	Total Energies
11.	Bill Allen	BP
12.	Jacob Gauthier	BPX Energy
13.	Chad Dubois	XTO | ExxonMobil
14.	Juan Jose Exposito Gonzalez	CEPSA
15.	Heather Vannoy	EOG

Guests

1.	Adrian Ledroz	Gyrodata
2.	Marc Willerth	H&P Technologies
3.	Gary Skinner	Baker Hughes
4.	Timothy Patton	Superior QC

OWSG Mission

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

OWSG Anti-Trust

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. 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.

WITS-Tables
LEVEL 7
Survey / Directional

J. Lightfoot

WITS Pre-Defined Record Types

Record Number	Name	Description
01	General Time-Based	Drilling data gathered at regular time intervals
02	Drilling - Depth Based	Drilling data gathered at regular depth intervals
03	Drilling - Connections	Data gathered at drilling connections
04	Hydraulics	Hydraulics data gathered while circulating
05	Trip - Time	Tripping data gathered while running in/pulling out
06	Trip - Connections	Tripping data gathered at tripping connections
07	Survey/Directional	Directional/Survey data
08	MWD Formation Evaluation	MWD Formation Evaluation data
09	MWD Mechanical	MWD Mechanical data
10	Pressure Evaluation	Pressure Evaluation data
11	Mud Tank Volumes	Mud Tank (Pit) Volume data
12	Chromatograph Cycle-Based	Chromatograph Cycle data
13	Chromatograph Depth-Based	Chromatograph data averaged over depth intervals
14	Lagged Mud Properties	Mud Property data based returns depth increments
15	Cuttings / Lithology	Cuttings Lithology and related data
16	Hydrocarbon Show	Hydrocarbon Show related data
17	Cementing	Well Cementing operations data
18	Drill Stem Testing	Well Testing operations data
19	Configuration	Drillstring and Rig Configuration data
20	Mud Report	Mud Report data
21	Bit Report	Bit Report data
22	Remarks	Freeform Comments
23	Well Identification	Well Identification data
24	Vessel Motion / Mooring Status	Vessel Motion and Mooring Status data
25	Weather / Sea State	Weather and Sea State data

Wellsite Information Transfer Specification

Revsion 1.1

The *WELLSITE INFORMATION TRANSFER SPECIFICATION (WITS)* is an industry standard data communication format used by Petrospec Technologies in its software. The WITS standard is intended for use at the wellsite. It is a recommended format by which service companies and operating companies can exchange data.

WITS defines a set of pre-defined records for specific data values. Additionally, users may add data items in the fields marked SPARE.

WITS is a multi-level transmission format. This arrangement offers a basic transmission format (LEVEL 0), and additional levels with increasingly flexibility. At the lowest levels, a fixed format ASCII data stream is transmitted; at the highest level a self-defining customizable data stream is available.

A WITS data stream is made up of a series of data records. Each data record type can be created independently of other data record types and each has a unique trigger variable and sampling interval. The activity on the rig determines which records are applicable at any given time so that only appropriate data is transmitted.

WITS Transmission Levels

Level 0

Also known as *"Intra Rig Transfer Specification"*, this involves a very basic ASCII transfer format intended primarily for sharing of information between service companies, though lending itself well as a simple entry point into wellsite data transfer. Data items are identified by a numeric string tying the value to a particular location within a Pre-Defined Record, or to an agreed upon addition to the Data Dictionary.

Level 1

In Level 1 and above, the data stream takes on a binary (LIS) format. Values are expressed in LIS-defined representations (e.g. floating point, integer, string, etc) The data items are packaged into a WITS Data Record and then sandwiched between LIS Physical and Logical Record Headers and Trailers, to make up a LIS Data Record.

Level 2

WITS Level 2 builds on Level 1 through addition of WITS bidirectional dialogue through the use of LIS Comment records. This dialogue is used in synchronization at start up and after a communications line interruption, as well as permitting two-way messaging between the sender and receiver. Such messages might include requests for change in transmission intervals for certain records, for example.

Level 2b

WITS Level 2b adds the option to buffer data that has been transmitted, making it available for re-transmission in the event of non-receipt of data by the receiver.

Level 4

WITS Level 4 employs a completely different format than the previous levels since it is based on the emerging data transfer standard of API RP66. The concepts of Pre-Defined Records and Bi-Directional Dialogue remain, but using RP66 as the formatting mechanism.

RECORD # 7 : SURVEY / DIRECTIONAL

WITS Record ID:	07
Logical Record Type:	157
Auto/Manual:	AUTO(MWD) / MANUAL
Trigger:	[EVENT] Transmit when new survey data values are received and computed (MWD) or when manually triggered by operator
Data Source:	Data acquired in real-time by MWD tools or entered manually from other sources

ID	Item	Description	Long Mnemonic	Short Mnemonic	Type	Length	Metric Units	FPS Units
07	01	Well Identifier	WELLID	WID	A	16	----	----
07	02	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	----	----
07	03	Record Identifier	RECID	RID	S	2	----	----
07	04	Sequence Identifier	SEQID	SQID	L	4	----	----
07	05	Date	DATE	DATE	L	4	----	----
07	06	Time	TIME	TIME	L	4	----	----
07	07	Activity Code	ACTCOD	ACTC	S	2	----	----
07	08	Depth Svy/reading (meas)	DEPTSVYM	DSVM	F	4	M	F
07	09	Depth Svy/reading (vert)	DEPTSVYV	DSVV	F	4	M	F
07	10	Pass Number	PASSNUM	PASS	S	2	----	----
07	11	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
07	12	Svy Type	SVYTYPE	STYP	A	08	----	----
07	13	Svy Inclination	SVYINC	SINC	F	4	DEG	DEG
07	14	Svy Azimuth (uncorrected)	SVYAZU	SAZU	F	4	DEG	DEG
07	15	Svy Azimuth (corrected)	SVYAZC	SAZC	F	4	DEG	DEG
07	16	Svy Magnetic Toolface	SVYMTF	SMTF	F	4	DEG	DEG
07	17	Svy Gravity Toolface	SVYGTF	SGTF	F	4	DEG	DEG
07	18	Svy North-South Position	SVYNS	SNS	F	4	M	F
07	19	Svy East-West Position	SVYEW	SEW	F	4	M	F
07	20	Svy Dog Leg Severity	SVYDLS	SDLS	F	4	DGHM	DGHF
07	21	Svy Rate of Walk	SVYWALK	SWLK	F	4	DGHM	DGHF
07	22	< SPARE 1>	SPARE1	SPR1	F	4	----	----
07	23	< SPARE 2>	SPARE2	SPR2	F	4	----	----
07	24	< SPARE 3>	SPARE3	SPR3	F	4	----	----
07	25	< SPARE 4>	SPARE4	SPR4	F	4	----	----
07	26	< SPARE 5>	SPARE5	SPR5	F	4	---	----

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WITS-LEVEL 7
Survey Object Tables

