

# Pipeline Research Council International 2021 Virtual Research Exchange

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## Pipeline Integrity in the era of machine learning and artificial intelligence



LEADING PIPELINE RESEARCH

**Hossein Khalilpasha - Worley**

**Tim Edward – OneBridge Solutions**

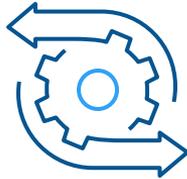
# Presentation Outline

2

- **Integrity Engineering Challenges at time of large data**
- **Developing a Machine Learning tool for Pipeline Integrity**
- **Case Studies and Benefits**
- **Q&A**



**Limited Resources to continuously monitor pipeline conditions**



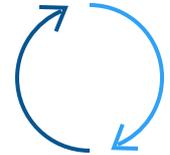
**Current pipeline integrity analysis is inaccurate because it doesn't use all of the information and data available**



**Increased risk of failure because analysis can take months**



**Integrity assessments are vendor driven, making it difficult to access pipeline data**



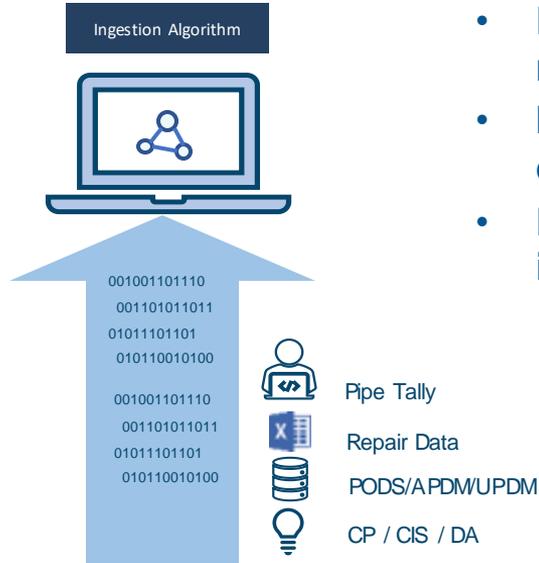
**New pipeline data isn't correlated effectively with past inspection data, increasing the uncertainty and cost**

Machine learning is a field of computer science that use statistical techniques to learn and predict 'events' based on pattern recognition





# Ingestion Algorithm



- Bayesian classifier trained on data from over 5,000 ILI reports, 50 million anomaly indications
- Interpret ILI vendor report format and normalize into structured dataset & schema
- Extract semantic meaning of vendor anomaly type & comment information into a standardized alias taxonomy

001001101110  
001101011011  
01011101101  
010110010100



# Ingestion Algorithm

CIM Cognitive Integrity Management Workley 3.13 Welcome, hossein.khalipasha@advisian.com

[Setup Data](#)
[Import/Export](#)
[System](#)
[Process History](#)
[User Activity](#)
[Analytics](#)

System (Step 2 of 2) Refresh Run Ingestion Validation Process Copy New

Q Filters

Action	System Code	System Name	Division	Diameter(s)	Length (miles)	Installation Date	Completion Date	Assigned To
<input type="checkbox"/> <input type="button" value="Info"/> <input type="button" value="Refresh"/> <input type="button" value="Copy"/> <input type="button" value="Delete"/> <input type="button" value="Up"/> <input type="button" value="Down"/> <input checked="" type="checkbox"/> <span>COMPLETE</span>				98ILI		03-16-1998		MFL Rosen
<input type="checkbox"/> <input type="button" value="Info"/> <input type="button" value="Refresh"/> <input type="button" value="Copy"/> <input type="button" value="Delete"/> <input type="button" value="Up"/> <input type="button" value="Down"/> <input checked="" type="checkbox"/> <span>COMPLETED</span>				2008 ILI		11-20-2008		MFL Rosen
<input type="checkbox"/> <input type="button" value="Info"/> <input type="button" value="Refresh"/> <input type="button" value="Copy"/> <input type="button" value="Delete"/> <input type="button" value="Up"/> <input type="button" value="Down"/> <input checked="" type="checkbox"/> <span>COMPLETED</span>				2018 ILI		11-12-2018		MFL Baker Hughes

Action	Name	Description
<input type="button" value="Info"/>	Assessment History	Listing of all historical and future assessments for a selected segment
<input type="button" value="Info"/>	Assessment Summary	Compares all ILI files loaded for the System and identifies alias classifications for the current ILI
<input type="button" value="Info"/>	Casings	Casings With ILI Vendor Reported Casings per Assessment
<input type="button" value="Info"/>	Feature Counts	Number of features by type based on vendor data
<input type="button" value="Info"/>	HCA Locations	Displays all the HCAs and their Types provided by PODS
<input type="button" value="Info"/>	Log Features	Vendor provided Log Features including All Joints and Casings
<input type="button" value="Info"/>	Pipe Transitions	Pipe Transitions based on Vendor provided information
<input type="button" value="Info"/>	Pipeline Reference Locations	Pipeline Locations for all Above Ground Reference (AGR) types listed in the Vendor ILI Data

Close

# Ingestion Algorithm

[Edit](#)
[Print](#)
[Refresh](#)

Assessment Name: All  
 107.54 Segment Length  
 20.000 Pipe Diameter (in)

**1998IU**  
 Assessment Name: 3/15/1998 (Blank)  
 Report Name: Rosen  
 MFL  
 Distance: 566,085.74  
 Tool Vendor: MFL  
 Tool Type:  
 -55.84 Begin Odometer  
 566,029.90 End Odometer

**2008IU**  
 Assessment Name: 11/30/2008 (Blank)  
 Report Name: Rosen  
 MFL  
 467,273.64

Launch Valve: (Blank)  
 0.00 Wheel Count  
 -33.83158616 Latitude

Receive Valve: (Blank)  
 067.61285 Wheel Count  
 (Blank) Latitude  
 Longitude:

**Features Detected**  
 Alias Type: 1998IU 2008IU 2018IU - 2018IUIWendy60000

AGM	79	85	
Above Ground Marker	79		
AGM		85	
<b>Bend</b>	<b>2,026</b>	<b>1,732</b>	
BEND		1,732	
Bend Begin	1,013		
Bend End	1,013		
<b>Casing End</b>	<b>10</b>	<b>12</b>	
Casing begin	5		
Casing end	5	6	
Casing Start:		6	
<b>Clamp On Sleeve</b>	<b>49</b>	<b>1</b>	
Clamp	45		
Clamp begin	2		
Clamp end	2		
CTHE		1	
<b>Corrosion Wall Loss</b>	<b>1,382</b>	<b>106</b>	<b>7,552</b>
ANOM	1,381		
Corrosion		04	7,217
Corrosion cluster		12	334
MIDE		1	
<b>Total</b>	<b>16,370</b>	<b>17,778</b>	<b>40,227</b>

**Orientation Offset by Odometer**  
 Assessment: 1998IU 2008IU 2018IU 2018IUIWendy60000

**Anomalies Detected**  
 Assessment Name: ANOM Corrosion Corrosion cluster Dent Girth Weld Anomaly Gov...

Assessment Name	ANOM	Corrosion	Corrosion cluster	Dent	Girth Weld Anomaly	Gov...
1998IU	1,381					
2008IU		04	12	50	61	

Alias Type	2008 IU	2018 IU - 2018IUI60KSMYS	98IU
<b>AGM</b>	<b>79</b>		<b>85</b>
Above Ground Marker	79		
AGM			85
<b>Bend</b>	<b>2,026</b>		<b>1,732</b>
BEND			1,732
Bend Begin	1,013		
Bend End	1,013		

Girth Weld	14,986	15,075	14,988
WELD	14,774		14,918 14,988
WELD-Change in Wall thickness	162		157
Weld-Installation begin	13		
Weld-Installation end	13		
Weld-Iso joint begin	3		
Weld-Iso joint end	3		
Weld-Launcher end	1		
Weld-Other	16		
Weld-Receiver begin	1		

# Ingestion Algorithm- Weld Alignment

**Cognitive Integrity Management** Help 3.54

Home Processes Admin Reports Exports

Reports

\*/Q Administrator Integrity Engineer Other Preview Regulatory Supervisor

Preview Reports **18**

Drag a column header and drop it here to group by that column

Report Name	Report Description
Feature Lineage	Anomaly correlation across the complete assessment history
Dent Distribution	Show the distribution of Dents plotting Depth vs Log Distance
Dent Orientation	Show the distribution of Dents Orientation vs Log Distance
Dig Locations	Map displaying Dig Locations
Metal Loss Distribution	Show the distribution of Metal Loss plotting Depth vs Log Distance including Dig Locations and Repair status
Metal Loss Frequency per Joint	Show the distribution of Metal Loss Anomalies per Joint Log Distance
Metal Loss Orientation	Show the distribution of Metal Loss Orientation vs Log Distance
Feature Dig Sheet	Listing of all the Anomalies for the selected Digs
Metal Loss Distribution With Digs	Show the distribution of Metal Loss plotting Depth vs Log Distance including Dig Locations and Repair status
Metal Loss Growth Distribution	Show the growth rates of Metal Loss Anomalies by Log Distance
Repair Fraction	Show the fraction of dings which yielded productive repairs by certain criteria
Projected Dig Costs	Forecast future dings based on projected depth & pressure condition dates
Metal Loss Top Growth	Show the fastest-growing anomalies by forecasted remaining wall
Run Summary	Summary of dings assigned by Assessment
Dent Frequency per Joint	Show the frequency of Dent Anomalies per Joint and Log Distance
<b>Weld Alignment</b>	<b>Weld Alignment</b>
Close Interval Survey Analysis	Analysis of Close Interval Survey data
Metal Loss Distribution by Elevation	Show the distribution of Metal Loss plotting Elevation vs Log Distance

