54th General Meeting
6 & 7 of October 2021
Virtual Conference

Wellbore Positioning Technical Section

The Industry Steering Committee on
Wellbore Survey Accuracy (ISCWSA)

Looking Forward While Looking Back

10 years of Automated Clearance Scans Ahead-of the Bit while Drilling

Carol Mann – Dynamic Graphics, Inc

Gary Skinner – Baker Hughes

Looking Forward While Looking Back

A quick look back on 2011

- Fukishima (9.1), Christchurch (6.3), and eastern Turkey (7.1) suffer severe earthquakes
- Wikileaks occurs
- World population reaches 7 billion
- iPhone 4s and Siri debuts

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- ISCWSA 33 Copenhagen
- ISCWSA 34 Denver
- Education Subcommittee Formed: Plans Hits and Misses ATW
- ISCWSA MWD model rev. 3
- Human Factors highlighted in official reports following 3 oil-field incidents in 8 months (2009-2010)

Human Factors in while-drilling clearances

- The ISCWSA, "Current Common Practice in Collision Avoidance Calculations" document states:

  "[An MASD] rule, no matter how conservative, does not ensure acceptably low probability of collision. Many other factors contribute, including the level of compliance by office and rig personnel with collision avoidance procedures..."

  https://www.iscwsa.net/articles/collision-avoidance-calculations-current-common-practice/

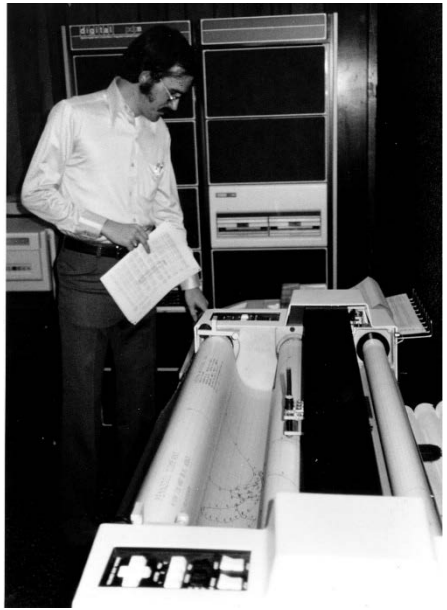
- "Spot focus on offshore safety: the human factor", Offshore Technology. Elisabeth Fischer, 25 Mar 2012:

  "The recognition of human factors in the oil and gas industry is not widespread.... Studies have shown that up to 90% of accidents are attributable to some degree to human failures. … The prevention of major accidents depends to a large degree upon human reliability at all sites, no matter how automated. … The topics range from broad, high-level issues such as staff competence, to those covering specific subjects like fatigue risks and alarm handling."

  https://www.offshore-technology.com/features/featurespot-focus-offshore-safety-the-human-factor

Pathway to Automated Clearance Calculations

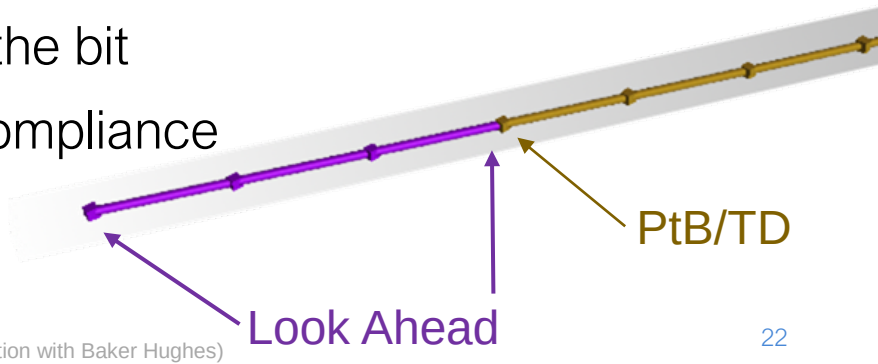
- Digitisation of Directional Surveying and Collision Avoidance started over 40 years ago
- Improvements made to calculation methods, models and management practices
- While-drilling collision avoidance calculations typically remained mirrors of planning process
- Difficult to validate adherence to procedures without reams of paperwork



Design philosophy for auto-clearances

Goal: To aid the DD while drilling

- Be invisible until necessary
- Alert with time to react
- Ensure (and encourage) policy AND procedures are followed
- Assures scans are done at and ahead of the bit
- Eliminate busywork through automated compliance
- Clear, concise, unambiguous results



Revisions and Refinements

Business Evolution

- Feedback and lessons learned implemented in software and procedures
- While-Drilling Collision Management
  - Procedures and training re-written
  - Greater focus on DDs compliance
- Well Planning
  - Make the plan drillable with additional planning functions and rules to cater for off-plan situations
  - Distance from plan / risk assessment rule
- Remote Operations Ready

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Software Evolution

- Distance from plan warning – pre 2011

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- Remote Operations Ready

Software Evolution

- Distance from plan warning – pre 2011
- Auto-clearances ahead of the bit
  - Primary and Secondary ACR rules
  - Actuals only
  - "Look Ahead" options: Ptb-method or trend

Revisions and Refinements

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Software Evolution

- o Distance from plan warning – pre 2011
- ❖ Actuals only / 2 rules / Ptb-method or trend
- ➢ More flexibility for defining look ahead path
- ➢ Accommodate incoming WITSML surveys
- ➢ Copy results
- ➢ Plans optionally included