J. Lightfoot

Intro to Sustained Inclination Calculation

Pete Clark

Inferred Wellbore Position

Pete Clark

Chevron CTC Wells, Wellbore Placement Focal Point

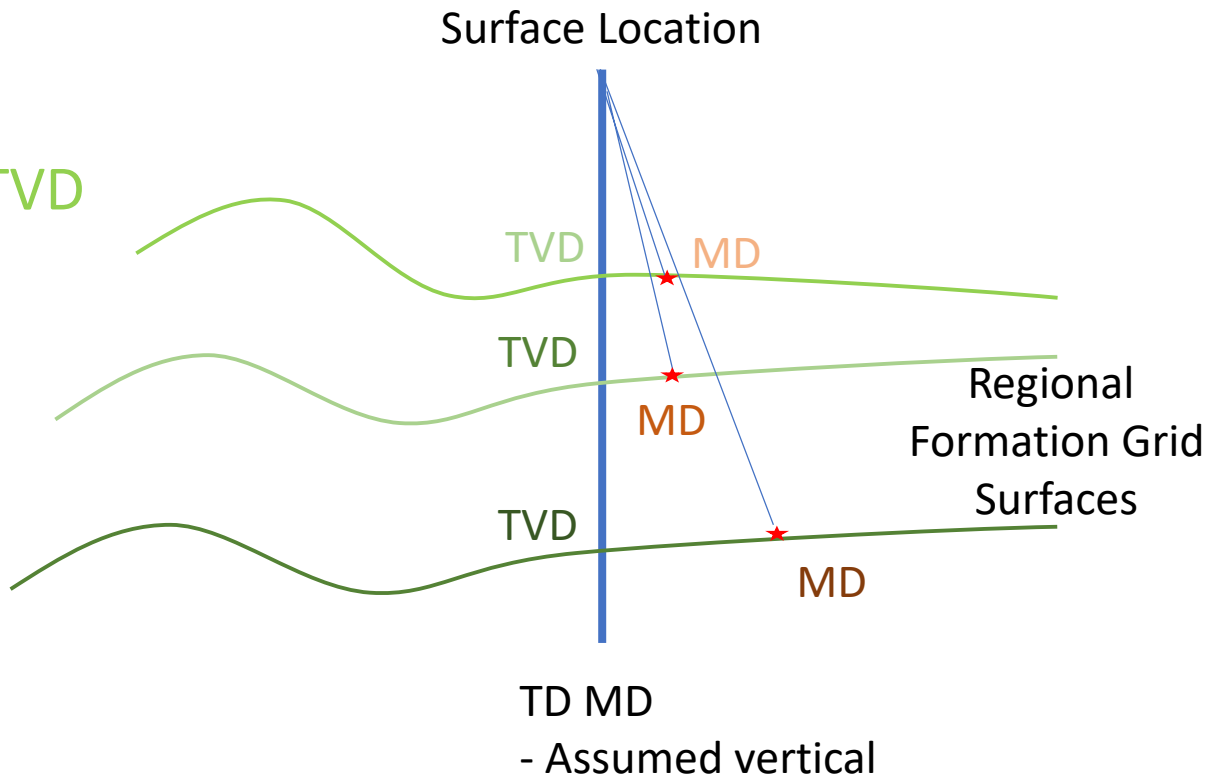
01/21/22

Inferred Wellbore Position - Challenge

- Challenge
  - Many downhole wellbore positions defined by
    - Surface location
    - TD MD
  - No directional survey information
- Leads to
  - Assign “Blind” positional uncertainty model
  - ~46° cone
  - at TD error radius is greater than depth
    - Additional cost due to directional drilling to avoid possible well’s placement
    - Inefficiency risk assessing potentially unlikely well collision
      - Discount Blind wells as no risk

Inferred Wellbore Position – Proposal

- From existing measurements & models
  - Calculate TVD for formation grid using
    - Surface location
    - Regional formation top surfaces
  - Compare recorded top MD to projected TVD
    - Calculate **Sustained Inclination (SustInc)**
      - **SustInc** = ArcCosine(TVD / MD)
      - If **SustInc** < 5°
        - Assign “Inc-Only-Planned” PU model
        - ~7.26° cone @ 3σ
      - If 5° ≤ **SustInc** < 10°
        - Assign “Inc-Only-Planned-10” PU model
        - ~14.52° cone @ 3σ
      - If **SustInc** ≥ 10°
        - Assign “Blind” PU model
        - Not credible to consider this as a near vertical well
        - Means there’s no surveys for a deviated well & is why Blind is an appropriate model



Process & Rules

- For SustInc to be valid
  - Calculated from at least two credible formation top comparisons
  - SustInc = Maximum of all available comparisons

- Individual calculation outcomes
  - No match, no calculation
  - MD ≥ TVD, potentially valid calculation
  - MD < TVD, invalid calculation
    - Realistic situation as recorded top may be deep to true or formation grid may be shallow to true
    - Assign value to this comparison of 5°

Credible Calculations

- Safeguard against gross error
  - Recorded top and formation grid refer to different items
  - Set delta length tolerance
    - ABS(delta formation grid to recorded top) < tolerance

  - Suggested tolerance value =
    deepest productive horizon / cos(10) - deepest productive horizon
    e.g. if deepest productive horizon = 10,000ft, tolerance = 154ft, or less

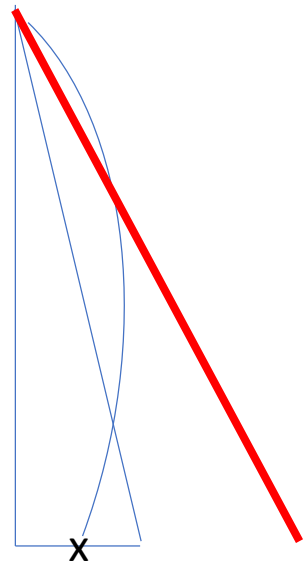
  - Counter for credible calculations (cumulative credible calculations)
  - Must exceed two
    - If ABS(delta formation grid to recorded top) ≥ tolerance then
    cummulative credible calculations = cumulative credible calculations - 1

Implementation

- Anticipated to be by machine
  - Hence algorithmic approach

Inferred Wellbore Position – Surface Issue

- Is this only a geometric issue?
- It's always possible to generate a wellpath that exceeds the error bounds at surface
- Example
  - SustInc calculated to be less than 5°
  - Inc-Only-Planned generates ~7.26° cone (red line)
  - Hypotenuse is MD
  - Vertical side is TVD
  - Keeping TVD and reducing displacement provides "slack"
    - Generate curve (hyperbola / parabola?)
  - Assumes initial inclination > 7.26°
    - Realistic?



Proposal

- Form a CA sub-committee work group

- Review this proposal
- Alternate approaches
- Optimize method
- Identify issues
- Produce guidance
  - To include the statement that good surveying practices should always be employed and resurveying wells missing surveys is best practice

- Actions
  - Present full process @ ISCWSA Collision Avoidance Sub-Committee
    - Form work group
      - Refine and codify process for industry

- If interested, please let me know
  - Will be added to CA sub-committee invite

Thanks!