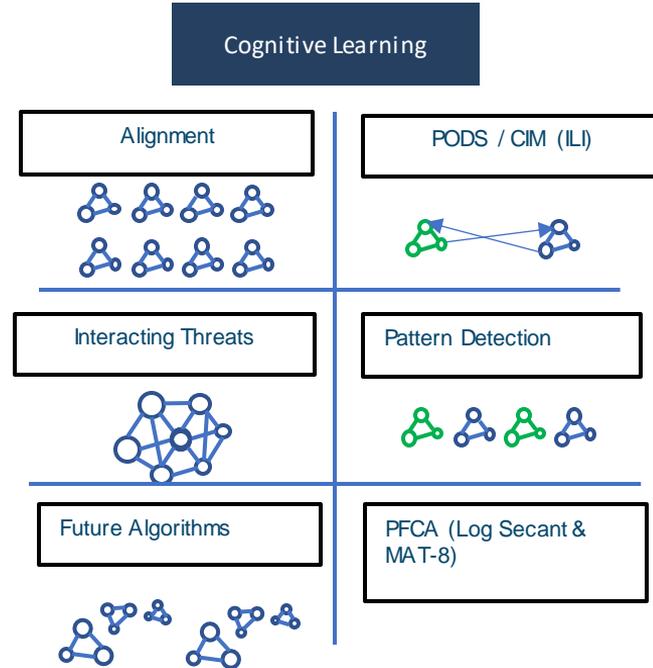
500,003,800.00	220	266.83	40.56	220	277.11	41.70	220	258.40	41.77
500,003,900.00	230	307.39	39.21	230	318.81	40.21	230	300.16	40.12
500,004,000.00	240	346.60	41.41	240	359.02	42.30	240	340.29	42.22
500,004,100.00	250	388.01	41.47	250	401.31	41.98	250	382.51	41.73
500,004,200.00	260	429.49	40.41	260	443.29	40.81	260	424.25	40.65
500,004,300.00	270	469.90	38.86	270	484.11	39.30	270	464.90	39.07
500,004,400.00	280	508.75	38.86	280	523.41	40.11	280	503.97	40.09
500,004,500.00	290	547.61	40.78	290	563.52	41.50	290	544.06	41.34
500,004,600.00	300	588.38	38.86	300	605.02	39.76	300	585.40	39.30
500,004,700.00	310	627.24	40.31	310	644.78	41.67	310	624.71	41.47
500,004,800.00	320	667.55	38.06	320	686.45	39.14	320	666.17	38.68
500,004,900.00	330	705.61	41.76	330	725.59	42.57	330	704.86	42.36
500,005,000.00	340	747.37	34.31	340	768.16	34.59	340	747.21	34.32
500,005,100.00	350	781.68	40.39	350	802.75	41.40	350	781.53	41.24
500,005,200.00	360	822.08	35.88	360	844.15	36.51	360	822.77	36.38
500,005,300.00	370	857.95	39.16	370	880.67	39.94	370	859.15	39.57
500,005,400.00	380	897.11	34.18	380	920.61	34.57	380	898.72	34.42
500,005,500.00	390	931.30	40.32	390	955.18	40.76	390	933.14	40.42
500,005,600.00	400	971.62	29.57	400	995.94	29.76	400	973.56	29.69
500,005,700.00	410	1,001.19	39.42	410	1,025.70	40.05	410	1,003.25	39.96
500,005,800.00	420	1,040.61	33.91	420	1,065.75	34.76	420	1,043.21	34.61
500,005,900.00	430	1,074.52	8.08	430	1,100.51	8.22	430	1,077.82	8.04
500,006,000.00	440	1,082.61	42.24	440	1,108.73	42.62	440	1,085.86	42.55
500,006,100.00	450	1,124.85	42.28	450	1,151.34	42.79	450	1,128.41	42.39
500,006,200.00	460	1,167.13	41.43	460	1,194.13	42.03	460	1,170.80	41.83
500,006,300.00	470	1,208.56	41.38	470	1,236.16	41.70	470	1,212.63	41.54
500,006,400.00	480	1,249.95	41.80	480	1,277.86	42.31	480	1,254.17	41.90
500,006,500.00	490	1,291.75	40.99	490	1,320.17	41.36	490	1,296.06	41.14
500,006,600.00	500	1,332.74	41.25	500	1,361.53	41.66	500	1,337.21	41.54
500,006,700.00	510	1,373.99	41.71	510	1,403.19	42.13	510	1,378.74	41.67
500,006,800.00	520	1,415.71	41.77	520	1,445.31	42.31	520	1,420.41	42.13
500,006,900.00	530	1,457.47	38.76	530	1,487.62	39.17	530	1,462.53	38.98
500,007,000.00	540	1,496.24	40.60	540	1,526.79	41.65	540	1,501.51	41.27

# Ingestion Algorithm- Reverse Pigging

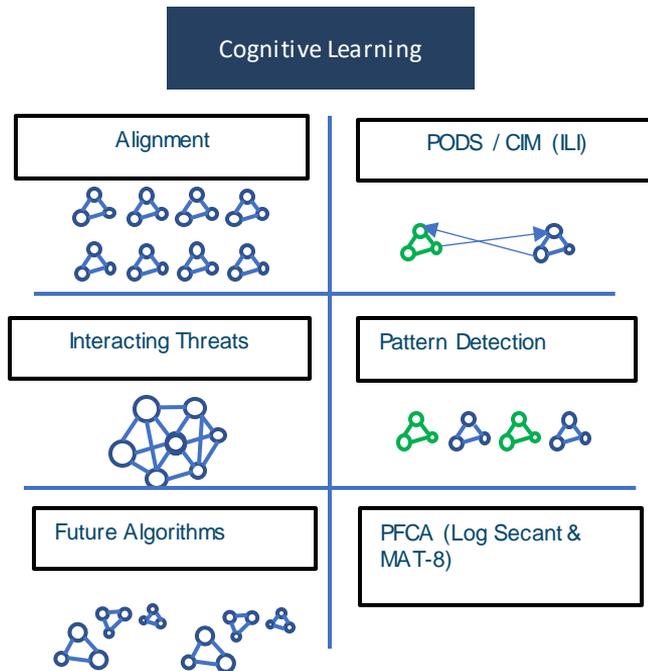
Assessment Name	ILI2010			ILI2020		
Master Joint ID	Joint No.	Log Distance	Joint Length	Joint No.	Log Distance	Joint Length
500,005,700.00	68070	1,972.39	58.56	68070	389,849.05	58.62
500,005,800.00	68060	2,030.95	60.16	68060	389,790.43	58.61
500,005,900.00	68050	2,091.11	57.96	68050	389,730.26	60.17
500,006,000.00	68040	2,149.07	59.73	68040	389,672.31	57.96
500,006,100.00	68030	2,208.80	46.11	68030	389,612.91	59.39
500,006,200.00	68020	2,254.92	59.42	68020	389,566.41	46.50
500,006,300.00	68010	2,314.34	57.44	68010	389,506.86	59.55
500,006,400.00	68000	2,371.78	59.53	68000	389,449.28	57.58
500,006,500.00	67990	2,431.31	59.48	67990	389,389.71	59.57
500,006,600.00	67980	2,490.79	58.55	67980	389,330.15	59.56
500,006,700.00	67970	2,549.34	57.66	67970	389,271.60	58.55
500,006,800.00	67960	2,607.00	57.69	67960	389,213.86	57.74
500,006,900.00	67950	2,664.69	57.50	67950	389,156.12	57.74
500,007,000.00	67940	2,722.19	58.07	67940	389,098.62	57.50
500,007,100.00	67930	2,780.26	57.78	67930	389,040.53	58.09
500,007,200.00	67920	2,838.04	58.08	67920	388,982.77	57.76
500,007,300.00	67910	2,896.12	59.54	67910	388,924.73	58.04
500,007,400.00	67900	2,955.66	59.29	67900	388,865.19	59.54
500,007,500.00	67890	3,014.95	57.68	67890	388,805.85	59.34
500,007,600.00	67880	3,072.63	57.36	67880	388,748.13	57.72
500,007,700.00	67870	3,129.99	57.36	67870	388,690.73	57.40
500,007,800.00	67860	3,187.35	59.48	67860	388,633.31	57.43
500,007,900.00	67850	3,246.84	59.37	67850	388,573.81	59.50
500,008,000.00	67840	3,306.21	59.23	67840	388,514.39	59.42
500,008,100.00	67830	3,365.44	57.40	67830	388,455.10	59.29
500,008,200.00	67820	3,422.83	56.94	67820	388,397.70	57.40
500,008,300.00	67810	3,479.77	60.02	67810	388,340.75	56.95
500,008,400.00	67800	3,539.79	57.76	67800	388,280.72	60.03
500,008,500.00	67790	3,597.55	59.53	67790	388,223.00	57.72
500,008,600.00	67780	3,657.08	58.51	67780	388,163.46	59.54
500,008,700.00	67770	3,715.59	58.52	67770	388,104.93	58.53
500,008,800.00	67760	3,774.11	59.48	67760	388,046.40	58.53
500,008,900.00	67750	3,833.59	58.49	67750	387,986.87	59.53