Revisions and Refinements

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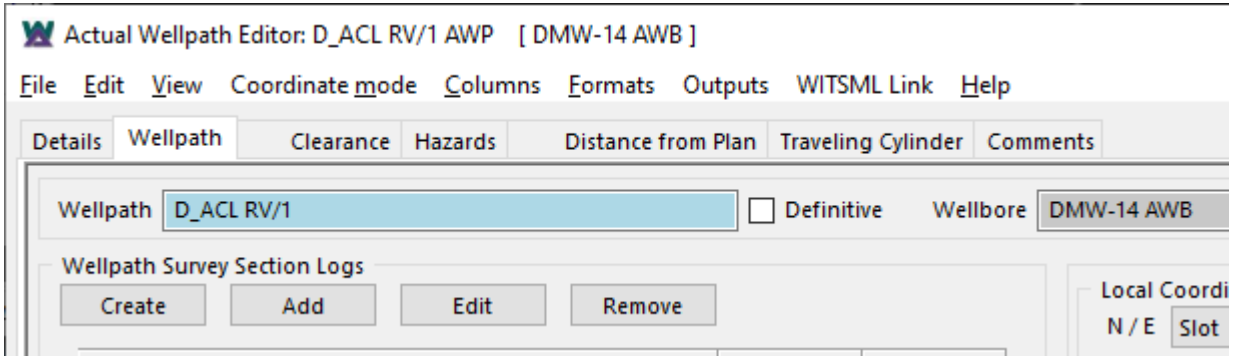
Software Evolution

- o Distance from plan warning – pre 2011
- ❖ Actuals only / 2 rules / Ptb-method or trend
- ➢ More flexibility for defining look ahead path
- ➢ Accommodate incoming WITSML surveys
- ➢ Copy results
- ✓ Plans ~~optionally~~ included by default
- ✓ Automated logging & Reporting
- ✓ Warning limits added
- ✓ Simultaneous drilling
- ✓ Ability to silence alert
- ✓ Look Ahead “distance from plan” & 3D collision shapes

Auto-clearances in Practice

- Invisible, silent partner
- Alert with sufficient time
- Silent until necessary



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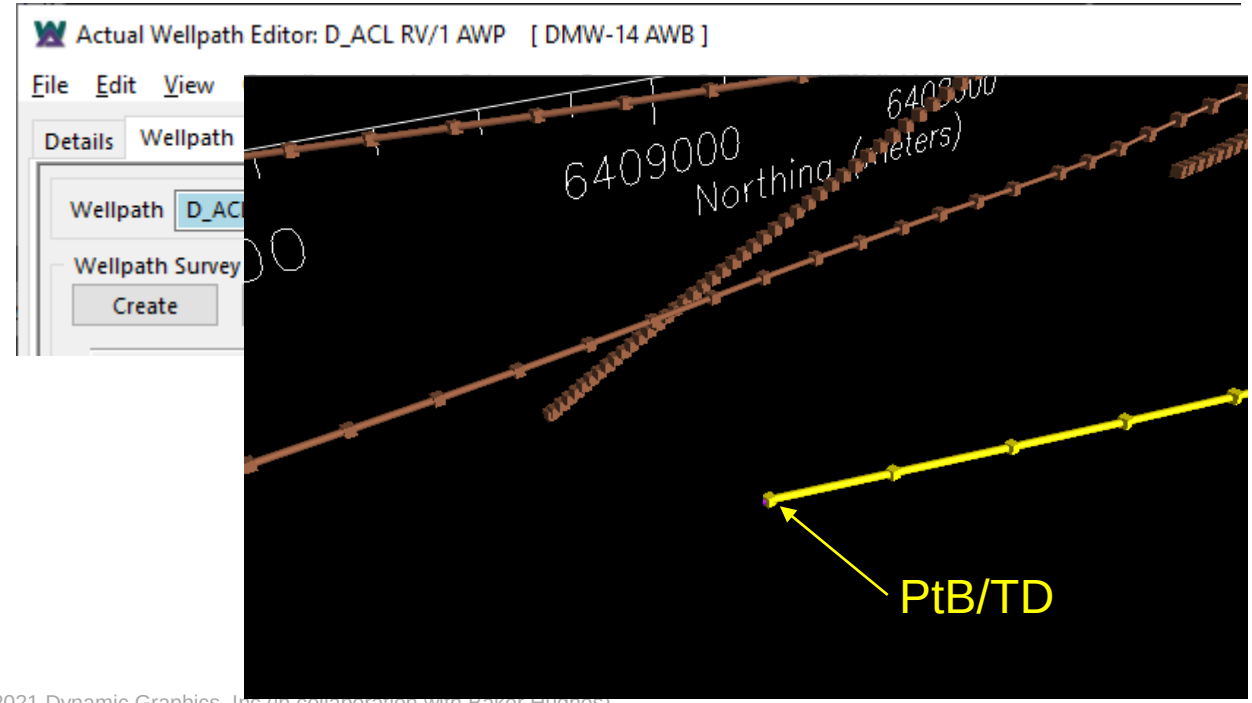

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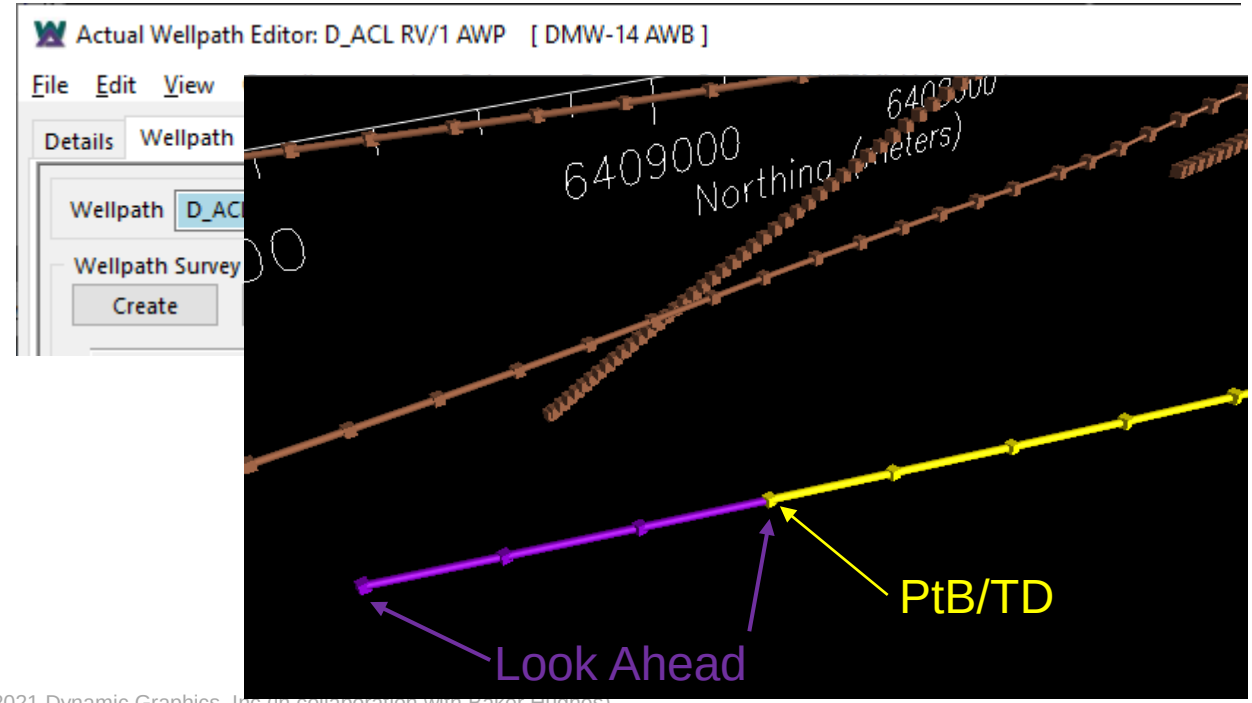

