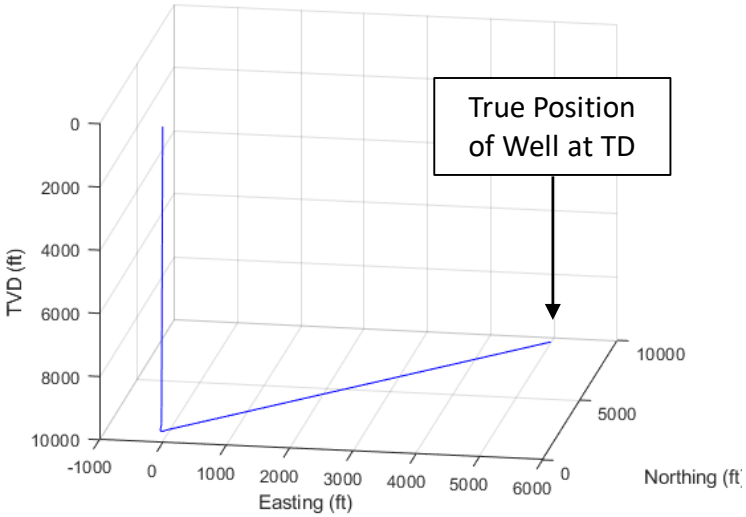
Are You Using the Correct EOU?

Introducing an Industry Standard Process to Validate the Accuracy of Survey Correction Software