Assessment Name	ILI2010			ILI2020		
Master Joint ID	Joint No.	Log Distance	Joint Length	Joint No.	Log Distance	Joint Length
500,005,700.00	68070	1,972.39	58.56	68070	389,849.05	58.62
500,005,800.00	68060	2,030.95	60.16	68060	389,790.43	58.61
500,005,900.00	68050	2,091.11	57.96	68050	389,730.26	60.17
500,006,000.00	68040	2,149.07	59.73	68040	389,672.31	57.96
500,006,100.00	68030	2,208.80	46.11	68030	389,612.91	59.39
500,006,200.00	68020	2,254.92	59.42	68020	389,566.41	46.50
500,006,300.00	68010	2,314.34	57.44	68010	389,506.86	59.55
500,006,400.00	68000	2,371.78	59.53	68000	389,449.28	57.58
500,006,500.00	67990	2,431.31	59.48	67990	389,389.71	59.57
500,006,600.00	67980	2,490.79	58.55	67980	389,330.15	59.56
500,006,700.00	67970	2,549.34	57.66	67970	389,271.60	58.55
500,006,800.00	67960	2,607.00	57.69	67960	389,213.86	57.74
500,006,900.00	67950	2,664.69	57.50	67950	389,156.12	57.74

- Industry-leading alignment and anomaly matching algorithm provides spatially normalized representation of ILI geometry
- Pit-to-pit corrosion growth model based on alignment of the complete measurement history of every reported anomaly

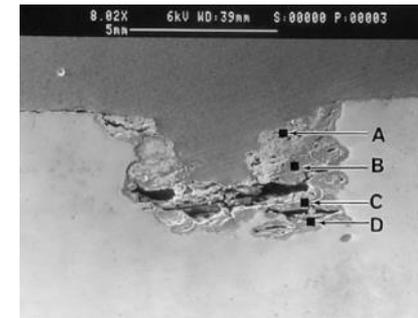
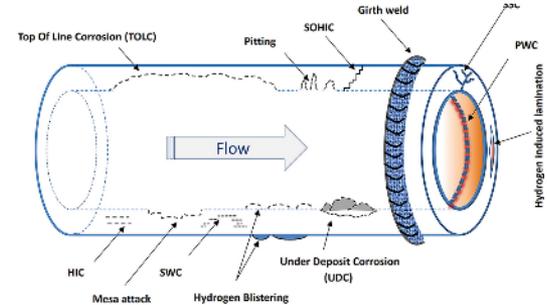


- **Interacting Threats detection algorithms allow integration of data from multiple tool runs & technologies**
- **Pattern Detection algorithms based on input from subject matter experts and data science analysis identify patterns of external corrosion which can indicate potential coating failure or internal corrosion requiring chemical mitigation**



# Corrosion Growth Rate Calculations

- Pit to Pit Measurement
  - The best method for determining corrosion rates is by directly comparing measured wall thickness changes after a known time interval.
- Half Life calculation
  - Measuring the corrosion rate of the material and manage future inspection based on the worst case half life established at each location.
- One Size fit all – flat/default rate
  - The least accurate method is by using a default rate