Measure of Lateral Straightness

Pete Clark

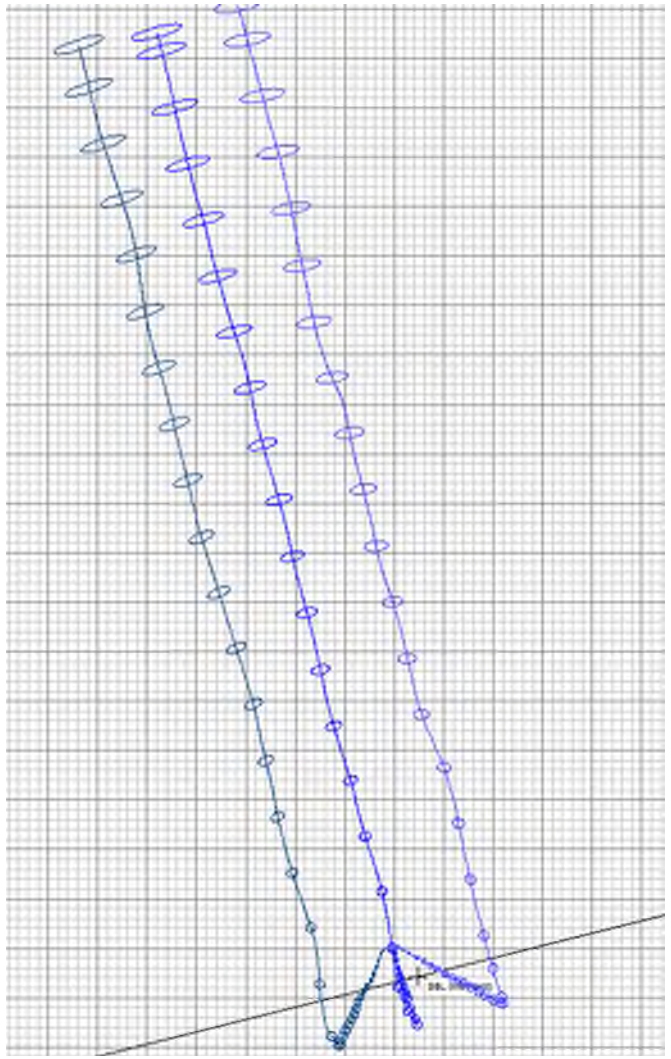
Measure of Lateral Straightness

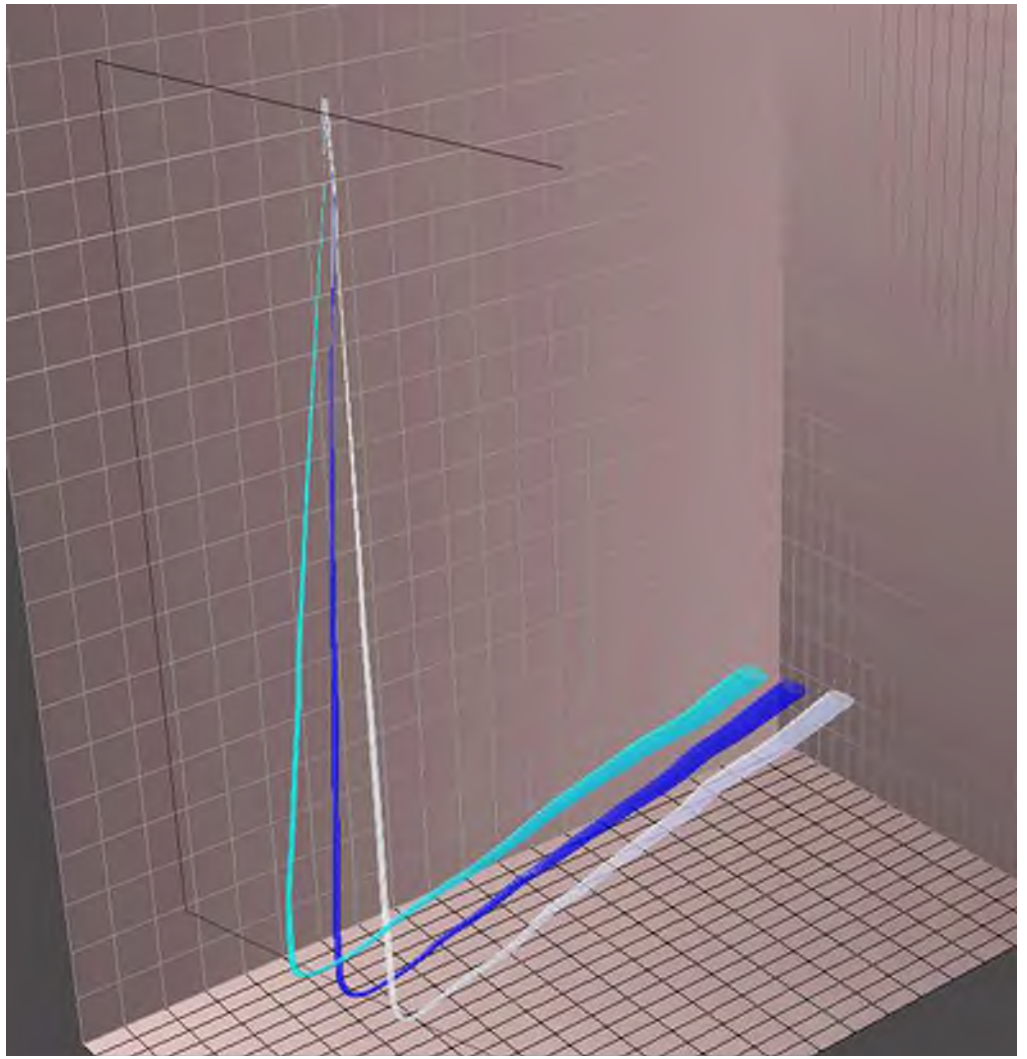
Pete Clark

Chevron CTC Wells, Wellbore Placement Focal Point

01/21/22

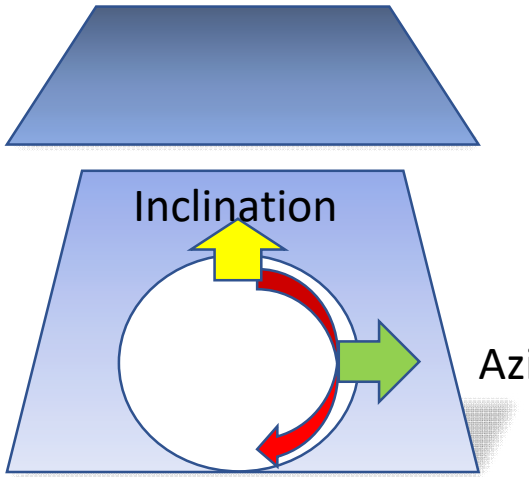
UCR Directional Challenge





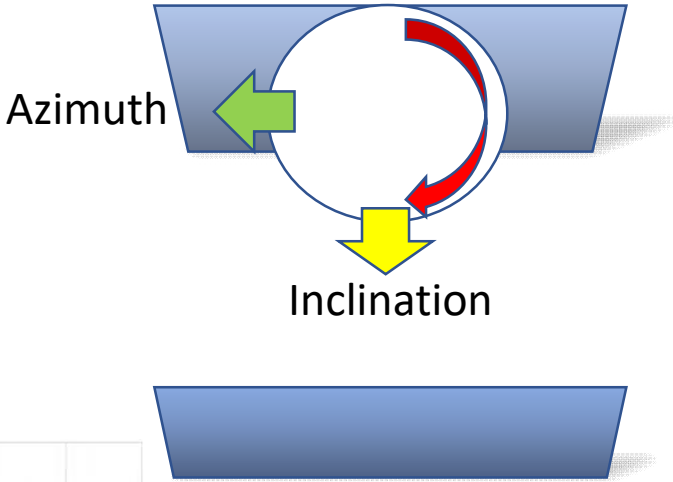
Why can’t we drill a straight wellbore?

Tagging hard floor with low incidence

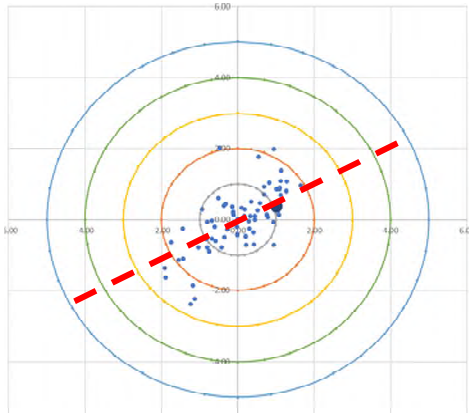


Build inclination &
ROLL RIGHT

Tagging hard ceiling with low incidence



Drop inclination &
LEVER LEFT

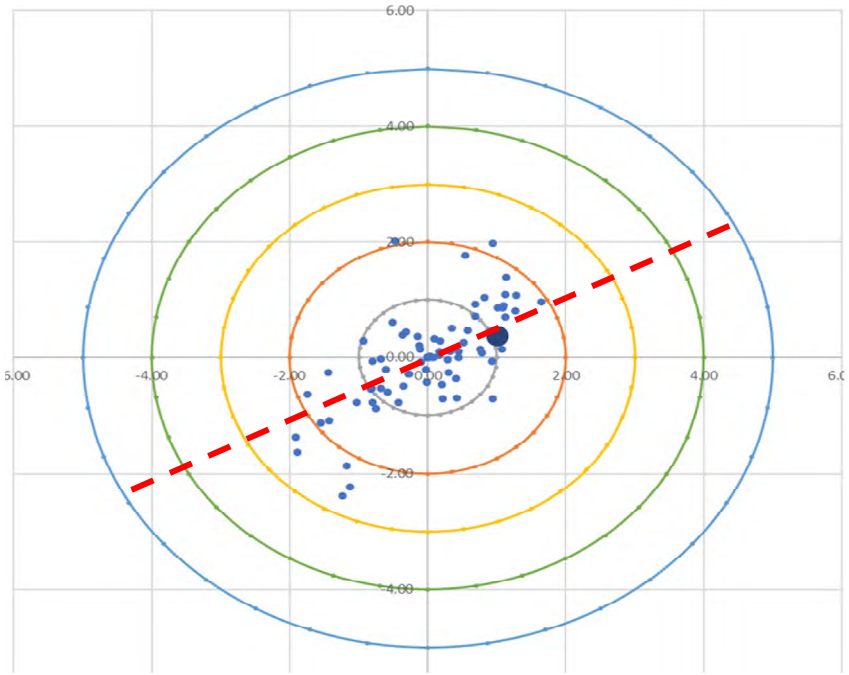


Gordy Oil Co
Pecos County
Bone Springs
API 42371395710100

Example of typical resultant toolfaces and dogleg severity from directional survey measurements

DLS v TF

- Polar plot of DLS and resultant toolface
- Resultant toolface is the highside toolface required to get from one directional survey measurement to the next