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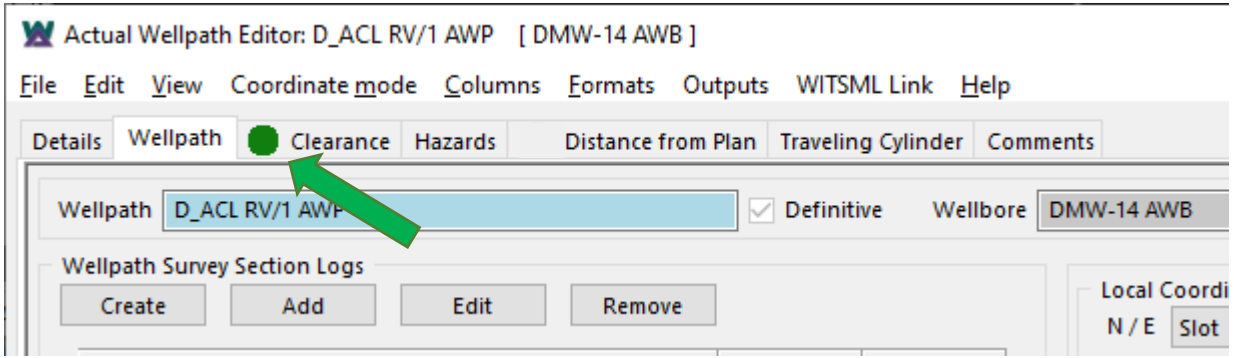

- Survey 1 added

Auto-clearances in Practice

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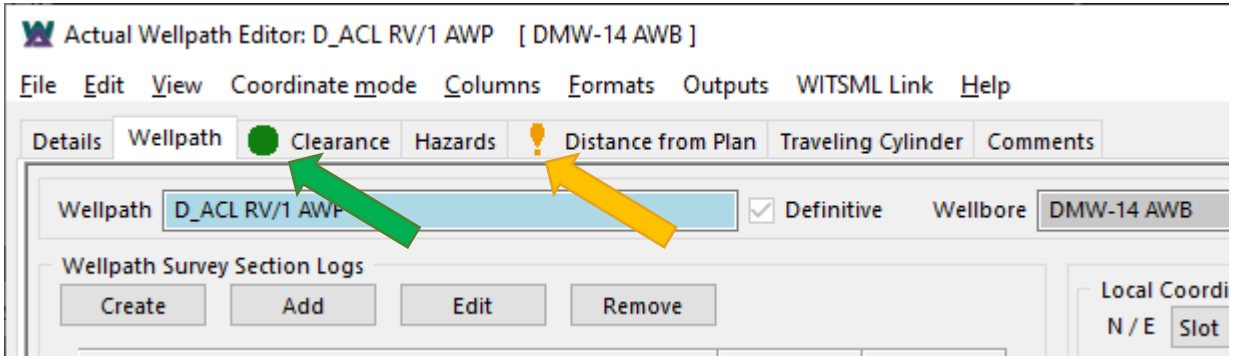

- Survey 1 added
- Survey 20 added

Auto-clearances in Practice

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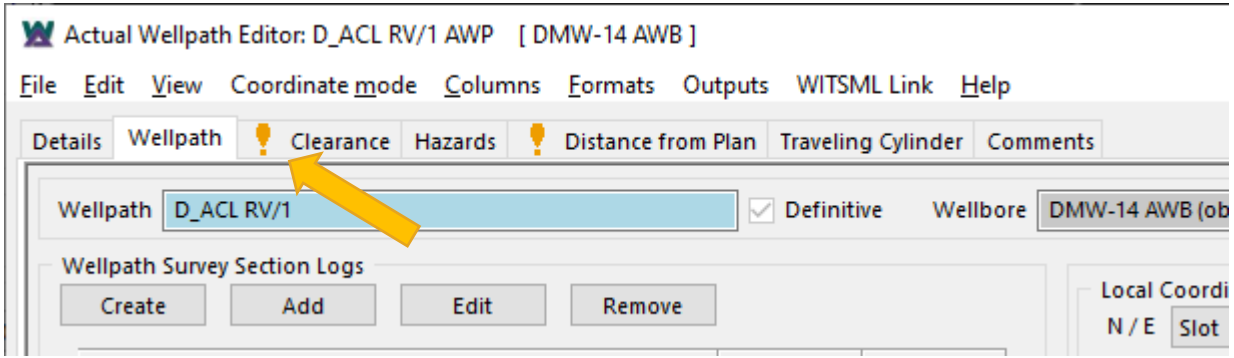