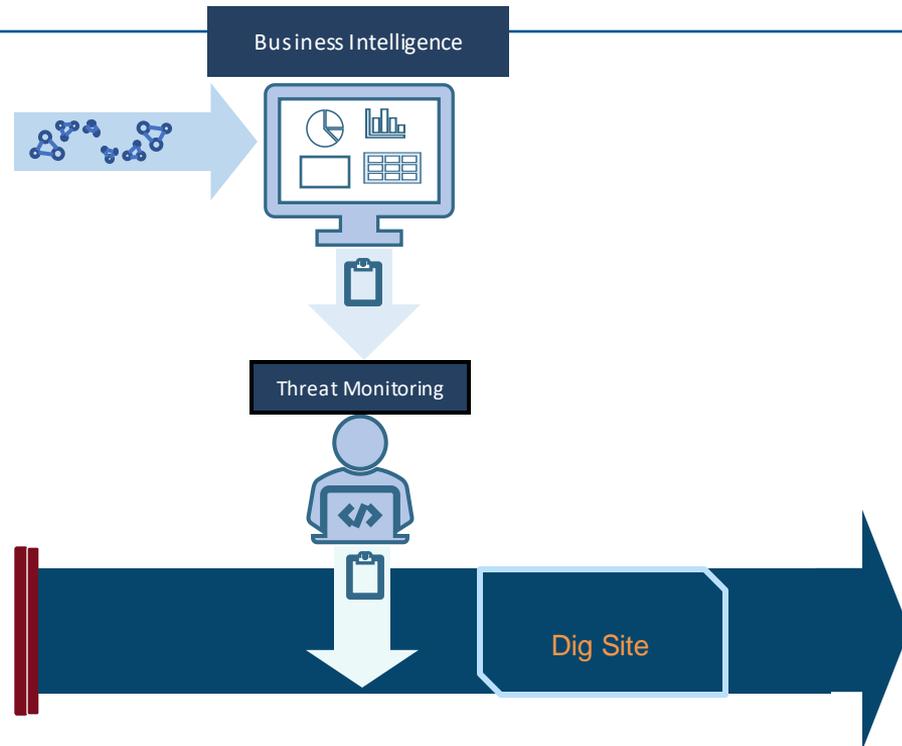


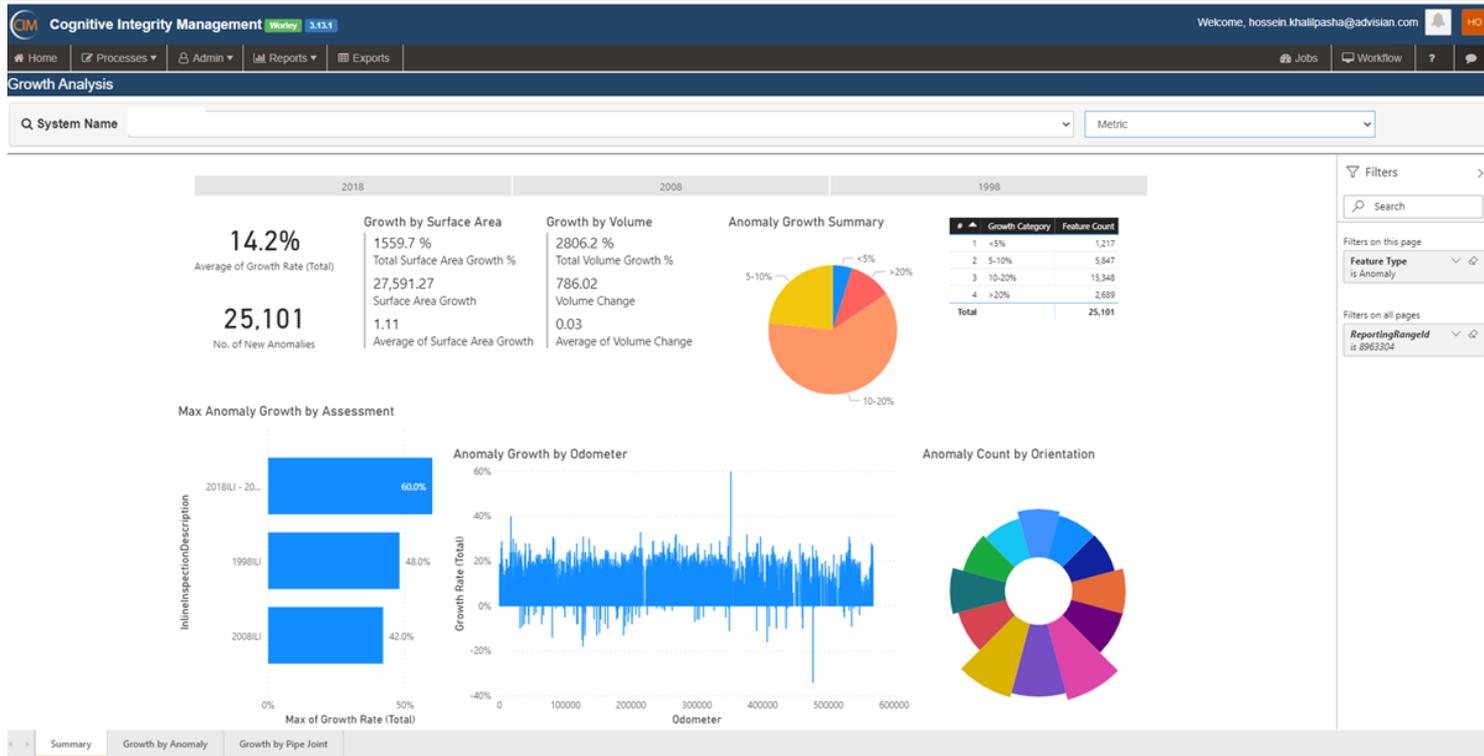
# Data Alignment – Feature Lineage

Feature Lineage										Corrosion Growth Rate (MPY)	2018 ILI				2008 ILI				1997 ILI			
Joint No.	Odometer (ft)	Feature ID	Feature Type	Int / Ext	Comments	UIS Weld Distance (ft)	DIS Weld Distance (ft)	N <sub>w</sub> Di		Odometer (ft)	Length (in)	Width (in)	Depth (%)	Odometer (ft)	Length (in)	Width (in)	Depth (%)	Odometer (ft)	Length (in)	Width (in)	Depth (%)	
									-2.1	29,949.17	0.51	1.26	48.0%	29,958.41	0.43	1.93	57.0%	29,922.59	0.43	0.94	47.0%	
350	1438.04	Anomaly (ANOM)	External	EXT BOX:350-14		58.46	0.16		6.2	257,024.30	4.13	2.91	40.0%	257,104.07	0.87	0.59	13.0%	257,291.05	0.32	0.39	8.0%	
350	1438.04	Anomaly (ANOM)	External	EXT BOX:350-13		58.46	0.16		6.2	257,024.52	0.83	0.28	40.0%	257,104.07	0.87	0.59	13.0%	257,291.05	0.32	0.39	8.0%	
360	1438.22	Anomaly (ANOM)	External	EXT BOX:360-3		0.03	59.45		6.8	265,221.24	3.90	4.13	44.0%	265,304.75	1.97	2.87	14.0%	265,501.16	0.32	0.32	8.0%	
360	1438.26	Anomaly (ANOM)	External	EXT BOX:360-4		0.09	59.39		6.8	265,221.24	3.90	4.13	44.0%	265,304.75	1.97	2.87	14.0%	265,501.16	0.32	0.32	8.0%	
350	1438.16	Anomaly (ANOM)	External	EXT BOX:350-16		59.59	0.03		6.8	265,221.52	0.55	0.20	44.0%	265,304.75	1.97	2.87	14.0%	265,501.16	0.32	0.32	8.0%	
350	1438.04	Anomaly (ANOM)	External	EXT ML		58.46	0.16		6.8	265,221.52	0.55	0.20	44.0%	265,304.75	1.97	2.87	14.0%	265,501.16	0.32	0.32	8.0%	
350	1437.79	Anomaly (ANOM)	External	EXT ML		58.21	0.41		4.6	265,280.65	9.06	14.80	40.0%	265,364.37	0.75	1.06	20.0%	265,560.71	0.43	0.39	7.0%	
350	1437.90	Anomaly (ANOM)	External	EXT BOX:350-9		59.32	0.29		5.3	265,280.65	9.06	14.80	40.0%	265,364.38	0.79	0.83	17.0%	265,560.71	0.43	0.39	7.0%	
350	1437.95	Anomaly (ANOM)	External	EXT BOX:350-12		59.37	0.24		6.8	265,280.65	9.06	14.80	40.0%	265,364.52	0.83	0.75	10.0%	265,560.71	0.43	0.39	7.0%	
470	2,087.90	Anomaly (ANOM)	External	EXT BOX:470-2		0.20	59.81		6.8	266,116.42	12.24	43.98	40.0%	266,200.80	1.14	0.55	10.0%	266,397.68	1.30	1.10	5.0%	
590	2,799.99	Anomaly (ANOM)	External	EXT BOX:590-41		59.11	0.21		7.1	266,116.42	12.24	43.98	40.0%	266,200.81	0.94	0.63	9.0%	266,397.68	1.30	1.10	5.0%	
590	2,799.99	Anomaly (ANOM)	External	EXT ML		59.91	0.41		6.8	266,116.42	12.24	43.98	40.0%	266,200.81	0.94	0.63	9.0%	266,397.68	1.30	1.10	5.0%	
590	2,799.99	Anomaly (ANOM)	External	EXT ML		59.91	0.41		6.8	266,116.42	12.24	43.98	40.0%	266,200.81	0.94	0.63	9.0%	266,397.68	1.30	1.10	5.0%	
590	2,799.99	Anomaly (ANOM)	External	EXT ML		59.90	0.42		6.6	266,116.42	12.24	43.98	40.0%	266,200.82	1.65	0.87	11.0%	266,397.72	0.83	1.30	6.0%	
690	3,283.82	Anomaly (ANOM)	External	EXT ML		59.46	0.45		7.5	266,116.42	12.24	43.98	40.0%	266,200.82	0.71	1.18	7.0%	266,397.72	0.83	1.30	6.0%	
690	3,283.82	Anomaly (ANOM)	External	EXT ML		59.93	0.16		6.6	266,116.42	12.24	43.98	40.0%	266,200.82	1.65	0.87	11.0%	266,397.72	0.83	1.30	6.0%	
690	3,283.99	Anomaly (ANOM)	External	EXT ML		59.93	0.16		7.2	266,116.42	12.24	43.98	40.0%	266,200.82	0.71	1.18	7.0%	266,397.72	0.83	1.30	6.0%	
690	3,284.10	Anomaly (ANOM)	External	EXT ML		59.22	0.04		6.2	266,116.42	12.24	43.98	40.0%	266,200.82	0.79	0.55	13.0%	266,397.72	0.83	1.30	6.0%	
690	3,283.90	Anomaly (ANOM)	External	EXT BOX:690-10		59.02	0.24		7.1	266,116.42	12.24	43.98	40.0%	266,200.83	0.71	0.98	9.0%	266,397.72	0.35	0.39	8.0%	
690	3,283.90	Anomaly (ANOM)	External	EXT BOX:690-10		59.02	0.24		7.5	266,116.42	12.24	43.98	40.0%	266,200.82	0.71	1.18	7.0%	266,397.72	0.83	1.30	6.0%	
700	3,284.28	Anomaly (ANOM)	External	EXT ML		0.14	59.97		6.2	266,116.42	12.24	43.98	40.0%	266,200.82	0.79	0.55	13.0%	266,397.72	0.83	1.30	6.0%	
690	3,284.12	Anomaly (ANOM)	External	EXT ML		59.23	0.02		7.1	266,116.42	12.24	43.98	40.0%	266,200.83	0.71	0.98	9.0%	266,397.72	0.35	0.39	8.0%	
690	3,284.12	Anomaly (ANOM)	External	EXT ML		59.23	0.02		7.1	266,116.42	12.24	43.98	40.0%	266,200.83	0.71	0.98	9.0%	266,397.72	0.35	0.39	8.0%	
690	3,284.12	Anomaly (ANOM)	External	EXT ML		59.23	0.02		7.1	266,116.42	12.24	43.98	40.0%	266,200.83	0.71	0.98	9.0%	266,397.72	0.35	0.39	8.0%	
710	3,514.96	metal loss - gen. & pit	External			59.12	0.13		8.0	266,116.42	12.24	43.98	40.0%	266,200.83	0.83	5.51	5.0%	266,397.72	0.35	0.39	8.0%	
710	3,502.95	Anomaly (ANOM)	External	EXT BOX:710-8		58.94	0.31		7.3	266,116.42	12.24	43.98	40.0%	266,200.83	0.83	0.55	14.0%	266,397.75	0.55	0.55	5.0%	
710	3,503.02	Anomaly (ANOM)	External	EXT BOX:710-13		59.11	0.14		7.5	305,024.68	3.94	3.39	42.0%	305,138.00	1.22	13.78	9.0%	305,448.56	0.20	0.20	8.0%	
710	3,503.04	Anomaly (ANOM)	External	EXT ML		59.13	0.13		7.3	266,116.42	12.24	43.98	40.0%	266,200.92	0.51	0.55	8.0%	266,397.75	0.55	0.55	5.0%	
720	3,503.17	Anomaly (ANOM)	External	EXT ML		0.01	60.06		7.5	305,024.99	0.28	0.91	42.0%	305,138.00	1.22	13.78	9.0%	305,448.56	0.20	0.20	8.0%	

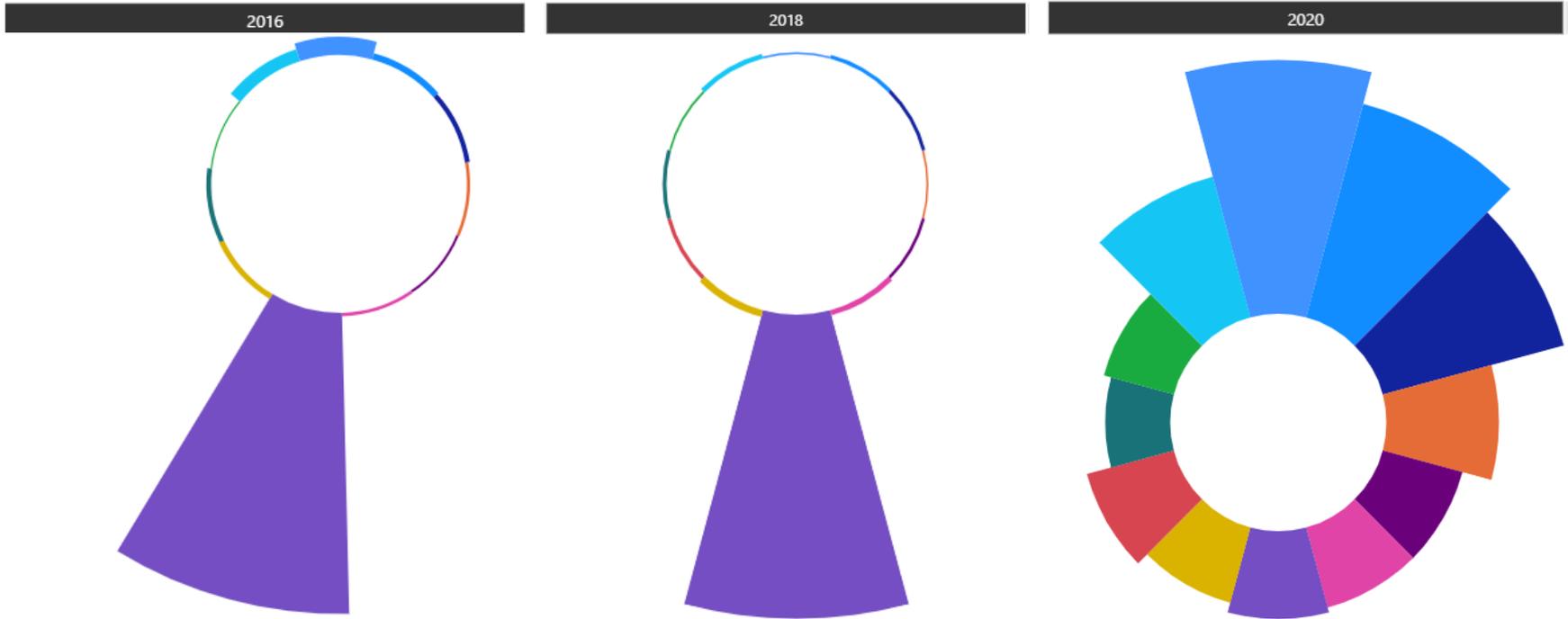
# Business Intelligence

- **Business Intelligence platform based on integrated integrity data system and algorithmic insights**
- **Leverage data from ILI, CP survey, GIS, and dig site to drive operational efficiency, improve decision-making, enable predictive maintenance, and forecasting**
- **Shift operators from reporting & responding to analysing & predicting**





# Identify Changes in Pattern



**CIM Cognitive Integrity Management** Items: 3,113 Welcome, hossein.khalipasha@advisian.com

Home Processes Admin Reports Exports Jobs Workflow ?