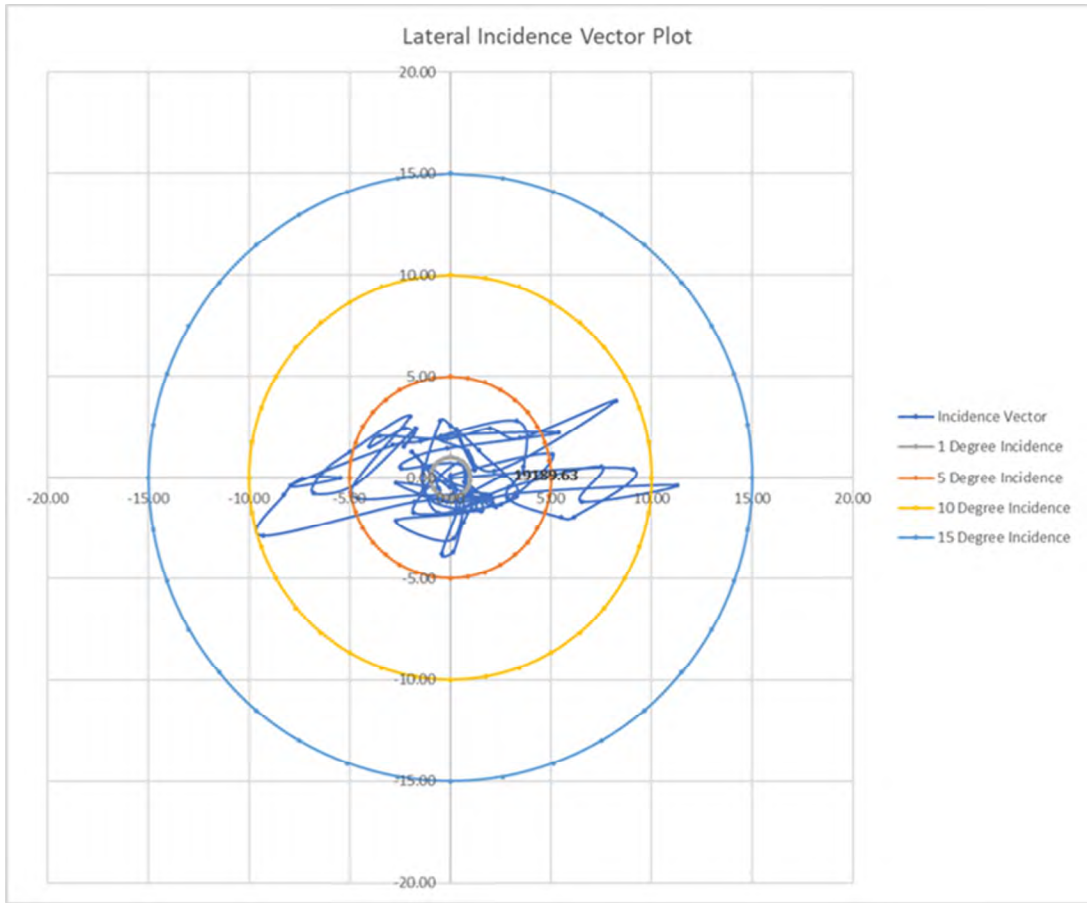


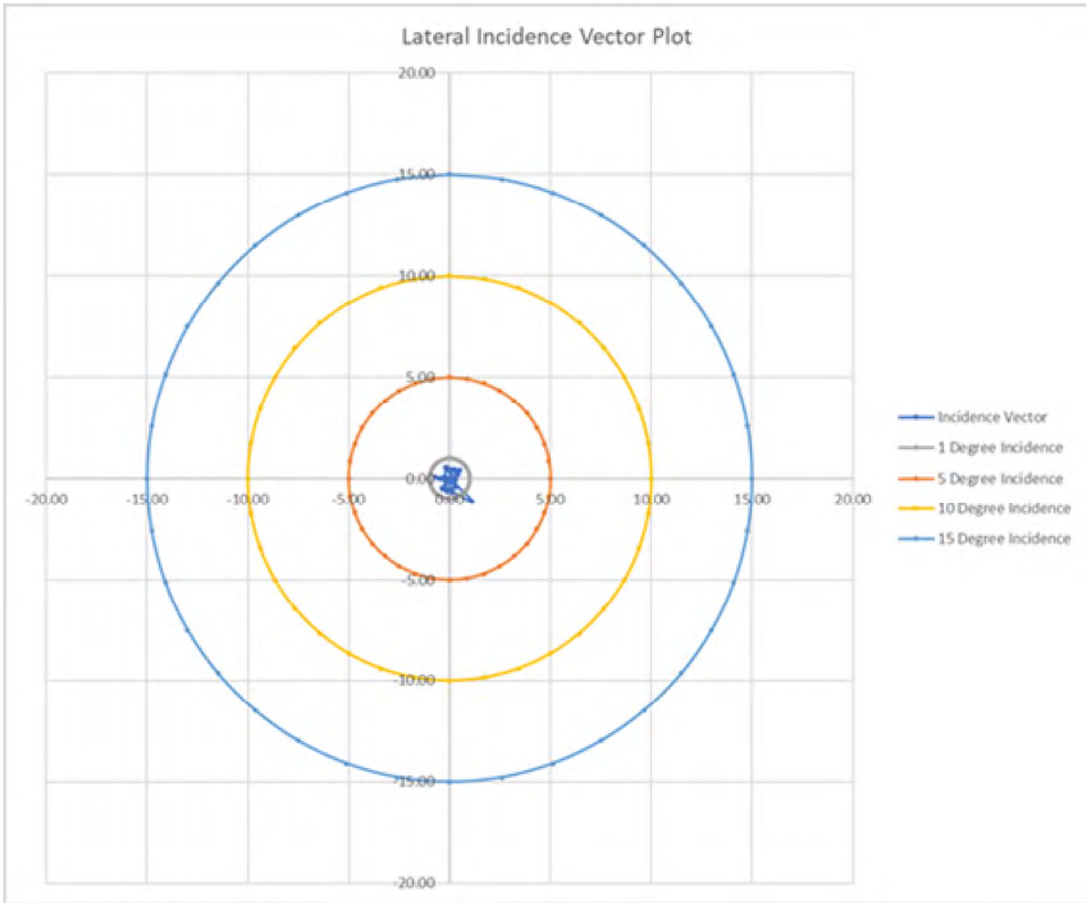
- DLS & TF distribution has similarities with lateral incidence plot as it uses resultant TF but this polar plot has DLS as magnitude. Again, the closer to the center the better
- This distribution often illustrates interaction with bedding planes causing an up/right & down/left tilt
- An average DLS & TF is calculated (big blue dot). Average DLS is its mean value. Average TF calculation rectifies all TF into the positive quadrants before taking the mean.
  - Should weight the values for survey course length
- If inc hold was perfect the average TF would be on the horizontal line

Lateral Incidence Plot / Value

- Calculate a straight line from first survey to last point in the lateral
  - Lateral's average azimuth, lateral's average inclination
- Calculate the incidence angle (attitude different) between this line and the orientation of the wellbore at each survey point (cosine rule)
- The incidence angles can be matched with a resultant toolface (toolface required to go from one survey station to the next) and plotted on a circular (polar) plot using incidence angle as the magnitude
- A perfectly straight line would be a dot in the center
  - …the tighter the better, the greater the spread the less straight the well and the higher the sideload forces required while drilling
- Average incidence angle in the lateral is a measure of the wellbore straightness
  - Values should be weighted for survey interval

Lateral Incidence Plot





Tortuosity v Average DLS v Average Incidence

Measure	Tortuosity	Average DLS	Average Incidence
Whole Well	Yes		
Lateral Only	Possible	Yes	Yes
Standard Calculation	No	Yes	Yes
Easily Understood		Yes	
Curvature		Yes	Yes
Straightness	Yes		Yes


Questions
&
Answers
Discussion

Cone of Uncertainty Error Models

J. Lightfoot

Utility Error Models for Vertical Cone of Error (COE)
Inclination for Vertical Wells
Max Departure Calculation

OWSG Prefix	Short Name	Long Name	Application	Replaces	Source	Technology Type
COE_IO05Ub	COE_IO05Ub_INC-ONLY	COE Inc-Only_FieldData_5ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 5ft/1,000' of Displacement, 50ft EOU at 10K ft Vertical. Rev - WWDC-DDS	COE_IO05Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO10Ub	COE_IO10Ub_INC-ONLY	COE Inc-Only_FieldData_10ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 10ft/1,000' of Displacement. 100ft EOU at 10K ft Vertical. Rev - WWDC-DDS	COE_IO10Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO15Ub	COE_IO15Ub_INC-ONLY	COE Inc-Only_FieldData_15ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 15ft/1,000' of Displacement. 150ft EOU at 10K ft Vertical. Rev - WWDC-DS	COE_IO15Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO20Ub	COE_IO20Ub_INC-ONLY	COE Inc-Only_FieldData_20ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 20ft/1,000' of Displacement. 200ft EOU at 10K ft Vertical. Rev - WWDC-DDS	COE_IO20Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO25Ub	COE_IO25Ub_INC-ONLY	COE Inc-Only_FieldData_25ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 25ft/1,000' of Displacement. 250ft EOU at 10K ft Vertical. Rev - WWDC-DS	COE_IO25Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO30Ub	COE_IO30Ub_INC-ONLY	COE Inc-Only_FieldData_30ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 30ft/1,000' of Displacement. 300ft EOU at 10K ft Vertical. Rev - WWDC-DDS	COE_IO30Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO35Ub	COE_IO35Ub_INC-ONLY	COE Inc-Only_FieldData_35ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 35ft/1,000' of Displacement. 350ft EOU at 10K ft Vertical. Rev - WWDC-DS	COE_IO35Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO40Ub	COE_IO40Ub_INC-ONLY	COE Inc-Only_FieldData_40ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 40ft/1,000' of Displacement. 400ft EOU at 10K ft Vertical. Rev - WWDC-DDS	COE_IO40Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO45Ub	COE_IO45Ub_INC-ONLY	COE Inc-Only_FieldData_45ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 45ft/1,000' of Displacement. 450ft EOU at 10K ft Vertical. Rev - WWDC-DS	COE_IO45Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO50Ub	COE_IO50Ub_INC-ONLY	COE Inc-Only_FieldData_50ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 50ft/1,000' of Displacement. 500ft EOU at 10K ft Vertical. Rev - WWDC-DDS	COE_IO50Ua_INC-ONLY	Operator Specified	Operator Utility Tool
COE_IO55Ub	COE_IO55Ub_INC-ONLY	COE Inc-Only_FieldData_55ft_per_1Kft	Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 55ft/1,000' of Displacement. 550ft EOU at 10K ft Vertical. Rev - WWDC-DS	COE_IO55Ua_INC-ONLY	Operator Specified	Operator Utility Tool