- Survey 1 added
- Survey 20 added
- Survey 25 added – ACR warning limit

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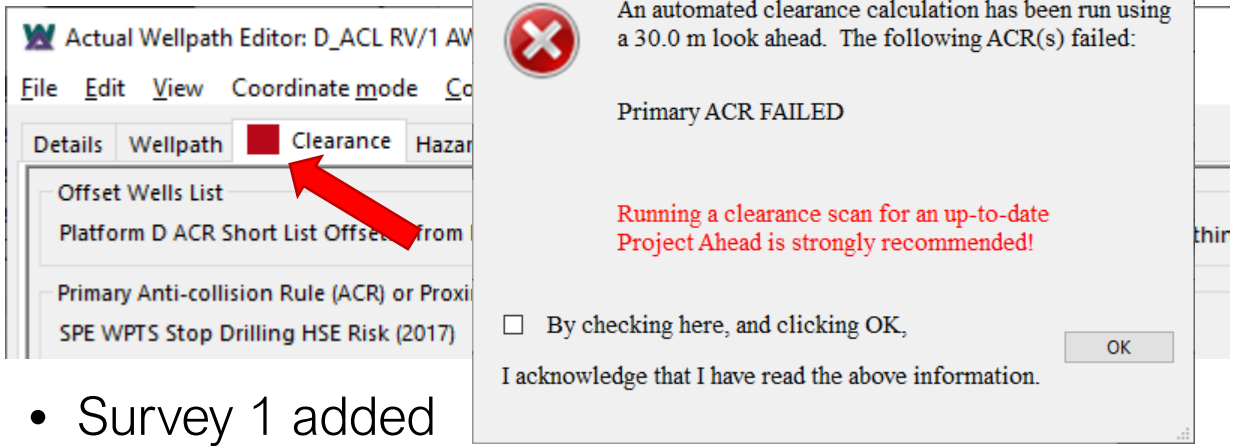
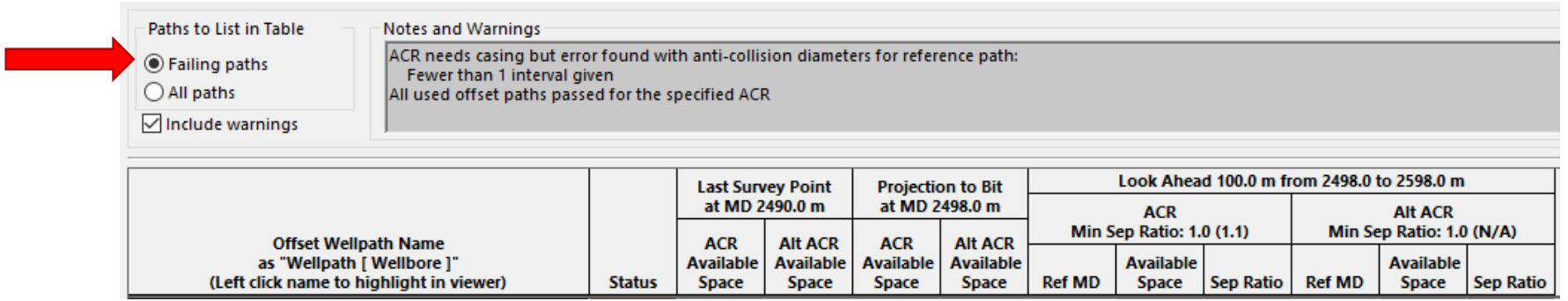


- Survey 1 added
- Survey 20 added
- Survey 25 added – ACR warning limit
- Survey 27 added – ACR failure limit

Auto-clearances in Practice



Paths to List in Table

- (•) Failing paths
- ( ) All paths
- [✓] Include warnings

Notes and Warnings

ACR needs casing but error found with anti-collision diameters for reference path:
Fewer than 1 interval given
All used offset paths passed for the specified ACR

Offset Wellpath Name as "Wellpath [Wellbore]" (Left click name to highlight in viewer)	Status	Last Survey Point at MD 2490.0 m		Projection to Bit at MD 2498.0 m		Look Ahead 100.0 m from 2498.0 to 2598.0 m					
						ACR Min Sep Ratio: 1.0 (1.1)			Alt ACR Min Sep Ratio: 1.0 (N/A)		
		ACR Available Space	Alt ACR Available Space	ACR Available Space	Alt ACR Available Space	Ref MD	Available Space	Sep Ratio	Ref MD	Available Space	Sep Ratio

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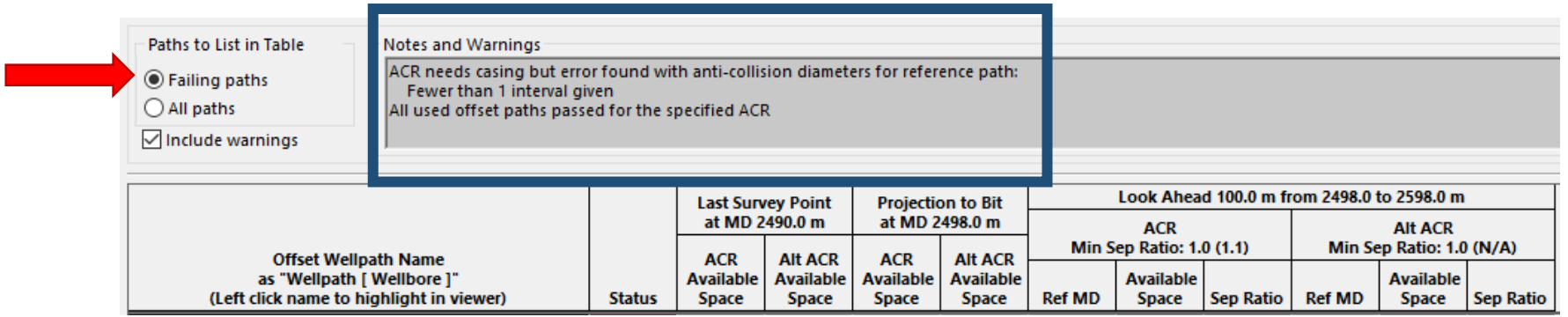