### Growth Analysis

Q System Name  Imperial

2018ILI - 2018ILIFeature    2008ILI - 2008ILIExt    1998ILI Rosen MFL

Alias Type: All

High Growth (40+%)    Other

Repair Status	Feature ID	Odometer	Alias Type	Vendor Anomaly Type	Comments	Curr. Max Depth %	Ref. Max Depth %	Wall Thickness	Growth Rate (Per Year)	Gr-
Corrosion	230670.070		Corrosion Wall Loss	Corrosion		36.0 %	14.0 %	0.209	2.21 %	
Corrosion cluster	426262.464		Corrosion Wall Loss	Corrosion cluster	COCL 293   Under WSLC 2	47.0 %	26.0 %	0.334	2.11 %	
Corrosion cluster	426262.464		Corrosion Wall Loss	Corrosion cluster	COCL 293   Under WSLC 2	47.0 %	30.0 %	0.334	1.71 %	
Corrosion	340430.443		Corrosion Wall Loss	Corrosion		35.0 %	19.0 %	0.209	1.61 %	
Corrosion	462132.396		Corrosion Wall Loss	Corrosion		30.0 %	16.0 %	0.209	1.41 %	
Corrosion	548766.302		Corrosion Wall Loss	Corrosion		25.0 %	11.0 %	0.334	1.41 %	
Corrosion	353014.802		Corrosion Wall Loss	Corrosion		51.0 %		0.334	1.31 %	
Corrosion cluster	426018.039		Corrosion Wall Loss	Corrosion cluster	COCL 289	27.0 %	14.0 %	0.334	1.31 %	
Corrosion cluster	434531.886		Corrosion Wall Loss	Corrosion cluster	COCL 298	31.0 %	19.0 %	0.209	1.21 %	
Corrosion cluster	340430.593		Corrosion Wall Loss	Corrosion cluster	COCL 257   On GWD	30.0 %	19.0 %	0.209	1.10 %	
Corrosion cluster	409166.436		Corrosion Wall Loss	Corrosion cluster	COCL 284	36.0 %	25.0 %	0.209	1.10 %	
Corrosion cluster	478664.582		Corrosion Wall Loss	Corrosion cluster	COCL 318   On GWD	42.0 %		0.209	1.08 %	
Corrosion	41986.169		Corrosion Wall Loss	Corrosion		23.0 %	13.0 %	0.232	1.00 %	
Corrosion	145631.312		Corrosion Wall Loss	Corrosion		20.0 %	10.0 %	0.209	1.00 %	
Corrosion	436121.176		Corrosion Wall Loss	Corrosion		21.0 %	11.0 %	0.209	1.00 %	
Corrosion cluster	426018.039		Corrosion Wall Loss	Corrosion cluster	COCL 289	27.0 %	17.0 %	0.334	1.00 %	
Pipe Mill Anomaly	277636.920		Mill Related Wall Loss	Pipe Mill Anomaly		37.0 %		0.334	0.95 %	
Corrosion	269820.947		Corrosion Wall Loss	Corrosion		35.0 %		0.250	0.90 %	
Corrosion	145631.377		Corrosion Wall Loss	Corrosion		28.0 %		0.209	0.72 %	
Corrosion	340430.190		Corrosion Wall Loss	Corrosion		33.0 %	26.0 %	0.209	0.70 %	
Corrosion	202579.503		Corrosion Wall Loss	Corrosion		27.0 %		0.209	0.69 %	

**Filters**

Search

Filters on this visual

- Alias Type is (All)
- Client Joint ID is (All)
- Comments is (All)
- Curr. Max Depth % is (All)
- D/S Weld Distance is less than or equal to 1
- Show items when the value: is less than or equal to 1
- And Or
- Feature ID is (All)
- FeatureId is (All)
- Growth Rate (Per Year) is (All)
- Growth Rate (Total)

Apply filter

Summary    Growth by Anomaly    Growth by Pipe Joint

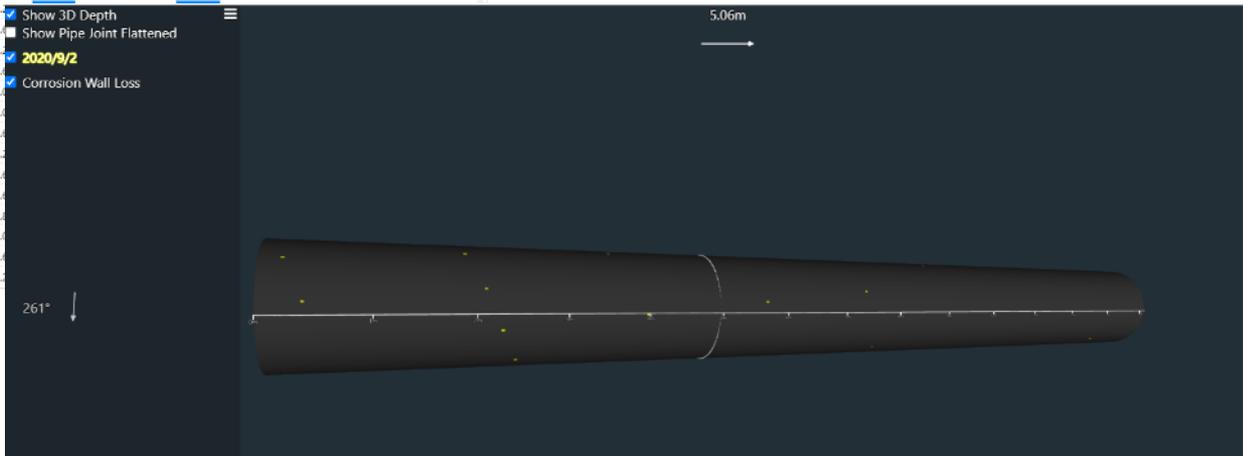
# Business Intelligence – Growth by Joint

Feature ID	Aligned to Feature	Max Depth %	U/S Weld Distance	Length	Width	Orientation	Assessment
Spall Elementary		16.4%	7291	6.84	8.98	33	2018/11/15
Spall Elementary		16.4%	12126	6.86	8.98	34	2018/11/15
Spall Elementary		16.4%	18740	6.75	6.70	35	2018/11/15
Spall Elementary		16.4%	16281	6.51	6.78	33	2018/11/15
Spall Elementary		16.4%	22474	6.84	8.98	210	2018/11/15
Spall Elementary		16.2%	33281	6.56	8.08	148	2018/11/15
Spall Elementary		16.2%	31262	6.65	8.57	152	2018/11/15
Spall Elementary		16.2%	31246	6.31	6.57	149	2018/11/15
Spall Elementary		16.2%	23685	6.54	6.74	152	2018/11/15
Spall Elementary		17.1%	19257	6.63	6.73	149	2018/11/15

Feature ID	Aligned to Feature	Max Depth %	U/S Weld Distance	Length	Width	Orientation	Assessment
		17.0%	35,946	1,068	2,717	65	1998/5/15
		13.0%	36,611	1,221	1,614	84	2008/11/30
		18.0%	39,672	1,268	2,813	269	1998/10/13
Corrosion		44.0%	36,631	1,187	1,868	80	2018/11/15
		12.0%	36,677	1,533	1,289	282	2008/11/30
Corrosion		51.0%	36,695	1,000	6,651	265	2018/11/15