*COE_IO30Ua_INC-ONLY.ipm - Notepad

File Edit Format View Help

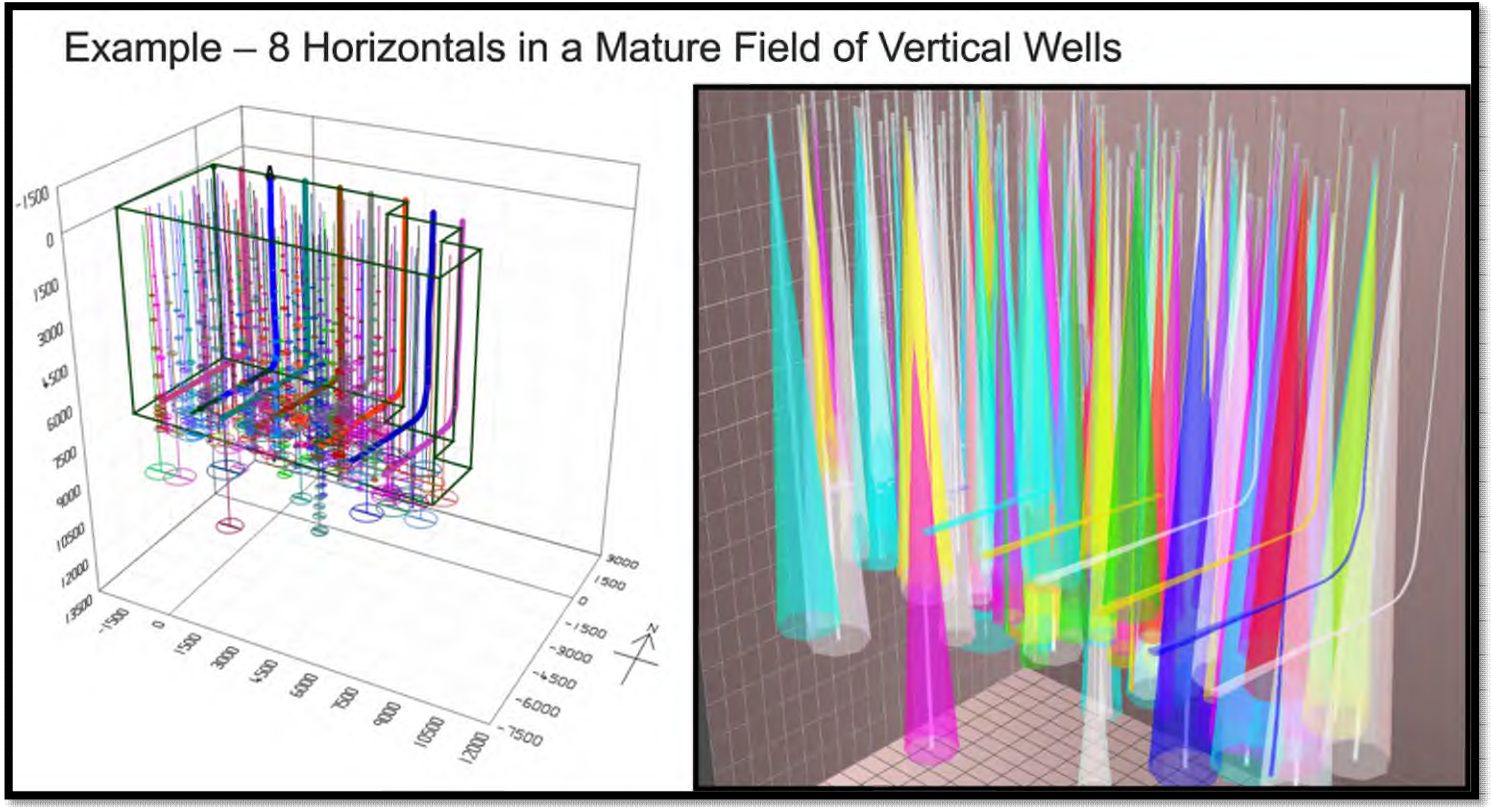
```
#ShortName:COE_IO30Ua_INC-ONLY
#Description:COE Inc-Only_FieldData_30ft_per_1Kft
#Remarks:For vertical wells with inclinations less than 5 deg.^~Rev a Review SEPT-2016-13
#ToolGroup:5
#ToolType:0
#Correlate:0
#SingleShot:0
#CostPerRun:0
#CostPerLength:0
#RunningSpeed:0
#RevisionNumber:1
#RevisionDate:7/5/2016 12:00 AM
#RevisionComment:July-2016-09-13_ForVeritcalWells
#SourceReference:Created by JLightfoot
#ToolApplication:Occidental Error Model for vertical wells with inclination data analysis that supports an anticipated maxiumum 30ft/1,000' of Displacement.  300ft EOU at 10K ft Vertical
#CurrentStatus:Agreed
#ReplacesTool:None /
#InclinationRangeMin:0
#InclinationRangeMax:5
#AzimuthEWRestriction:0
#RangeComment:Estimated EOU based on Field Data
#ToolParameters:COE_IO30
#UtilityToolType:
#MagneticCorrectionType:
#DepthReferenceType:
#GyroToolType:
#GyroContractorType:
#MagneticToolType:
#MagneticReferenceType:
#InclinationToolType:Planned
#ChecksumValue:-739151103
#Name   Vector  Tie-On  Unit    Value   Formula
coe     m       w       t       10.75269        1.0     0       5
doe     d       w       t       3.5842294       1.0     0       5
drfs    s       s       m       1       1.0
dsfs    e       s       -       0.0015  tmd
dstg    e       g       im      2.5e-007        tmd*tvd
```

EXAMPLE CONE OF ERROR MODEL

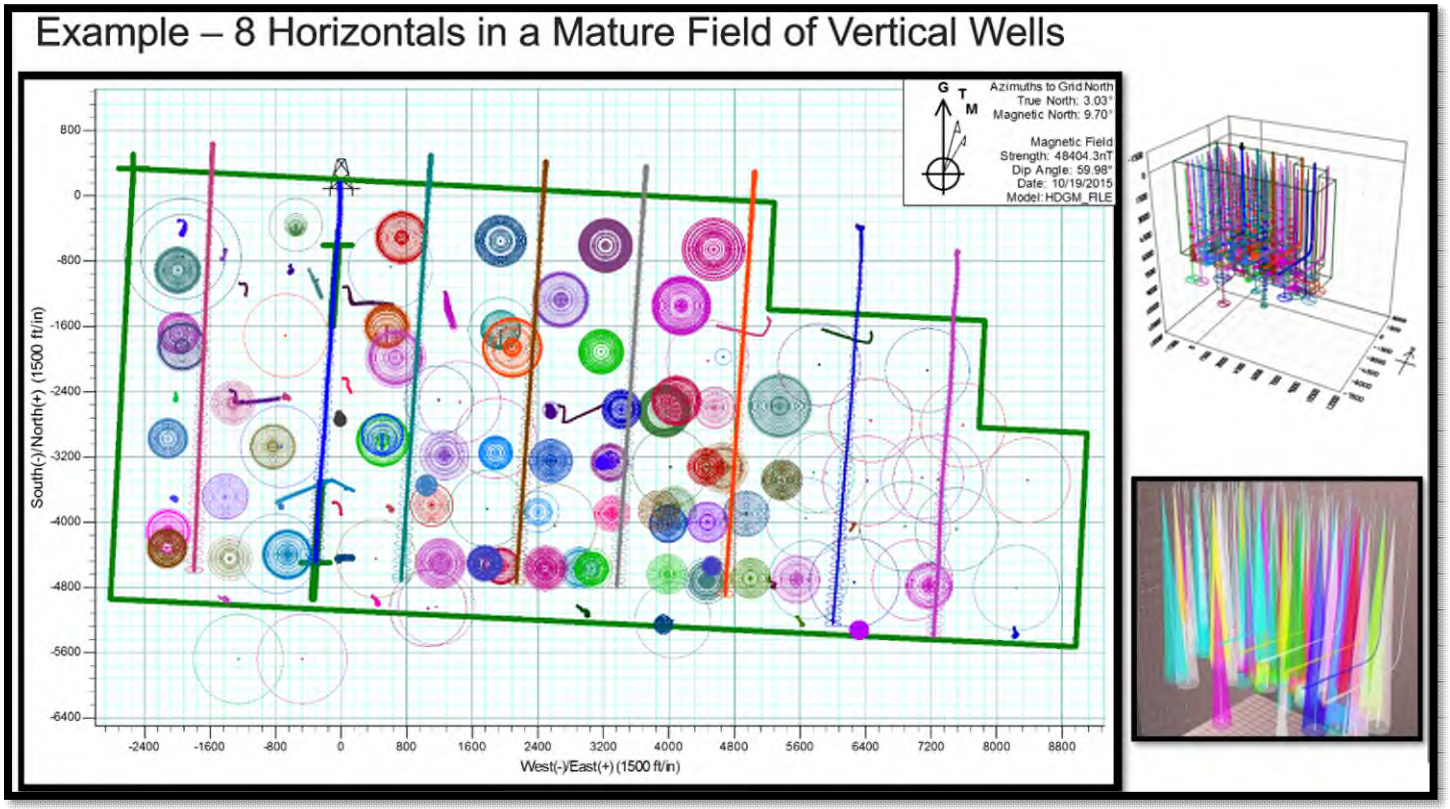
https://www.landmark.solutions/life2019-presentations