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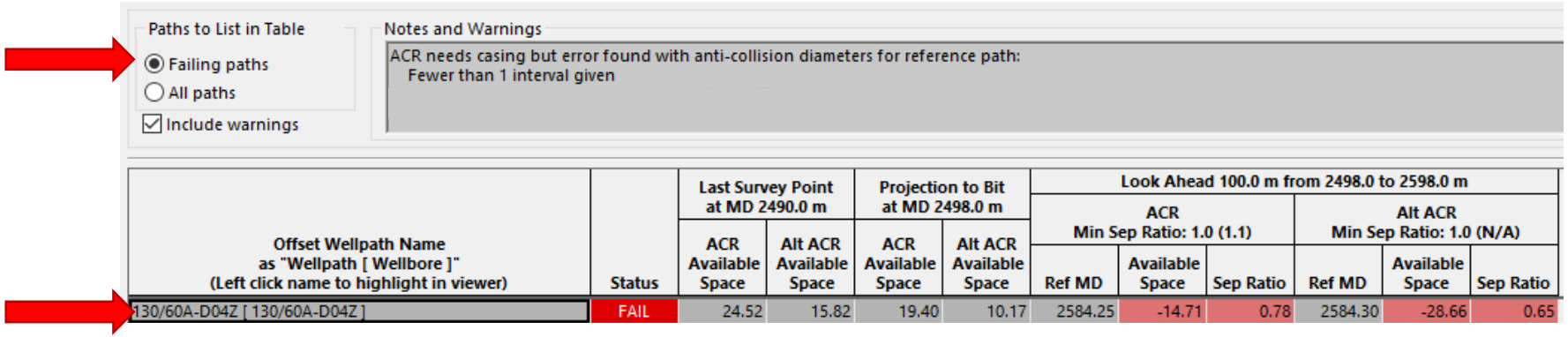

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		ACR Available Space	Alt ACR Available Space	ACR Available Space	Alt ACR Available Space	Ref MD	Available Space	Sep Ratio	Ref MD	Available Space	Sep Ratio
130/60A-D04Z [130/60A-D04Z]	FAIL	24.52	15.82	19.40	10.17	2584.25	-14.71	0.78	2584.30	-28.66	0.65

Auto-clearances in Practice

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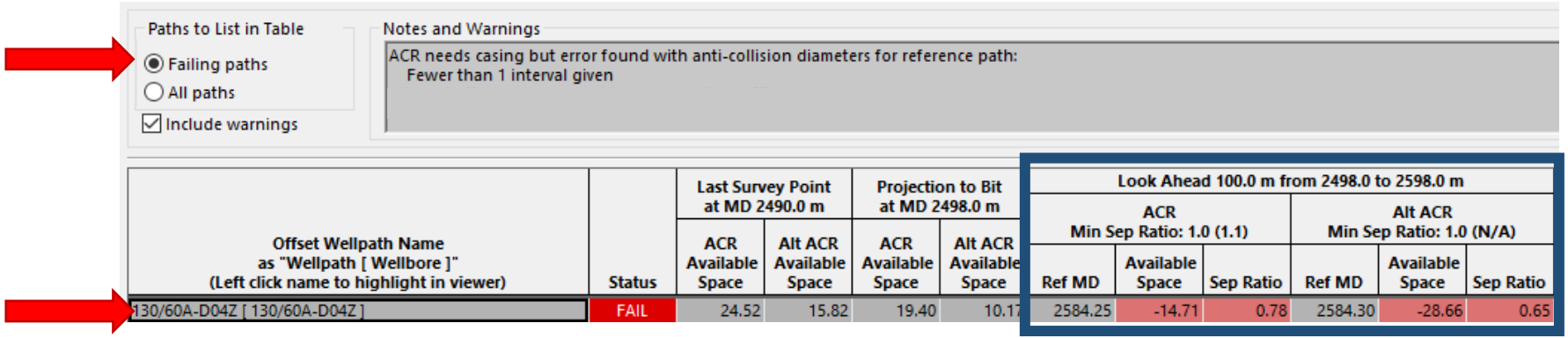
Auto-clearances in Practice