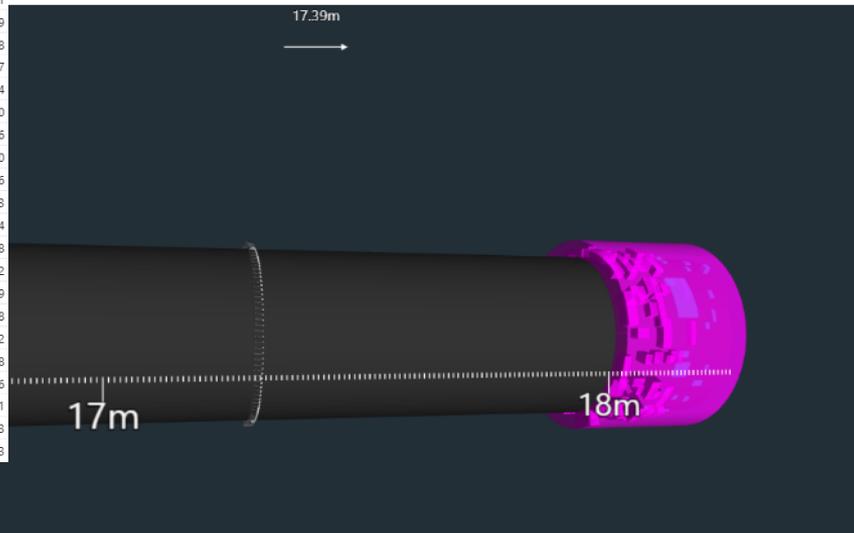
# Spiral welded Pip - Pattern

Client Joint ID	Growth Rate (Vol / Year)	Growth Rate (WT / Year)	Curr. Max Depth %	Max of Growth Rate (Per Year)	Max of Growth Rate (Total)	Feature Count	Joint ID
128890			7.0%	2.62%	7.0%	11	12585992
149584			8.0%	3.00%	8.0%	17	12582466
138076			8.0%	3.00%	8.0%	16	12580028
149899			10.0%	3.75%	10.0%	15	12590100
143759			6.0%	2.25%	6.0%	12	12571486
128863			6.0%	2.25%	6.0%	12	12586019
135980			9.0%	3.37%	9.0%	11	12576428
125775			7.0%	2.62%	7.0%	11	12578019
147783			10.0%	3.75%	10.0%	11	12578836
149454			7.0%	2.62%	7.0%	11	12582581
141472			6.0%	2.25%	6.0%	11	12578836
147596			7.0%	2.62%	7.0%	11	12578836
146887			6.0%	2.25%	6.0%	11	12578836
146886			7.0%	2.62%	7.0%	11	12578836
149734			8.0%	3.00%	8.0%	11	12578836
128889			8.0%	3.00%	8.0%	11	12578836
141058			7.0%	2.62%	7.0%	11	12578836
135713			6.0%	2.25%	6.0%	11	12578836
135351			7.0%	2.62%	7.0%	11	12578836
147747			7.0%	2.62%	7.0%	11	12578836
147316			5.0%	1.75%	5.0%	11	12578836
147235			8.0%	3.00%	8.0%	11	12578836
146951			7.0%	2.62%	7.0%	11	12578836
146892			6.0%	2.25%	6.0%	11	12578836

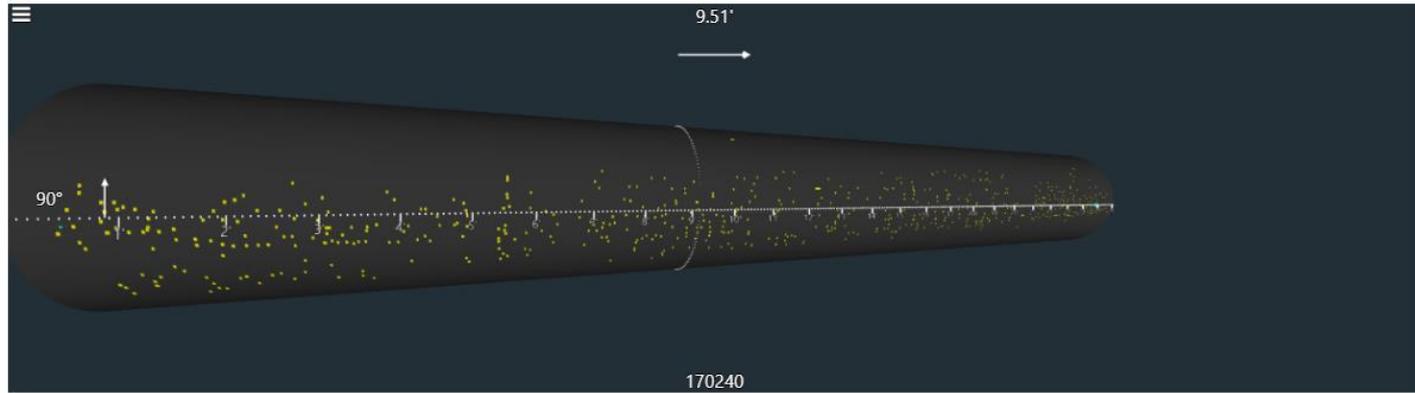


# Field Joint

Client Joint ID	Growth Rate (Vol / Year)	Growth Rate (WT / Year)	Curr. Max Depth %	Max of Growth Rate (Per Year)	Max of Growth Rate (Total)	Feature Count	Joint ID
26730	3,875.43	19.27	38.0%	3.10%	31.0%	239	34340167
45630	1,185.08	23.31	50.0%	4.30%	43.0%	237	34338277
46680	7,437.88	23.18	50.0%	4.50%	45.0%	210	34338172
62890	750.16	11.00	28.0%	2.20%	28.0%	208	34336551
45110	558.26	13.17	33.0%	2.80%	28.0%	208	34338329
53720	6,246.76	19.81	36.0%	4.10%	41.0%	206	34337468
60430	1,401.46	13.82	32.0%	2.50%	25.0%	203	34336797
8630	2,977.10	14.38	37.0%	2.90%	37.0%	188	34341974
59200	2,310.34	14.99	39.0%	3.40%	34.0%	186	34336920
45640	952.63	15.18	49.0%	4.20%	42.0%	186	34338276
56900	1,670.37	10.36	23.0%	1.80%	23.0%	185	34337150
55540	183.08	12.30	38.0%	3.00%	35.0%	182	34337286
45370	1,155.26	12.35	40.0%	3.10%	33.0%	182	34338303
46660	898.58	12.71	33.0%	2.80%	28.0%	180	34338174
32220	1,307.16	14.60	38.0%	3.20%	32.0%	180	34339618
45380	504.02	11.69	48.0%	3.30%	36.0%	179	34338302
60410	740.88	12.66	34.0%	2.80%	28.0%	178	34336799
45420	404.66	14.21	53.0%	4.60%	46.0%	175	34338298
37180	276.42	13.24	49.0%	4.10%	41.0%	175	34339122
43420	3,257.53	12.57	48.0%	3.80%	38.0%	173	34338498
45340	303.45	9.10	33.0%	2.60%	32.0%	172	34338306
60490	432.79	10.06	50.0%	4.50%	45.0%	171	34336791
45170	2,003.07	11.71	43.0%	3.50%	35.0%	171	34338323
60470	1,301.14	13.39	40.0%	3.50%	35.0%	170	34336793



# Defective line pipe



Anomalies on Selected Joint

Feature ID	Aligned to Feature	Max Depth %	U/S Weld Distance	Length	Width	Orientation	Assessment
		4.0%	0.443	0.394	0.591	105	2018/5/4
		4.0%	0.472	0.315	0.591	237	2018/5/4
		11.9%	0.489	0.276	0.354	102	2020/8/6
		4.0%	0.531	0.433	0.591	243	2018/5/4
		4.0%	0.551	0.354	0.591	95	2018/5/4
		4.0%	0.584	0.354	0.591	102	2018/5/4
		3.0%	0.600	0.315	0.591	109	2018/5/4
		4.0%	0.630	0.315	0.591	112	2018/5/4
		4.0%	0.656	0.315	0.591	85	2018/5/4
		4.0%	0.656	0.315	0.591	88	2018/5/4



# Fitness For Service and Repair

**CIM Cognitive Integrity Management** Version 3.13.1 Worklog Welcome, hossein.khallipasha@advisian.com HO

Home Processes Admin Reports Exports Jobs Workflow ?

### Integrity Compliance (View)

- Indicates a required field

**Analysis Information** Analysis ID: 200000022

System Name:

Name:

Type:

Assessment(s):

Vendor Reports:

**Dates**

Discovery: 10/04/2020

Deration: 10/04/2020

Creation: 10/05/2020

Auto Delete: 11/04/2020

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**PODS** General Pipe Properties Interacting Threats Conditions Attributes Pre-Analysis Reports Post-Analysis Reports Validation

**PODS Information** Excel

*Drag a column header and drop it here to group by that column*

System Name	Line ID	Route Sequence	Route ID	Series Number	Begin Engr Station (ft)	End Engr Station (ft)	Begin Measure (ft)	End Measure (ft)	Length (miles)	HCA Length (miles)	Route Status	Flow Direction	Nominal Diameter	Commodity	Unconvent... Method	Exceptions	Integrity Management Program Status	Buried Insul...
<input type="text"/>	0	0	0	0			0	0	0.00	0.00					No		No	

1 - 1 of 1 items

# Fitness For Service and Repair

**CIM Cognitive Integrity Management** Monday 3.13.1 Welcome, hossein.khalilpasha@advisian.com HCI

Home Processes Admin Reports Exports Jobs Workflow ?