LIFE 2019 (Excerpt)

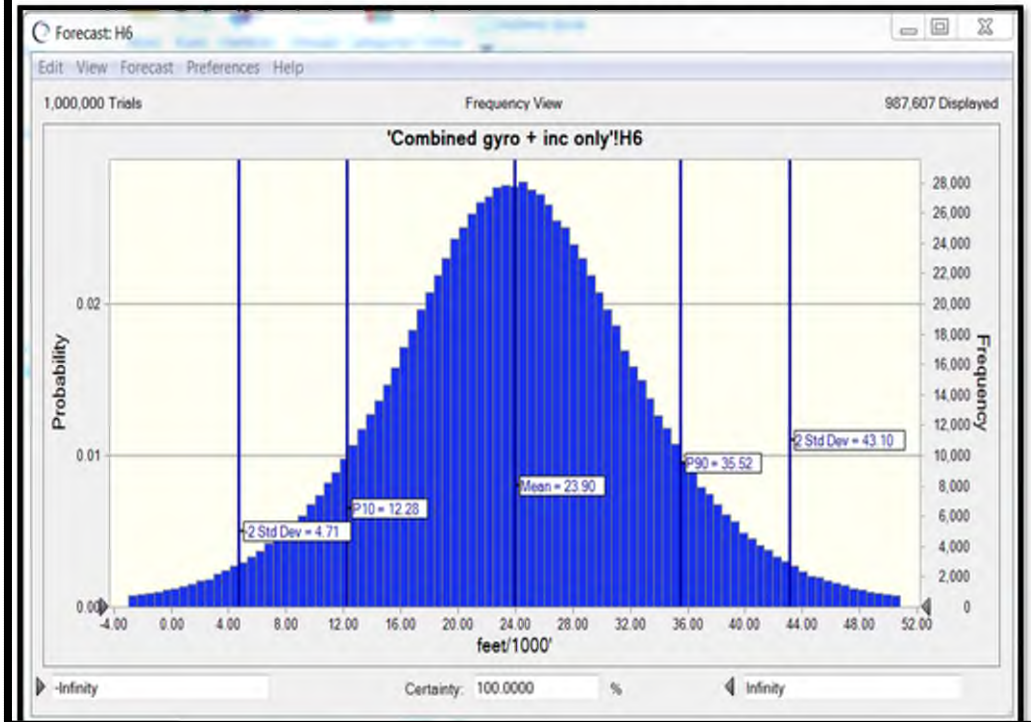
Example – 8 Horizontals in a Mature Field of Vertical Wells

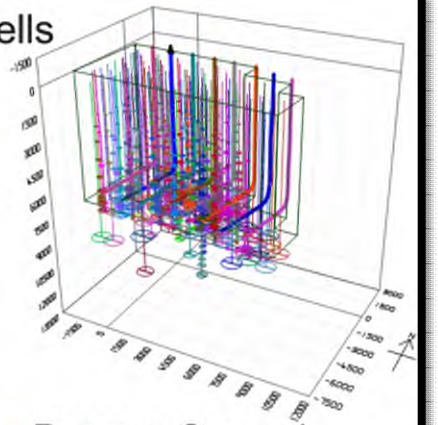


Example – 8 Horizontals in a Mature Field of Vertical Wells



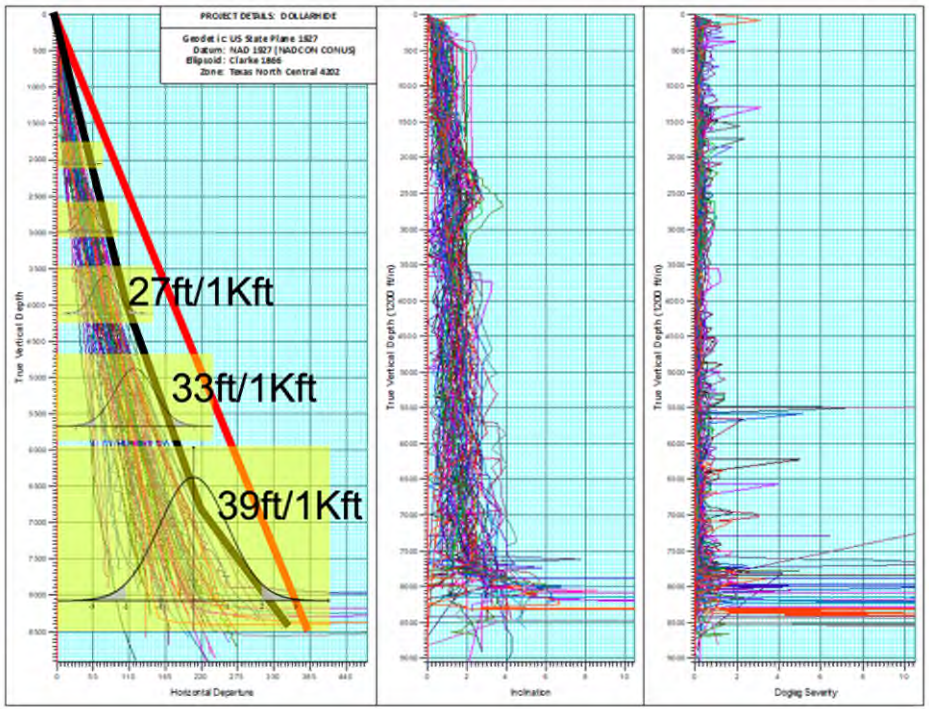
Example – 6 Horizontals in a Mature Field of Vertical Wells

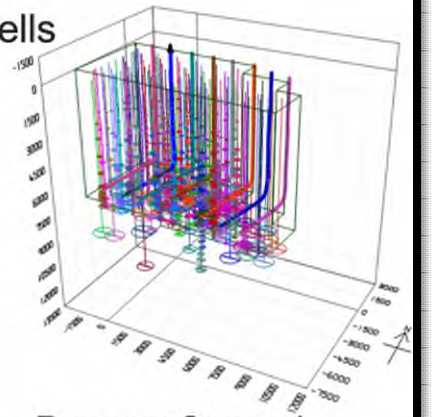




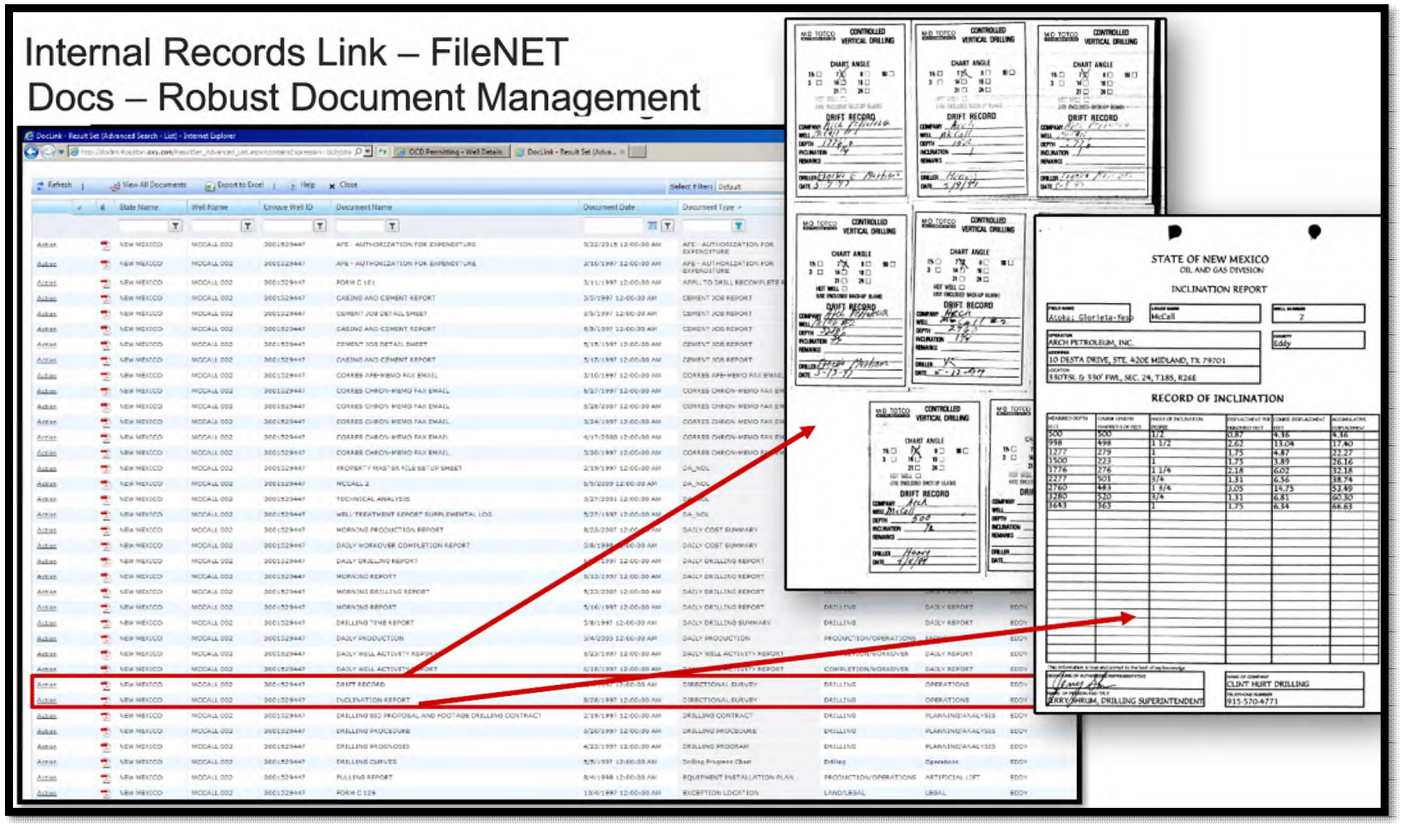
- Remove Steered Verticals using DLS Chart
- View Displacement Trend for the field
- 385ft/8.5 = 45.4ft/1Kft COU