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Auto-clearances in Practice

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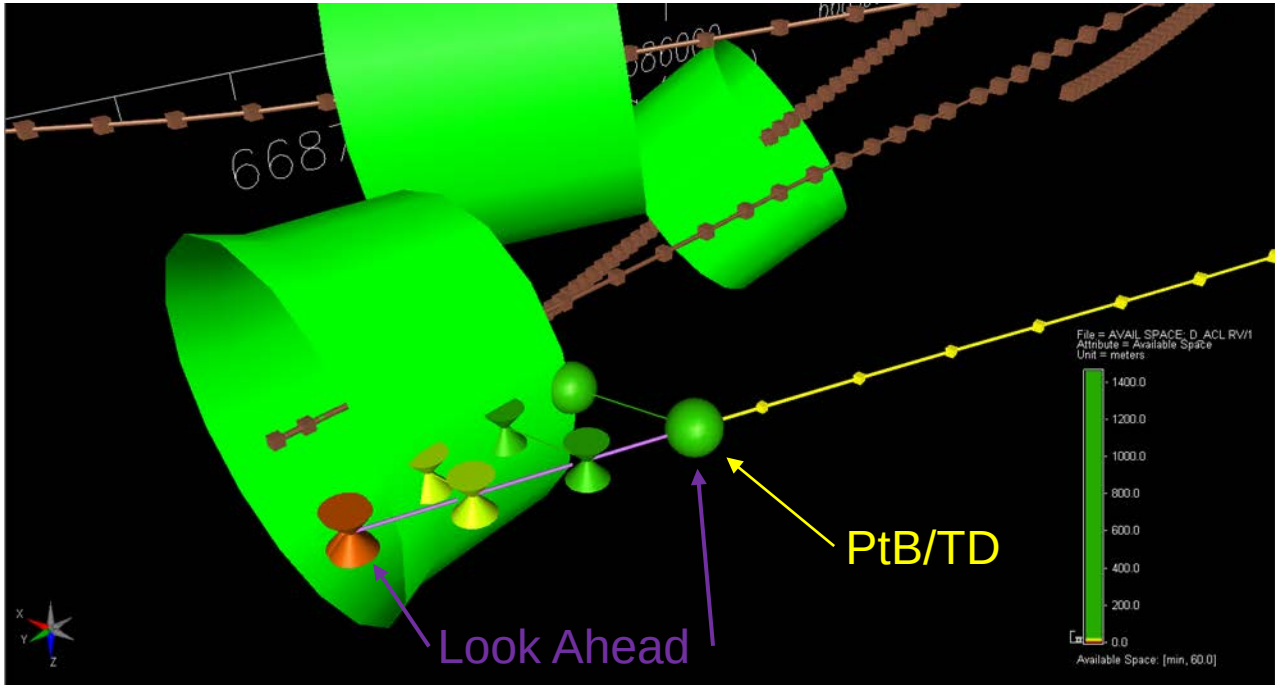
		ACR Available Space	Alt ACR Available Space	ACR Available Space	Alt ACR Available Space	Ref MD	Available Space	Sep Ratio	Ref MD	Available Space	Sep Ratio
130/60A-D04Z [130/60A-D04Z]	FAIL	24.52	15.82	19.40	10.17	2584.25	-14.71	0.78	2584.30	-28.66	0.65
130/60A-D06Z [130/60A-D06Z]	PASS	98.11	92.36	93.39	87.31	2588.00	62.17	2.25	2588.00	52.12	1.87
130/60A-D04 [130/60A-D04]	PASS	237.03	228.22	238.22	229.31	2588.00	251.65	6.18	2588.00	241.76	5.12
130/60A-D06 [130/60A-D06]	PASS	480.84	474.87	484.88	478.93	2498.00	484.88	15.59	2498.00	478.93	13.13
130/60A-D01 [130/60A-D01]	PASS	1167.69	1165.63	1175.07	1173.01	2498.00	1175.07	89.32	2498.00	1173.01	75.88
130/60A-D02 [130/60A-D02]	PASS	1306.74	1306.38	1314.37	1314.01	2498.00	1314.37	134.15	2498.00	1314.01	125.78
130/60A-D08 [130/60A-D08]	PASS	1322.19	1322.22	1329.99	1330.02	2498.00	1329.99	155.59	2498.00	1330.02	150.83
130/60A-D03 [130/60A-D03]	PASS	1328.49	1327.93	1336.16	1335.59	2498.00	1336.16	120.42	2498.00	1335.59	111.80

Visualizing Look-Ahead Collision Avoidance



Silencing Alerts

- Drilling in tight quarters
- Alerting on expected failures could cause missed unexpected failures

Offset Wellpath Name as "Wellpath [Wellbore]" (Left click name to highlight in viewer)	Status	Last Survey Point at MD 2730.0 m		Projection to Bit at MD 2750.0 m		Look Ahead 100.0 m from 2750.0 to 2850.0 m					
						ACR Min Sep Ratio: 1.0 (N/A)			Alt ACR Min Sep Dist: 30.0 (N/A)		
		ACR Available Space	Alt ACR Available Space	ACR Available Space	Alt ACR Available Space	Ref MD	Available Space	Sep Ratio	Ref MD	Available Space	Sep Dist
130/60A-D06Z [130/60A-D06Z]	FAIL	59.00	82.59	48.60	73.46	2850.00	-3.22	0.95	2850.00	33.43	63.43
130/60A-D04Z [130/60A-D04Z]	PASS					.00	116.08	2.95	2750.00	145.54	175.54
130/60A-D04 [130/60A-D04]	PASS					.00	253.79	5.33	2750.00	282.46	312.46
130/60A-D06 [130/60A-D06]	PASS					.00	469.88	12.49	2750.00	480.78	510.78
130/60A-D01 [130/60A-D01]	PASS	1118.99	1102.98	1137.95	1121.96	2750.00	1137.95	82.23	2750.00	1121.96	1151.96

130/60A-D06Z [130/60A-D06Z]

Suspend failure notifications for this path

Logging and Reporting

Records clearance statistics for each survey/iteration to each offset for:

- survey depth, projection to bit, closest approach in look ahead
- ++ Date/Time, ACRs, offset list, warnings generated, converging/diverging

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Records clearance statistics for each survey/iteration to each offset for:

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Reports:

- Pretty report for **proof of clearance calculations being done**

WellArchitect® By Dynamic Graphics

Auto-clearance log status summary report

Test-WMLFeed_awp

Baker Hughes

REFERENCE WELLPATH IDENTIFICATION			
Operator	**ISCWSA**	Well	**ISCWSA No1**
Field	**North Sea Example**	API	**API MMS**
Facility	**North Sea Facility**	Wellbore	**Test-WMLFeed**
Slot	**1**		

AUTO-CLEARANCE LOG STATUS SUMMARY

* = User suspended failure-notifications on one or more offset wellpath.

Scan		Survey			Bit			Look Ahead			Offset List	Primary ACR	Secondary ACR	Failing Offsets
Time	Status	MD	ACR	Alt ACR	MD	ACR	Alt ACR	MD	ACR	Alt ACR				
2021-06-17 08:24:57	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 08:27:32	Pass	1948.89	Pass	-	1974.89	Pass	-	1974.89	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 08:29:25	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 08:30:13	Pass	1948.89	Pass	-	1974.89	Pass	-	1974.89	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-18 15:48:56	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-18 15:49:20	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-09-21 13:24:54	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-09-21 13:25:18	Fail	138.48	Pass	-	138.48	Fail	-	138.48	Fail	-	Offsets2 (3)	SPE WPTS Stop Drilling HSE Risk (2017)		Backwards_pwp , Test SAG only model_awp
2021-09-21 13:26:44	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		

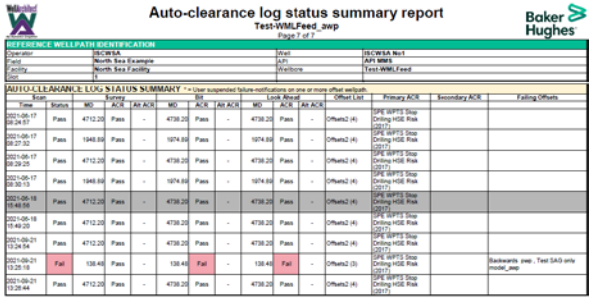
Logging and Reporting

Records clearance statistics for each survey/iteration to each offset for:

- survey depth, projection to bit, closest approach in look ahead
- ++ Date/Time, ACRs, offset list, warnings generated, converging/diverging

Reports:

- Pretty report for **proof of clearance calculations being done**
- CSV reports with summary and detailed results, XML for archive and future re-use



Auto-clearance log status summary report

Test-WMLFeed_awp

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Baker Hughes

REFERENCE WELLPATH IDENTIFICATION

Operator	ISCWSA	Well	ISCWSA No1
Field	North Sea Example	API	API: WMI
Facility	North Sea Facility	Wellbore	Test-WMLFeed
Slot	1		

AUTO-CLEARANCE LOG STATUS SUMMARY * = User suspended failure notifications on one or more offset wellpath

Scan			Survey			Bit			Look Ahead			Offset List	Primary ACR	Secondary ACR	Failing Offsets
Time	Status	MD	ACR	Alt ACR	MD	ACR	Alt ACR	MD	ACR	Alt ACR					
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2021-06-17 09:30:13	Pass	1948.89	Pass	-	1974.89	Pass	-	1974.89	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)			
2021-06-18 15:48:56	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)			
2021-06-18 15:49:20	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)			
2021-09-21 13:24:54	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)			
2021-09-21 13:25:18	Fail	138.48	Pass	-	138.48	Fail	-	138.48	Fail	-	Offsets (3)	SPE WPTS Stop Drilling HSE Risk (2017)			Backwards pwp , Test SAG only model_awp
2021-09-21 13:26:44	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)			

Scan date,	21/09/2021 14:15																	
Distance to plan																		
		MD	Distance to plan															
	Survey	138.48	0.01															
	Bit	138.48	0.32															
	Look ahead	238.48	0.32															
Clearance																		
	Primary AC rule	SPE WPTS Stop Drilling HSE Risk (2017)																
	Alternate AC rule	BH Risk Assessment Required (2019)																
	Offset	Survey	Primary			Alternate			Bit	Primary				Alternate				L
	Wellpath	MD	Status	Available	ACR value	Status	Available	ACR value	MD	Status	Trend	Available	ACR value	Status	Trend	Available	ACR value	R
	Backwards_pwp [B	138.48	pass	-3.7	-	pass	-13.7	-	138.48	fail	diverging	-3.23	-0.598	fail	diverging	-13.23	-5.55172	
	Test SAG only mode	138.48	pass	-3.36	-	pass	-13.36	-	138.48	fail	diverging	-3.16	-0.61787	fail	diverging	-13.16	-5.73619	
	ISCWSA No. 2 US_p	138.48	pass	457.84	126.213	pass	447.84	123.478	138.48	pass	CONVERG	457.8	124.757	pass	CONVERG	447.8	122.054	
Scan date,	21/09/2021 14:28																	
Distance to plan																		
		MD	Distance to plan															
	Survey	138.48	0.01															
	Bit	164.48	16.59															
	Look ahead	264.48	102.07															
Clearance																		
	Primary AC rule	SPE WPTS Stop Drilling HSE Risk (2017)																
	Alternate AC rule	BH Risk Assessment Required (2019)																
	Offset	Survey	Primary			Alternate			Bit	Primary				Alternate				L
	Wellpath	MD	Status	Available	ACR value	Status	Available	ACR value	MD	Status	Trend	Available	ACR value	Status	Trend	Available	ACR value	R
	Backwards_pwp [B	138.48	fail	-3.23	-0.598	fail	-13.23	-5.55172	164.48	pass	diverging	13.13	6.84805	pass	diverging	3.13	2.39491	
	Test SAG only mode	138.48	fail	-3.16	-0.61787	fail	-13.16	-5.73619	164.48	pass	diverging	13.21	7.07859	pass	diverging	3.21	2.47554	
	ISCWSA No. 2 US_p	138.48	pass	457.8	124.757	pass	447.8	122.054	164.48	pass	diverging	473.97	124.394	pass	diverging	463.97	121.791	

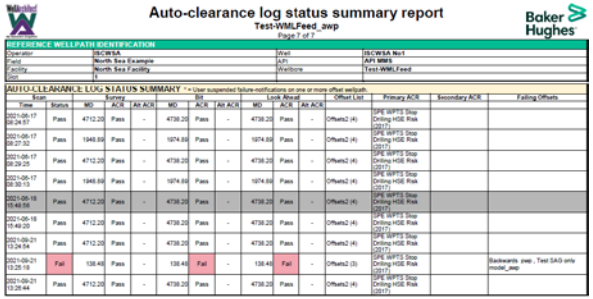
Logging and Reporting

Records clearance statistics for each survey/iteration to each offset for:

- survey depth, projection to bit, closest approach in look ahead
- ++ Date/Time, ACRs, offset list, warnings generated, converging/diverging

Reports:

- Pretty report for **proof of clearance calculations being done**
- CSV reports with summary and detailed results, XML for archive and future re-use



Auto-clearance log status summary report

Test-WML Feed_awp

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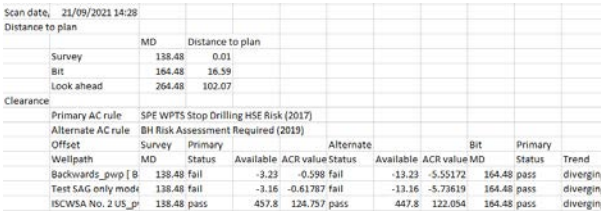
REFERENCE WELLPATH IDENTIFICATION

Operator	ISCWSA	Well	ISCWSA No1
Field	North Sea Example	API	API WBR
Facility	North Sea Facility	Wellbore	Test-WML Feed
Date			

AUTO-CLEARANCE LOG STATUS SUMMARY * = User suspended failure notifications on one or more offset wellpath.