### Integrity Compliance (View)

- Indicates a required field

**Analysis Information** Analysis ID: 200000022

System Name: \*

Name: \*

Type: \*  Preliminary  Final

Assessment(s): 
1998ILJ
2008ILJ
2018ILJ

Vendor Reports: 
1998ILJ
2008ILJ
2018ILJ60KSMYS

**Dates**

Discovery: \* 10/04/2020

Deration: \* 10/04/2020

Creation: 10/05/2020

Auto Delete: 11/04/2020

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PODS General Pipe Properties Interacting Threats Conditions Attributes Pre-Analysis Reports Post-Analysis Reports Validation

PODS Informatic Excel

*Drag a column header and drop it here to group by that column*

System Name	Line ID	Route Sequence	Route ID	Series Number	Begin Engr Station (ft)	End Engr Station (ft)	Begin Measure (ft)	End Measure (ft)	Length (miles)	HCA Length (miles)	Route Status	Flow Direction	Nominal Diameter	Commodity	Unconvent... Method	Exceptions	Integrity Management Program Status	Burle Insul
Demo	0	0	0	0			0	0	0.00	0.00					No		No	

5 Items per page 1 - 1 of 1 items

# FFS Set Up – CGA Pit to Pit

- Pipeline Data
- General**
- Pipe Properties
- Interacting Threats
- Conditions
- Attributes
- Pre-Analysis Reports
- Post-Analysis Reports
- Validation

Default Analysis:\*  
 Tool Tolerance:\*  
 Tool Tolerance Applied To:\*  
 Operating Pressure:\*  
 Corrosion Growth Rate: \*

- Gas
- None
- All
- MOP
- Pit to Pit Minimum**

- Top Side
- Bottom Side
- Girth Weld
- Long Seam Weld

- Pipeline Data
- General
- Pipe Properties
- Interacting Threats**
- Conditions
- Attributes
- Pre-Analysis Reports
- Post-Analysis Reports
- Validation

Object	Run ID	Vendor Report Name	Vendor Report Description	Tool Technology	Vendor Name	Report Receipt Date	Original Transmittal Date	Last Transmittal Date	Assessment ID	Assessment End Date
Assessment Name: EMAT2017m (1)										
<input type="checkbox"/>	150216	EMAT2017m	NA	EMAT	Rosen	05/04/2017			180	05/04/2017
Assessment Name: GT2016m (1)										
<input checked="" type="checkbox"/>	150215	2016m	NA	MFL	Rosen	05/04/2016			179	05/04/2016
Assessment Name: MFLUltra2020Finalm (2)										
<input type="checkbox"/>	150219	MFLAULTRA20201		MFL	Rosen	08/26/2020			182	08/06/2020
<input checked="" type="checkbox"/>	150218	MFLAUltra2020Finalm	NA	MFL	Rosen	08/06/2020			182	08/06/2020
Assessment Name: MFLCombo2018m (1)										
<input checked="" type="checkbox"/>	150217	MFLCombo2018m	NA	MFL	Rosen	05/04/2018			181	05/04/2018

# FFS Set Up – > 200 Conditions

Pipeline Data | General | Pipe Properties | Interacting Threats | **Conditions** | Attributes | Validation

- Liquid Immediate
  - Liquid 60-Day
  - Liquid 180-Day
  - Liquid Others
  - Growth
- Gas Immediate
  - Gas Others
  - Gas Priority
  - Gas 1-Year
  - Gas Monitored
  - Criteria for Non-HCA
  - Company 12-Month
  - Company RIA/PCFA

**Liquid Immediate** | **Growth**

- Select All
- Calculated ML >= 80% before ReAssessment ⓘ
- Growth Calculated ML Burst < MOP ⓘ
- Growth Calculated ML SOP < MOP ⓘ
- Growth Calculated ML @ Girth Weld >= 50% within HCA before ReAssessment ⓘ
- Growth Calculated ML @ Girth Weld >= 50% outside HCA before ReAssessment ⓘ

**Gas Immediate** | **Liquid Immediate**

- Select All
- (iA) ML > 80% ⓘ
- ML between 70 and 79% ⓘ
- (iB) ML Burst < MOP ⓘ
- ML Burst < 1.1\*MOP ⓘ
- (iC1) Top Side Dents w/ ML ⓘ
- (iC2) Top Side Dents w/ Cracking ⓘ
- (iC3) Top Side Dents w/ Stress Riser ⓘ
- ML Burst < MOP in HCA using Modified B31G ⓘ
- (iD) Top Side Dents > 6% ⓘ
- (iE) Other anomalies in our judgment that require immediate action ⓘ
- (iE1) Cracks, SSC, or HIC, where depth w/o upper bound ⓘ

Pipeline Data | General | Pipe Properties | Interacting Threats | **Conditions** | Attributes | Validation

- Liquid Immediate
  - Liquid 60-Day
  - Liquid 180-Day
  - Liquid Others
  - Growth
  - Gas Immediate
  - Gas Others
  - Gas Priority
  - Gas 1-Year
  - Gas Monitored
  - Criteria for Non-HCA
  - Company 12-Month
  - Company RIA/PCFA
  - Historical Ventilation Features
  - Pressure Cycle Fatigue Analysis
  - Pattern Detection
  - Company 18-Month
  - Company 180-Day
  - Company 60-Day

**Liquid Immediate** | **Company 12-Month**

- Select All
- (1005C) ML SOP < MOP ⓘ
- (4400A) Crack with Metal Loss near or on the Long Seam ⓘ
- (4400B) Crack with Metal Loss near or on the Girth Weld ⓘ
- (4400C) Crack with Metal Loss on pipe body ⓘ
- ML SOP < MOP in Non HCA using Modified B31G ⓘ
- ML on LS in Non HCA ⓘ
- (1205A) Gouge, Groove or Scratch > 12.5% ⓘ
- (2015A) SCC (Crack Field Vendor call that does not meet the 2005D or 2005C Criteria above) ⓘ
- (2005D) Cracks (Field Identified Crack that does not meet the 2005D or 2005C Criteria above) ⓘ
- (2010D) Likely crack > 50% of nominal wall thickness where time dependent or potentially time dependent ⓘ
- (2010E) Possible crack > 50% of nominal wall thickness where time dependent ⓘ
- (2010F) Likely crack with FPR < 1.25 where time dependent ⓘ
- (2010G) Possible crack with FPR < 1.25 where time dependent or potentially time dependent ⓘ
- (1005E) Selective Corrosion on LS (Field Personnel use Only) ⓘ
- (2100A) Lamination (if no previous 1.25 Hydro Test) ⓘ
- (2110A) Non Planar Lamination ⓘ
- (2120A) Lamination associated with weld ⓘ
- (3005B) Dents located on the bottom of the pipeline with a depth greater than 6% of nominal pipe diameter, and
- (3005C) Dents located on the top of the pipeline with a depth greater than 3% of the pipeline's nominal diameter
- (3005G) Top Side Dent > 6% (Gas Lines Only) ⓘ
- (3025B) Dents w/ ML that meet no other condition ⓘ

# Fitness For Service and Repair

CIM Cognitive Integrity Management Weekly 3.43.1 Welcome, hossein.khalilpasha@advisian.com

Home Processes Admin Reports Exports Jobs Workflow ?

Add Anomalies to Analysis Analysis ID: 200000021

Available Anomalies 25 Assigned Anomalies 25 Bulk Add Anomalies Custom Excel

Drag a column header and drop it here to group by that column

	Condition	Action	Site ID	Feature ID	Odometer (ft)	Eng'r Station (ft)	Corrosion Growth Rate (MPY)	Growth Rate Source	Metal Loss Depth (%)	Prev. Metal Loss Depth (%)	Change in Metal Loss Depth (%)
	Growth Calculated ML @ ...	Unclassified	1,490.41.56		5076.9056		- 8.1	Half-life	34		
	Growth Calculated ML @ ...	Unclassified	1,600.42.22		5526.94		- 6.5	Half-life	27		
	Growth Calculated ML @ ...	Unclassified	2,610.31.20		9615.3923		- 7.2	Half-life	30		
	Growth Calculated ML @ ...	Unclassified	3,670.41.17		13764.2922		- 6.9	Half-life	29		
	Calculated ML >= 80% bef	Unclassified	8,360.36.59	Corrosion	31646.0894		- 7.7	Pit to Pit Minimum	48	15	33
	Calculated ML >= 80% bef...	Unclassified	11,810.30.81	Corrosion	45497.8662		- 8.9	Pit to Pit Minimum	61	23	38
	Calculated ML >= 80% bef...	Unclassified	25,240.36.83	Corrosion cluster	97674.6141		- 10.7	Pit to Pit Minimum	51	19	32
	Calculated ML >= 80% bef...	Unclassified	39,980.02.45		153798.4131		- 8.2	Pit to Pit Minimum	62	20	42
	Calculated ML >= 80% bef...	Unclassified	39,980.02.46	Corrosion	154709.8655		- 10.6	Half-life	53	62	-9
	Growth Calculated ML, SO	Unclassified	49,100.23.07	Pipe Mill Cluster	190145.9696		- 7.2	Pit to Pit Minimum	41	10	31

100 items per page 1 - 25 of 25 items



# Fitness For Service and Repair

28

**Integrity Compliance (Assign Action) - CGA SF1.25PPM(200000062)**

Filter Anomalies By: Condition: All Type: All Priority: All Action: All

1 of 809

← Previous 640.00.00 Next →

Action: Unclassified User Prioritization: System Generated Prioritization: Calculated ML >= 80% before ReAssessment

Anomaly Information:		Pipeline Information:		Other Information:	
Site ID:	640.00.00	Joint Length (ft):	23.78'	Vendor Report Name:	MFLCombo2018m
Odometer (ft):	1851.72'	UIS Joint Number:	630	Due Date:	02/01/2022
ML Depth (%):	23.0	D/S Joint Number:	660	Safe Leak Date:	--
Internal / External:	External	Seam Type:	ERW	Safe Rupture Date:	--
Metal Loss Subclass:	--	Affecting Long Seam:	N	Burst Pressure (psig):	--
Anomaly Type:	Weld Feature	Seam Orientation (deg):	--	SOP (psig):	--
Vendor Comment:	--			Growth Rate (MPY):	65
Condition Category:	Growth	Diameter (in):	42"	Growth Rate Source:	Half-life
Eng't Station (ft):	--	Wall Thickness (in):	0.555"		
ML Depth w/Tot:	23.0	Install Date:	06/01/2014	In Prior Analysis:	N
Length (in):	0.32"	Grade:	--	HCA Status:	N
Width (in):	0.59"	MOP (psig):	1480	Interacting Threat:	N
Orientation (deg):	264	Affecting Girth Weld:	Y	Gov. Pressure Calc:	No Pressure Calc
		DOT Gas Class:	--		

Validation Issues | Dig Note | Log Data | Pipeline Data | Anomaly Tracking | Pressure Calculations | Anomaly History | Map View | Joint View