Example – 6 Horizontals in a Mature Field of Vertical Wells



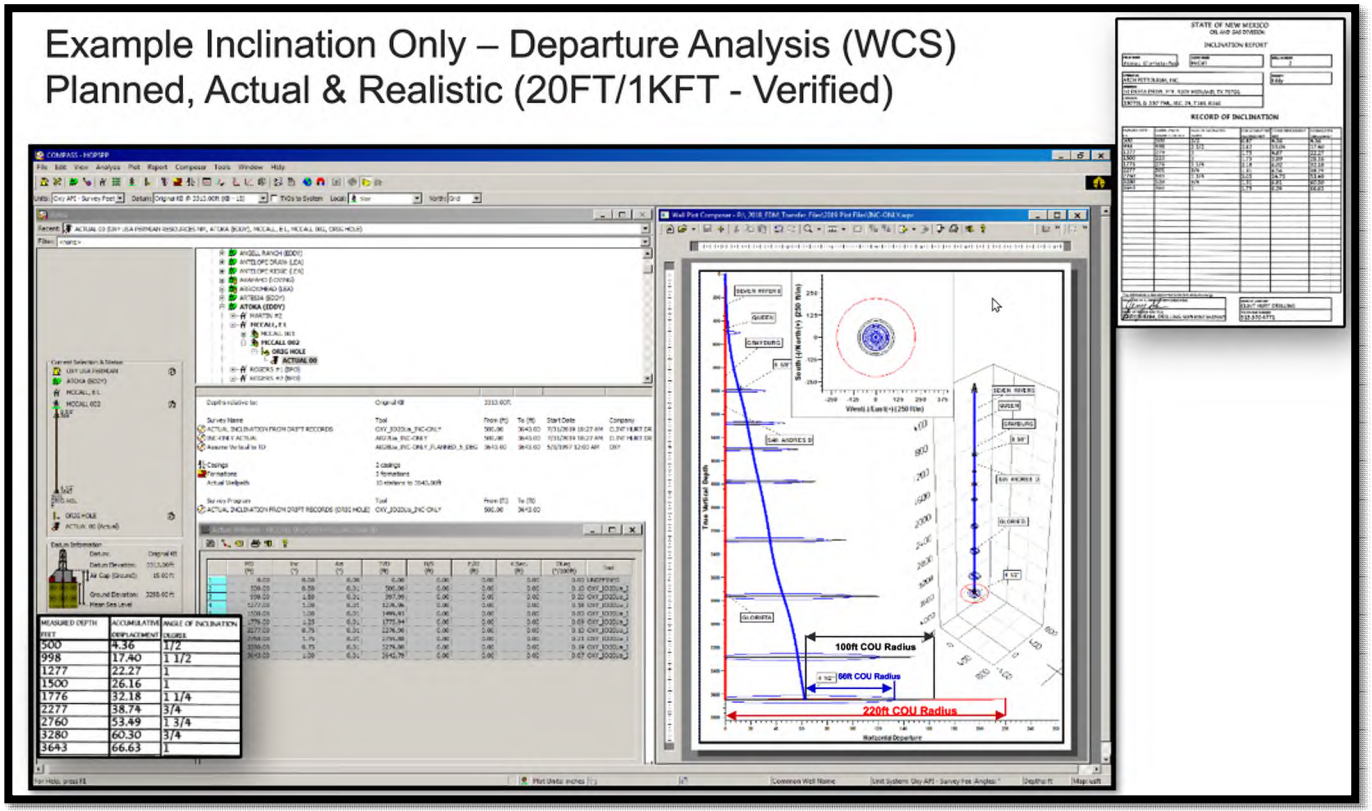


- Remove Steered Verticals using DLS Chart
- View Displacement Trend for the field
- 385ft/8.5 = 45.4ft/1Kft COU



Presentation Excerpt

Example Inclination Only – Departure Analysis (WCS)
Planned, Actual & Realistic (20FT/1KFT - Verified)



MEASURED DEPTH	ACCUMULATIVE DISPLACEMENT	ANGLE OF INCLINATION
500	9.36	1/2
998	17.40	1 1/2
1277	22.27	1
1500	26.16	1
1776	32.18	1 1/4
2277	38.74	3/4
2760	53.49	1 3/4
3280	60.30	3/4
3643	66.63	1

Open Discussion

All Members

Upcoming Meetings

ISCWSA ONLINE TRAINING – APPLY THRU JAN 31ST | $1,200 Tuition

ISCWSA Error Model Maintenance Sub-Committee Mtg. January 26th (Darren Aklestad)

ISCWSA Collision Avoidance Sub-Committee Mtg Feb. 15 (Gary Skinner)

ISCWSA General Meeting 55: MARCH 30th – 31st (Call for Abstracts)

OWSG Schedule: The Fourth Tuesday of Every 2 Months (Jonathan Lightfoot)

March 22nd

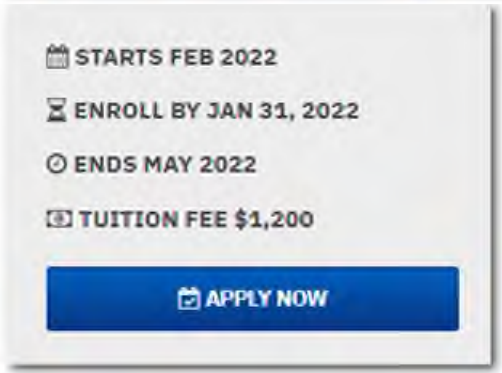
May 24th

July 26th

September 27th

November 22nd

ISCWSA Wellbore Positioning Course



Wellbore Positioning Course

Other Industry Events

- IADC ART: "Upgrading the Grading" – Feb. 9th (VPD Live Stream)
- DSAT / ART Symposium & Reception (Galveston, TX) Mar. 7th
- IADC/SPE International Drlg Conf. & Exhibition (Galveston, TX) Mar. 8th-10th
- IADC Drilling Engineering Committee Tech Forum (Houston, TX / Virtual) Mar. 30th
- SPE ATCE Annual Technical Conf. and Exhibition (Houston, TX) Oct. 3rd - 5th
  - Call for Papers Deadline: Jan. 31, 2022

Action Items

- Share Meeting Slides & Minutes with Jan. 25 Attendee Group
- Post slides & minutes on the OWSG Sub-Committee section of ISCWSA
- Schedule Presentation / Case Study Topics for the March Meeting
- Develop a March 2022 Operator Poll to prioritize topics and focus areas
- Organize the Agenda for the 2022 March Meeting
- Prepare a ISCWSA Meeting 55 Sub-Committee Report for OWSG

Review of the Survey Table from the last meeting

PROPOSED MASTER LIST OF EDM COMPASS ISCWSA REVISION 5-1 INSTRUMENT PERFORMANCE MODELS BASED ON ISCWSA / SPE WPTS PAPER: IADC/SPE 178843-MS