Scan		Survey			Bit			Look Ahead			Offset List	Primary ACR	Secondary ACR	Failing Offsets
Time	Status	MD	ACR	Alt ACR	MD	ACR	Alt ACR	MD	ACR	Alt ACR				
2021-06-17 09:24:57	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 09:27:32	Pass	1948.88	Pass	-	1974.88	Pass	-	1974.88	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 09:29:25	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 09:30:13	Pass	1948.88	Pass	-	1974.88	Pass	-	1974.88	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-18 10:48:56	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-18 10:49:20	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-21 13:24:54	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-21 13:25:18	Fail	138.48	Pass	-	138.48	Fail	-	138.48	Fail	-	Offsets2 (3)	SPE WPTS Stop Drilling HSE Risk (2017)		Backwards_pwp , Test SAG only model_awp
2021-06-21 13:26:44	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		



Scan date,	21/09/2021 14:28											
Distance to plan												
		MD	Distance to plan									
	Survey	138.48	0.01									
	Bit	164.48	16.59									
	Look ahead	264.48	102.07									
Clearance												
	Primary AC rule	SPE WPTS Stop Drilling HSE Risk (2017)										
	Alternate AC rule	BH Risk Assessment Required (2019)										
	Offset	Survey	Primary			Alternate			Bit		Primary	
	Wellpath	MD	Status	Available	ACR value	Status	Available	ACR value	MD	Status	Trend	
	Backwards_pwp [B	138.48	fail	-3.23	-0.598	fail	-13.23	-5.55172	164.48	pass	divergin	
	Test SAG only mod	138.48	fail	-3.16	-0.61787	fail	-13.16	-5.73619	164.48	pass	divergin	
	ISCWSA No. 2 US_p	138.48	pass	457.8	124.757	pass	447.8	122.054	164.48	pass	divergin	

Logging and Reporting

Records clearance statistics for each survey/iteration to each offset for:

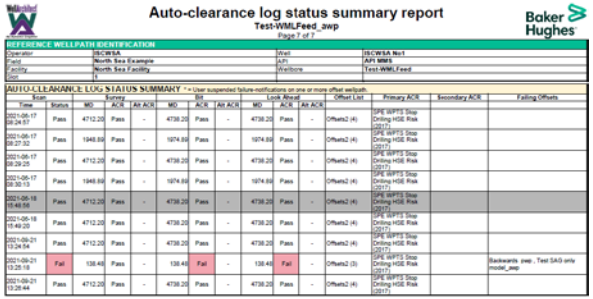
- survey depth, projection to bit, closest approach in look ahead
- ++ Date/Time, ACRs, offset list, warnings generated, converging/diverging

Reports:

- Pretty report for **proof of clearance calculations being done**
- CSV reports with summary and detailed results, XML for archive and future re-use

Invaluable in service failure investigations to understand what the DD was thinking and trying to do at the time

- Enables evaluation of minor incidents before you get to major incidents
- Helps identify degradation factors in bow-tie analysis of processes
- Allows improvement of software and/or procedures to prevent reoccurrence


Auto-clearance log status summary report
Test-WML Feed_awp
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Baker Hughes

REFERENCE WELLPATH IDENTIFICATION

Operator	ISCWSA	Well	ISCWSA No1
Field	North Sea Example	API	API: WMI
Facility	North Sea Facility	Wellbore	Test-WML Feed
Slot	1		

AUTO-CLEARANCE LOG STATUS SUMMARY * = User suspended failure notifications on one or more offset wellpath

Scan		Survey			Bit			Look Ahead			Offset List	Primary ACR	Secondary ACR	Failing Offsets
Time	Status	MD	ACR	Alt ACR	MD	ACR	Alt ACR	MD	ACR	Alt ACR				
2021-06-17 09:24:57	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 09:27:32	Pass	1948.88	Pass	-	1974.88	Pass	-	1974.88	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 09:29:25	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-17 09:30:13	Pass	1948.88	Pass	-	1974.88	Pass	-	1974.88	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-18 15:48:56	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-18 15:49:20	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-21 13:24:54	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		
2021-06-21 13:25:18	Fail	138.48	Pass	-	138.48	Fail	-	138.48	Fail	-	Offsets2 (3)	SPE WPTS Stop Drilling HSE Risk (2017)		Backwards_pwp , Test SAG only model_awp
2021-06-21 13:28:44	Pass	4712.20	Pass	-	4738.20	Pass	-	4738.20	Pass	-	Offsets2 (4)	SPE WPTS Stop Drilling HSE Risk (2017)		

Scan date, 21/09/2021 14:28												
Distance to plan												
		MD	Distance to plan									
	Survey	138.48	0.01									
	Bit	164.48	16.59									
	Look ahead	264.48	102.07									
Clearance												
	Primary AC rule	SPE WPTS Stop Drilling HSE Risk (2017)										
	Alternate AC rule	BH Risk Assessment Required (2019)										
	Offset	Survey	Primary			Alternate			Bit		Primary	
	Wellpath	MD	Status	Available	ACR value	Status	Available	ACR value	MD	Status	Trend	
	Backwards_pwp [B	138.48	fail	-3.23	-0.598	fail	-13.23	-5.55172	164.48	pass	divergin	
	Test SAG only mod	138.48	fail	-3.16	-0.61787	fail	-13.16	-5.73619	164.48	pass	divergin	
	ISCWSA No. 2 US_p	138.48	pass	457.8	124.757	pass	447.8	122.054	164.48	pass	divergin	

And for our next version

- Re-design look ahead to allow DD to model next 3 moves (stands)
- More flexible in tightly packed zones
- Can also follow current curve where design is simpler
- Links with Automation

- Automated drilling systems have a forward modelled well path
- Uses WITSML to populate look ahead from forward model
- Defined safeguards to ensure that modelled path relates to current survey depth

And after that? Are we done?

- We don't know
- Sharing of clearance data isn't defined by industry standards
  - The auto-clearance log could be transmitted and used in remote operations displays/monitoring systems, automation platforms and proof of clearances
- Can't make changes too quickly, because you don't know what's working
  - Feedback from operations takes time
  - The better it works the less chance there is for feedback
- But keep re-evaluating and keep up with changing needs

Thanks for listening

Questions?