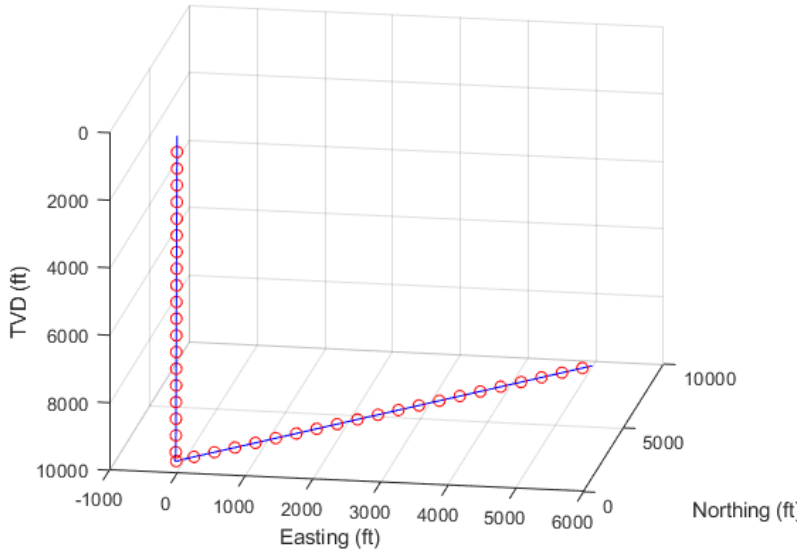
Monday, November 7, 2022

Simulated Test Well Creation Process

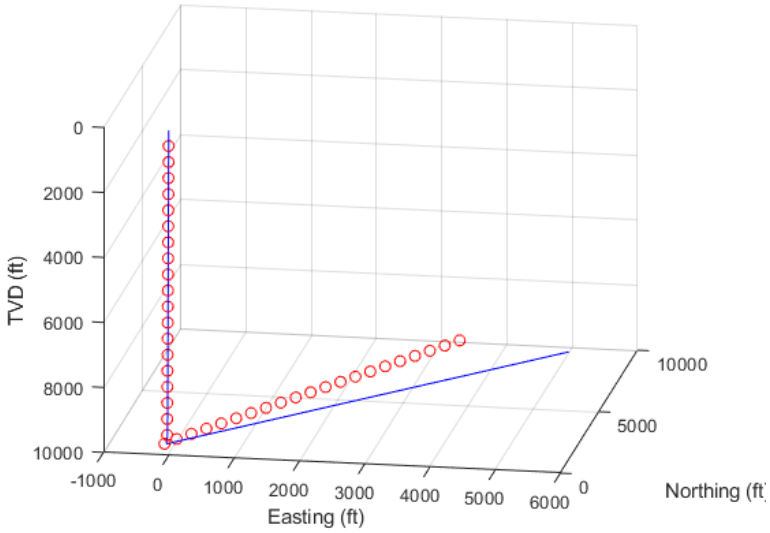
Step 1: Create Synthetic Well Profile



Step 2: Sample the Well & Calculate Perfect Surveys

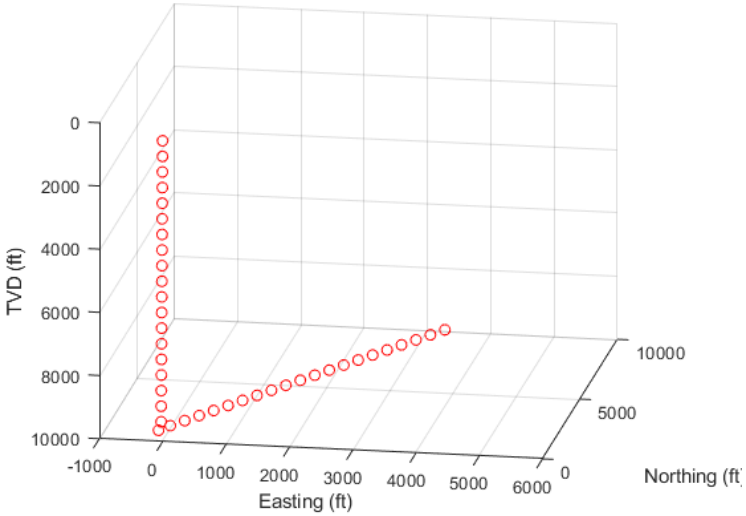


Step 3: Add Typical Measurement Errors to the Surveys

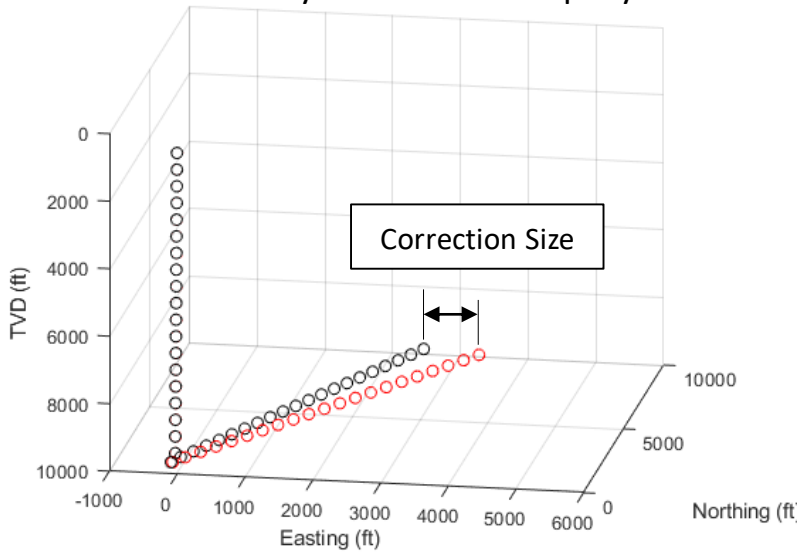


Test Data Corrected by Survey Correction Company