No	ISCWSA Prefix	Short Name	Long Name	Rev.	Application	Software Lookup Name	Replaces	FLOATER	Category	Sub-Category	Reference	Correction
1	A001Mc	MWD+SRGM	ISCWSA MWD + SRGM	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) with no additional corrections	A001Mc_MWD+SRGM_R5.1	A001Mb	N	Magnetic	MWD	SRGM	None
2	A001Mc	MWD+SRGM_FI	ISCWSA MWD + SRGM [Floating Rig]	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) with no additional corrections on a Floating Rig	A001Mc_MWD+SRGM_FI_R5.1	A001Mb	Y	Magnetic	MWD	SRGM	None
3	A002Mc	MWD+SRGM+SAG	ISCWSA MWD + SRGM + Sag Correction	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) and Sag Correction	A002Mc_MWD+SRGM+SAG_R5.1	A002Mb	N	Magnetic	MWD	SRGM	SAG
4	A002Mc	MWD+SRGM+SAG_FI	ISCWSA MWD + SRGM + Sag Correction [Floating Rig]	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) and Sag Corrections on a Floating Rig	A002Mc_MWD+SRGM+SAG_FI_R5.1	A002Mb	Y	Magnetic	MWD	SRGM	SAG
5	A003Mc	MWD+SRGM+AX	ISCWSA MWD + SRGM + Axial Correction	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) with Axial Correction	A003Mc_MWD+SRGM+AX_R5.1	A003Mb	N	Magnetic	MWD	SRGM	Axial
6	A003Mc	MWD+SRGM+AX_FI	ISCWSA MWD + SRGM + Axial Correction [Floating Rig]	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) with Axial Correction on a Floating Rig	A003Mc_MWD+SRGM+AX_FI_R5.1	A003Mb	Y	Magnetic	MWD	SRGM	Axial
7	A004Mc	MWD+SRGM+AX+SAG	ISCWSA MWD + SRGM + Axial Correction + Sag Correction	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) with Axial Correction and Sag Correction	A004Mc_MWD+SRGM+AX+SAG_R5.1	A004Mb	N	Magnetic	MWD	SRGM	Axial+SAG
8	A004Mc	MWD+SRGM+AX+SAG_FI	ISCWSA MWD + SRGM + Axial Correction + Sag Correction [Floating Rig]	5.1	MWD using 1-Year Standard Resolution Geomagnetic Mode (e.g. BGGM up to 2018, MVSD) with Axial Correction and Sag Correction on a Floating Rig	A004Mc_MWD+SRGM+AX+SAG_FI_R5.1	A004Mb	Y	Magnetic	MWD	SRGM	Axial+SAG
9	A005Mc	MWD+IFR1	ISCWSA MWD + IFR1	5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction)	A005Mc_MWD+IFR1_R5.1	A005Mb	N	Magnetic	MWD	IFR1	None
10	A005Mc	MWD+IFR1_FI	ISCWSA MWD + IFR1 [Floating Rig]	5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) on a Floating Rig	A005Mc_MWD+IFR1_FI_R5.1	A005Mb	Y	Magnetic	MWD	IFR1	None
11	A006Mc	MWD+IFR1+AX	ISCWSA MWD + IFR1 + Axial Corr	5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) and Axial Correction	A006Mc_MWD+IFR1+AX_R5.1	A006Mb	N	Magnetic	MWD	IFR1	Axial
12	A006Mc	MWD+IFR1+AX_FI	ISCWSA MWD + IFR1 + Axial Corr [Floating Rig]	5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) and Axial Correction on a Floating Rig	A006Mc_MWD+IFR1+AX_FI_R5.1	A006Mb	Y	Magnetic	MWD	IFR1	Axial
13	A007Mc	MWD+IFR1+AX+SAG	ISCWSA MWD + IFR1 + Axial Corr + Sag Correction	5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) and Axial Correction and Sag Correction	A007Mc_MWD+IFR1+AX+SAG_R5.1	A007Mb	N	Magnetic	MWD	IFR1	Axial+SAG
14	A007Mc	MWD+IFR1+AX+SAG_FI	ISCWSA MWD + IFR1 + Axial Corr + Sag Correction [Floating Rig]	5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) and Axial Correction and Sag Correction on a Floating Rig	A007Mc_MWD+IFR1+AX+SAG_FI_R5.1	A007Mb	Y	Magnetic	MWD	IFR1	Axial+SAG
				5.1	CARE TO BE TAKEN WHILE PLANNING A WELL – Refer to Survey Management Specialist to ensure MS is valid. MWD with IFR1 (IFR or Crustal Anomaly Correction) and Multi-Station Correction	A008Mc_MWD+IFR1+MS_R5.1	A008Mb	N	Magnetic	MWD	IFR1	Multi-Station
				5.1	CARE TO BE TAKEN WHILE PLANNING A WELL – Refer to Survey Management Specialist to ensure MS is valid. MWD with IFR1 (IFR or Crustal Anomaly Correction) and Multi-Station Correction on a Floating Rig	A008Mc_MWD+IFR1+MS_FI_R5.1	A008Mb	Y	Magnetic	MWD	IFR1	Multi-Station
				5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) and Sag Correction	A009Mc_MWD+IFR1+SAG_R5.1	A009Mb	N	Magnetic	MWD	IFR1	SAG
				5.1	MWD with IFR1 (IFR or Crustal Anomaly Correction) and Sag Correction on a Floating Rig	A009Mc_MWD+IFR1+SAG_FI_R5.1	A009Mb	Y	Magnetic	MWD	IFR1	SAG
				5.1	CARE TO BE TAKEN WHILE PLANNING A WELL – Refer to Survey Management Specialist to ensure MS is valid. MWD with IFR1 (IFR or Crustal Anomaly Correction) with Sag and Multi-Station Correction	A010Mc_MWD+IFR1+SAG+MS_R5.1	A010Mb	N	Magnetic	MWD	IFR1	SAG+Multi-Station
				5.1	CARE TO BE TAKEN WHILE PLANNING A WELL – Refer to Survey Management Specialist to ensure MS is valid. MWD with IFR1 (IFR or Crustal Anomaly Correction) with Sag and Multi-Station Correction on a Floating Rig	A010Mc_MWD+IFR1+SAG+MS_FI_R5.1	A010Mb	Y	Magnetic	MWD	IFR1	SAG+Multi-Station

PK_PK_OWSG_MAG_INT_TYPE

key_id	code	description
00001	MINONE	None
00002	MIAX	Axial
00003	MIAXS	Axial+Sag
00004	MISAG	Sag
00005	MIMSA	SagMulti-Station Analysis
00006	MIMSA	Multi-Station Analysis
00007	MIFDIRSAG	FDIR+Sag
00008	MIFDIR+Gyro	FDIR+Gyro
00009	MIFDIRGyro+SAG	FDIR+Gyro+Sag
00010	MIFDIRHIFINAV	FDIR+HIFINav
00011	MISLBDMAG	SLB DMAG
00012	MISLBGMAG	SLB GMAG
00013	MISLBTRULINK	SLB TruLink
00014	MIFDIR	FDIR

PK_PK_OWSG_INCL_TYPE

key_id	code	description
00001	IACT	Actual
00002	IPLAN	Planned
00003	ICALC	Calculated Field Departure
00004	IEST	Estimated Field Departure

PK_PK_OWSG_GYRO_TYPE

key_id	code	description
00001	GMWD	Gyro MWD
00002	GCONT	Continuous
00003	GGYC	Gyro Compass
00004	GHYB	Hybrid
00005	GINS	Inertial Guidance
00006	GCB	Camera Based
00007	GVEND	Contractor (C)
00008	GMEMS	MEMS Gyro
00009	GMEMSGM	MEMS Gyro MWD
00010	GCVRG	3-AXIS CVRG SOLID STATE
00011	GAADG	All Attitude Drop Gyro

PK_PK_OWSG_MAG_TYPE

key_id	code	description
00001	MMWD	MWD
00002	MDIP	Dipmeter
00003	MEMS	EMS
00004	MCB	Camera Based
00005	MVEND	Contractor (C)
00006	MRSS	RSS
00007	MMOTOR	LWDM
00008	MLWD	LWD
00009	MPMR	Passive Magnetic Ranging
00010	MAMR	Active Magnetic Ranging
00011	RMRS	Rotating Magnet Ranging

PK_PK_OWSG_GYRO_CONT_TYPE

key_id	code	description
00001	CBHI	Baker Hughes
00002	CGYRO	GyroData
00003	CSDI	SDI
00004	CHAL	Sperry
00005	CSCH	Schlumberger
00006	OTH	Other
00007	CWFD	Weatherford
00008	CVES	Vaughn
00009	CDHS	DHS
00010	CPHX	Phoenix
00011	CGASWAY	Gasway
00012	CSPT	Stockholm Precision Tools
00013	CCORETECH	Coretech
00014	CGGUIDE	Geoguidance
00015	CICEFIELD	Icefield
00016	CVECTOR	Vector
00017	CZENSORTR	Zensortron
00018	CTOTEM	Totem
00019	CZUPT	Zupt
00020	CMSE	MS Energy

PK_PK_OWSG_MAG_REF_TYPE

key_id	code	description
00001	MDEF	BGGM (Default)
00002	MIFR1	IFR1
00003	MIFR2	IFR2 (IIFR)
00004	MHDGM	HDGM
00005	MIGRF	IGRF/WMM
00006	MSRGM	Standard Resolution
00007	MHRGM	High Resolution
00008	MLRGM	Low Resolution
00009	MIGRF	IGRF
00010	MWMM	WMM
00011	MEMM	EMM
00012	MMVHD	MVHD HRGM
00013	MBGGM2019SR2	BGGM Pre2019SR2
00014	MBGGM2019SR2	BGGM HRGM

Please send any feedback to Jonathan Lightfoot about the categories and software survey name.

Master Error Model Maintenance Tables:

- ISCWSA_Generic_Toolcodes SetA Rev5-1
- ISCWSA_Generic_Toolcodes SetB Rev5-1

Thank you

Questions?