Step 4: Give Survey Data, Including Errors, to Survey Correction Company

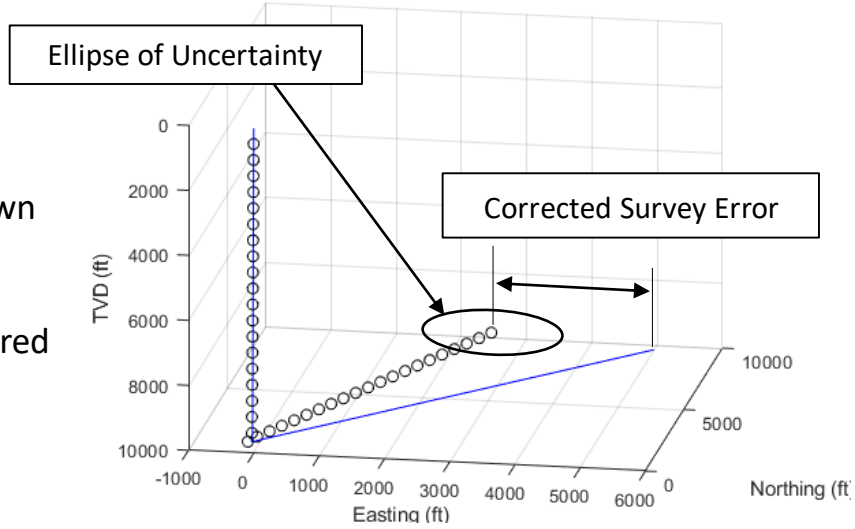


Step 5: Receive Corrected Survey Log from Survey Correction Company

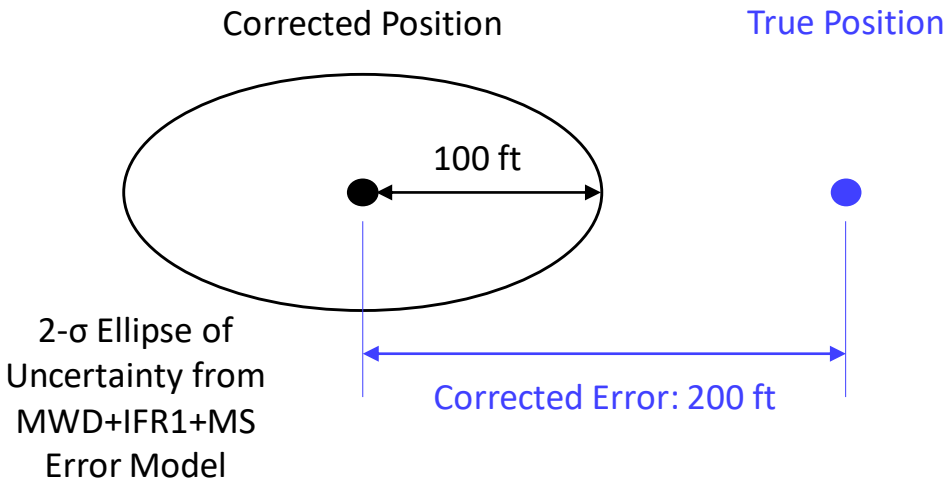


Step 6: Calculate Error in Corrected Position from Known True Position

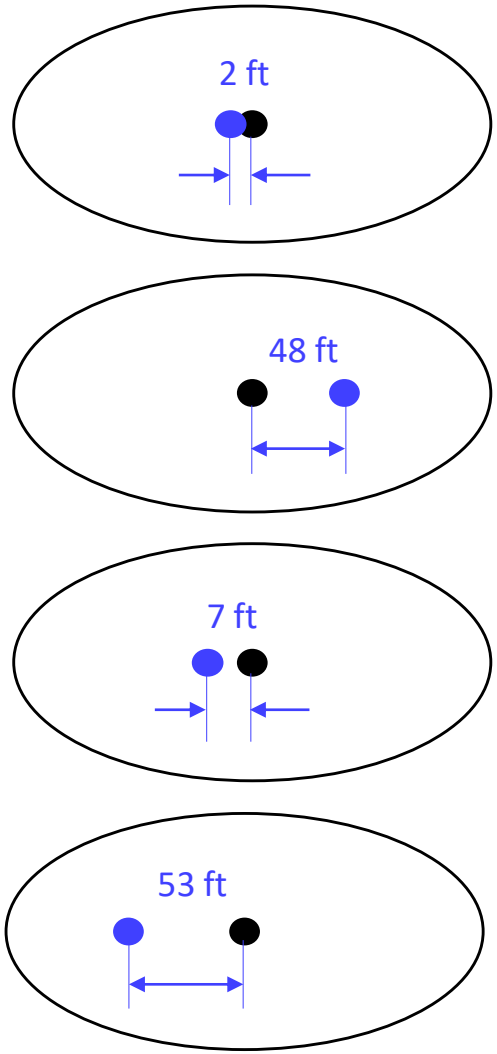
How Large is the Error Compared to the EOU?

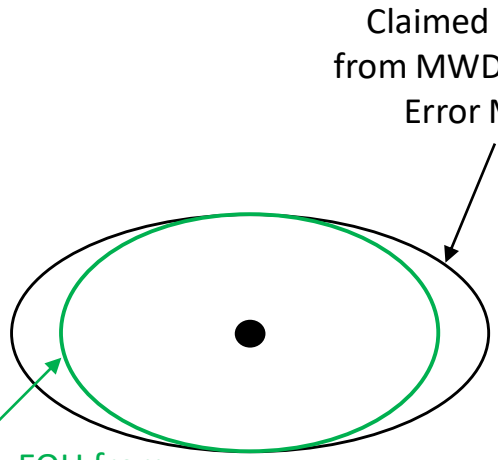


Correction Error Compared to Claimed EOU Size



Correction Error Compared to Claimed EOU Size

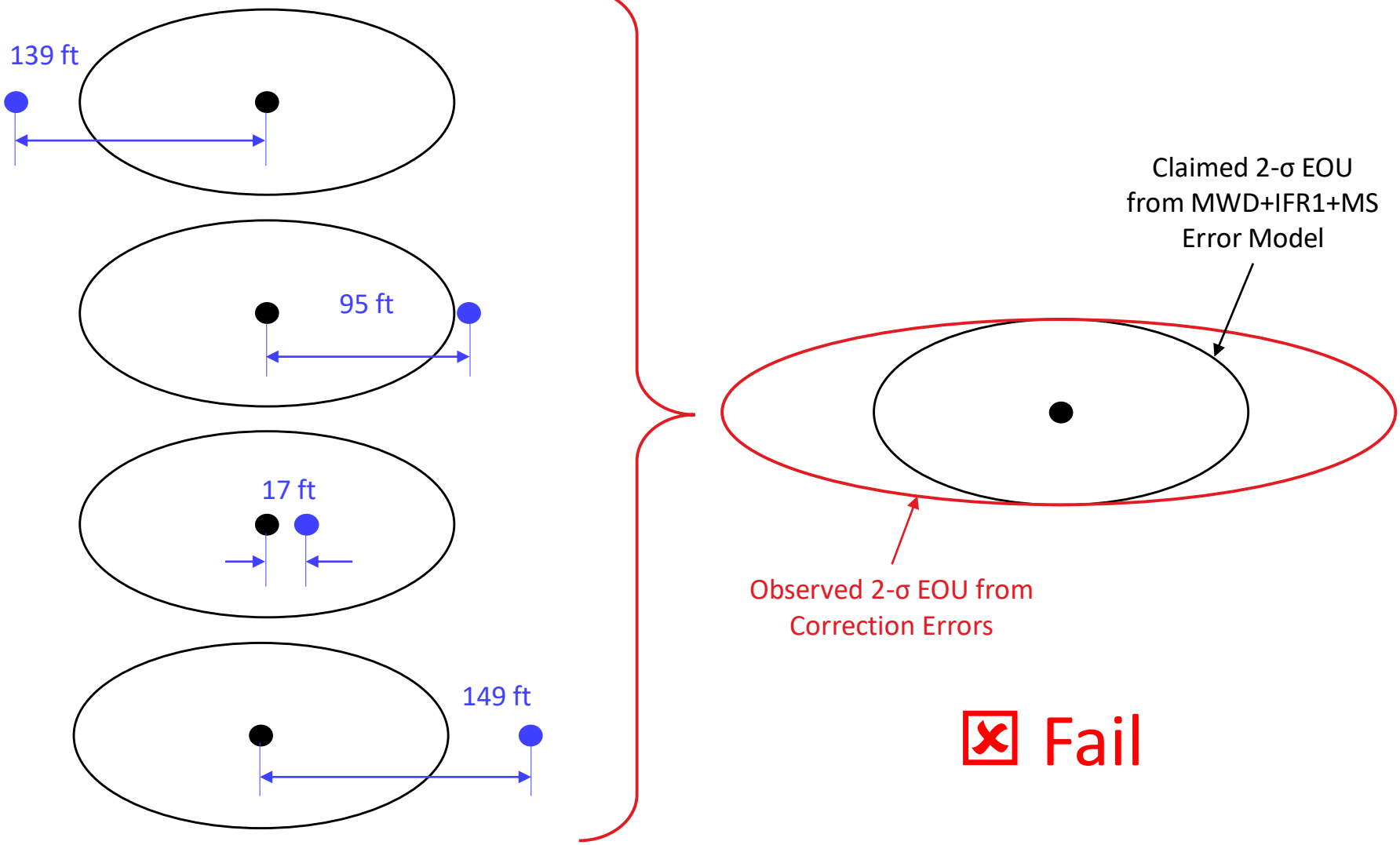




☑ Pass

**Use Chi-Squared distribution to determine pass/fail threshold for horizontal EOU*

Correction Error Compared to Claimed EOU Size



**Use Chi-Squared distribution to determine pass/fail threshold for horizontal EOU*

Advisory Panel of Operator Subject Matter Experts

Members

- Bill Allen – BP
- Pete Clark – Chevron
- Dalis Deliu - ConocoPhillips
- Jonathan Lightfoot – Oxy
- Heather Vannoy – EOG

Tasks

- Provide feedback on validation process (very positive)
- Review error sources included in test (standard ISCWSA & calibration errors)
- Suggest different levels of validation
  - Enhanced accuracy
  - Standard accuracy
  - Enhanced accuracy, but only in certain wellbore directions

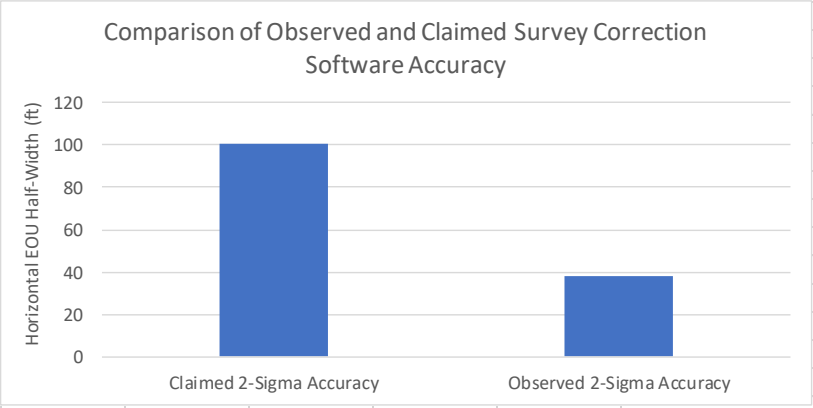
Proof of Concept

Survey Correction Software Validation Spreadsheet

Well Number	Approx. Azimuth	True (Simulated) Bottom Hole Location			Corrected Bottom Hole Location (from Survey Correction Company)			MWD+IFR1+MS (or MWD+IFR1+FDIR) 2σ EOU Half-Width	Survey Correction Error	Survey Correction Error Expressed in Terms of σ
		Northing	Easting	TVD	Northing	Easting	TVD			
1	0	10348.56684	792.5737685	9783.932962	10347.99	820.96	9783.2	89.33	28.40	0.64
2	0	10365.86726	-108.9944219	9786.46623	10363.99	-96.3	9789.67	89.33	13.23	0.30
3	30	8785.607469	5533.803041	9786.157077	8779.35	5541.92	9787.93	93.53	10.40	0.22
4	30	8831.752142	5429.286143	9783.683458	8829.35	5436.34	9786.41	93.53	7.93	0.17
5	60	5539.730349	8779.709808	9785.244844	5523.71	8789.59	9785.42	106.27	18.82	0.35
6	60	3688.439441	9694.119788	9785.518792	3669.8	9699.82	9783.38	106.27	19.61	0.37
7	90	507.0738454	10361.77356	9786.480478	493.73	10362.87	9782	113.20	14.12	0.25
8	90	320.8022422	10360.54644	9782.744715	291.94	10362.5	9785.74	113.20	29.08	0.51

Degrees of Freedom:	8
χ2 Probability of Success at Which to Fail Software:	10%

Average Error Model EOU Half-Width (2σ):	101
Survey Correction Error Sample Standard Deviation (2σ):	38
Pass (if under) / Fail (if over) Threshold:	130
Validation Result:	***PASS***



Start Time	12:20
End Time	13:03
Elapsed Time	0:43

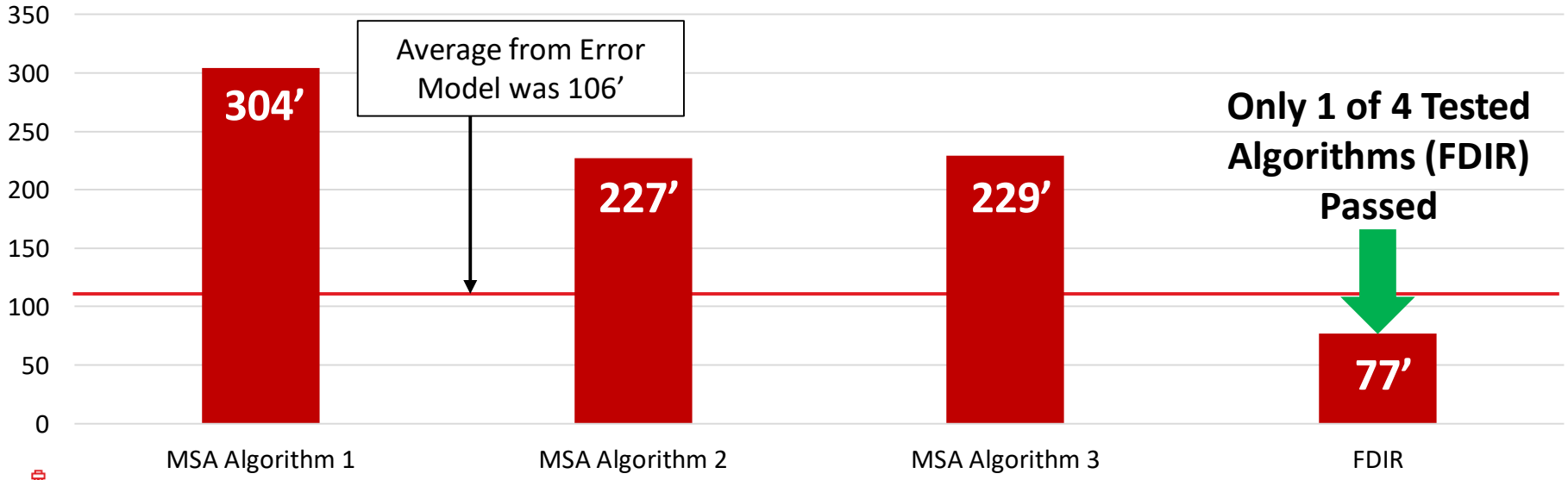
Results for Superior QC, with Philip Gurden Proctoring on 9/26/22

Is this Worth Industry Attention?

Test Well #	Data Type	Well Azimuth (deg)	Difference to True BHL (ft)				Error Model EOU 2σ half-width† (ft)
			MSA Algorithm 1	MSA Algorithm 2	MSA Algorithm 3	FDIR	
1	Simulated	90	212	139	53	2	113
2	Simulated	0	133	95	135	48	90
3	Simulated	90	176	17	6	7	113
4	Simulated	60	48	149	159	53	106

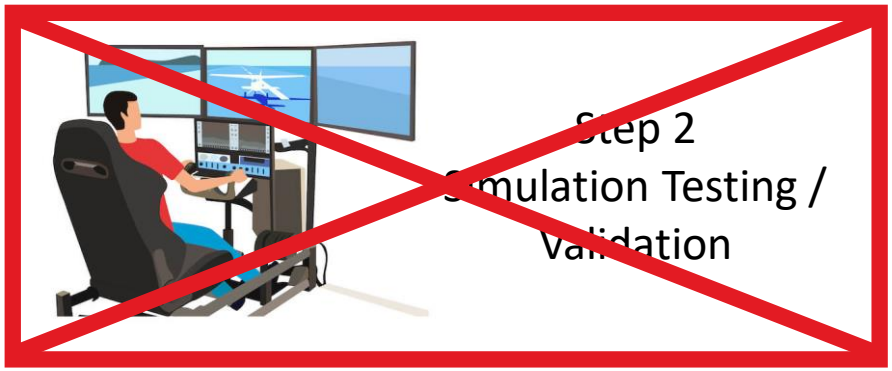
†*MWD+IFR1+FDIR*

Observed Ellipse of Uncertainty (2σ) Based on Test Results



Comparison to Aerospace Industry

Step 1
Create Flight
Software



Step 2
Simulation Testing /
Validation

Step 3
Develop Procedures
for Implementation

???


Superior QC