Validation Issues 1

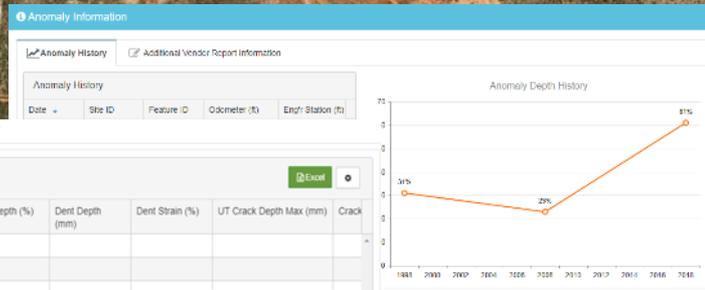
Type ↑	Description
Error	An Action must be selected for anomaly Site Id (640.00.00)

5 items per page 1 - 1 of 1 items



# Fitness For Service and Repair

Validation Issues  
  Dig Note  
  Log Data  
  Pipeline Data  
  Anomaly Tracking  
  Pressure Calculations  
  Anomaly History  
  Map View  
  Joint View



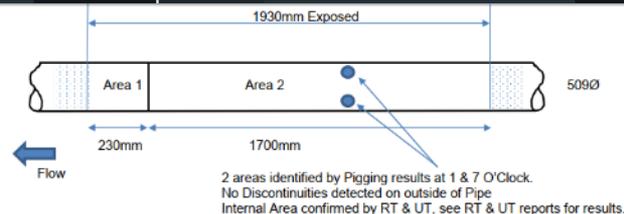
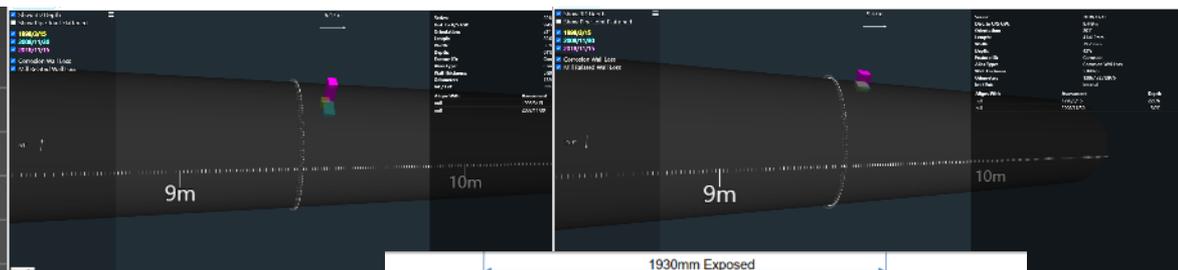
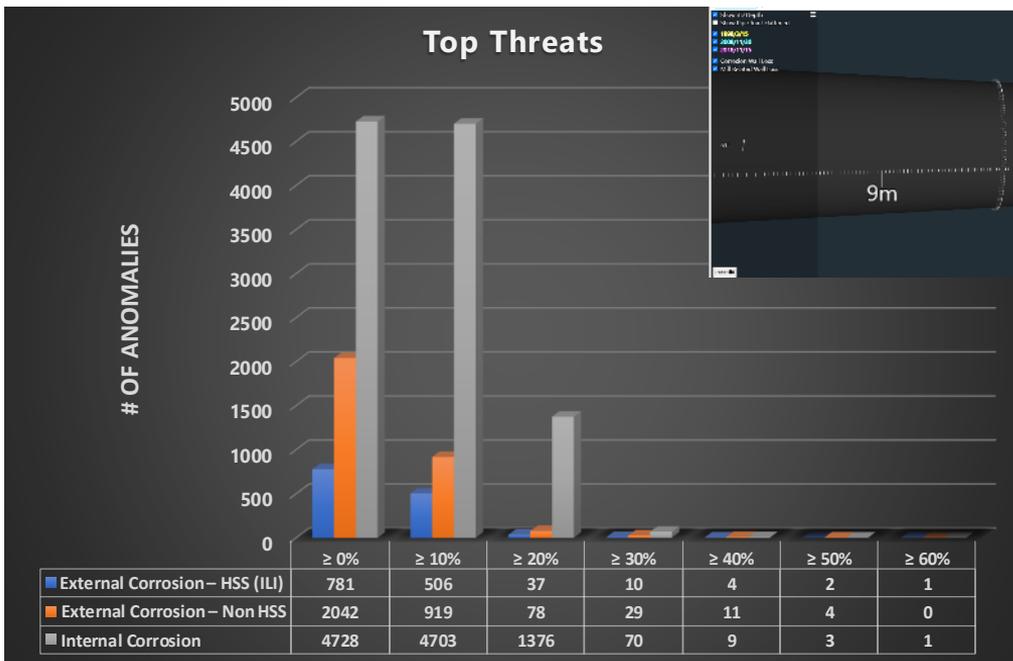
### Log Data

Site ID	Feature ID	Odometer (m)	Engr Station (m)	Classification Description	Vendor Comment	Vendor Report Name	Metal Loss Depth (%)	Effective Metal Loss Depth (%)	Dent Depth (mm)	Dent Strain (%)	UT Crack Depth Max (mm)	Crack
170.00.01		103.6921	0	External Corrosion	EXT ML	2018 I	1					
170.00.01		103.6921	0	External Corrosion	EXT ML	2018II	1					
170.00.01		103.6921	0	External Corrosion	EXT ML	2018II	1					
170.00.01		103.6921	0	External Corrosion	EXT ML	2018T	16					
170.00.04		103.702	0	External Corrosion	EXT BOX 170-2	2018 I	1					
170.00.04		103.702	0	External Corrosion	EXT ML	2018 I	17					
170.00.04		103.702	0	External Corrosion	EXT BOX 170-2	2018II	1					
170.00.04		103.702	0	External Corrosion	EXT ML	2018II	17					
170.00.04		103.702	0	External Corrosion	EXT BOX 170-2	2018II	1					
170.00.04		103.702	0	External Corrosion	EXT ML	2018II	17					
170.00.04		103.702	0	External Corrosion	EXT BOX 170-2	2018T	16					
170.00.04		103.702	0	External Corrosion	EXT ML	2018T	27					
170.00.10		103.7191	0	External Corrosion	EXT BOX 170-3	2018 I	1					
170.00.10		103.7191	0	External Corrosion	EXT BOX 170-3	2018II	1					
170.00.10		103.7191	0	External Corrosion	EXT BOX 170-3	2018T	16					
170.00.13		103.728	0	External Corrosion	EXT BOX 170-4	2018 I	1					
170.00.13		103.728	0	External Corrosion	EXT BOX 170-4	2018II	1					
170.00.13		103.728	0	External Corrosion	EXT BOX 170-4	2018II	1					
170.00.13		103.728	0	External Corrosion	EXT BOX 170-4	2018T	16					

### Pressure Calculations

Controlling	Metal Loss Depth (%)	Effective Metal Loss Depth (%)	Length
B21G Modified	27	87.12	87.12
LN Rectant Rectangular	27	87.12	87.12
LN-Rectant Rectangular	27	87.12	87.12
H21G	27	87.12	87.12
D21G	27	87.12	87.12

# Validation of the model



Anomaly	Anomaly Type	Ref. point	Dist. O'clock	Dist. from u/s Ref.	Dist. from d/s Ref.	length	width	Min wall Thickness	Max wall Thickness
1	Internal wall loss	Grirth Weld	1 O'clock	-	1400	30a	-	3.7	6.1
2	Internal wall loss	Grirth Weld	7 O'clock	-	1400	40a	-	4.2	6.1

Clock Position	Nominal wall thickness	Measured Wall thickness			ILI Report
		Min	Maximum	% Wall Loss	
1 O'Clock	5.8mm	3.7mm	6.1mm	39%	61%
7 O'Clock	5.8mm	4.2mm	6.1mm	31%	43%

# Comparison of Cost

## Results – 4.1MPa Growth vs 5MPa Growth

	3 years	5 years	7 years	10 Years
	Repaired/Inspected	Repaired/Inspected	Repaired/Inspected	Repaired/Inspected
<b>MOP = 5MPa</b>				
# of Digs	1	3	3	3
Threat type	4	5	5	6
	0	0	2	1
	0	1	1	5
Total Dig Cost 300k per dig				
<b>MOP = 4.1 MPa</b>				
# of Digs	1	3	3	3
Threat type	4	5	5	6
	0	0	2	2
	0	1	1	4
Total Dig Cost 300k per dig	<b>900K</b>	<b>900K</b>	<b>1500K</b>	<b>2700K</b>

MOP	Quantity	Total Cost
4.1	6	\$ 2.41 M
	4	
	16	
5.0	8	\$ 4.71 M
	15	
	30	

# Why a large difference?

- **CIM's estimated cost of maintenance in 5 years is 3-5 times less than the existing strategy depending on the pressure.**
  - **What Operator predicted as cost in the next 5 years is 75% higher than what CIM predicted for the next 10 years.**
  - **They also had to rerun ILI in the next 5 years as managing the number of dig ups was not financially viable.**
  - **Our assessment showed that they don't need to run an ILI in the next 5 years.**
- **Pit to Pit Measurement**
    - The best method for determining corrosion rates is by directly comparing measured wall thickness changes after a known time interval.
  - **Half Life calculation**
    - Measuring the corrosion rate of the material and manage future inspection based on the worst case half life established at each location.
  - **One Size fit all – Flat/default rate**
    - The least accurate method is by using a default rate



# Corrosion Growth Rate Calculations

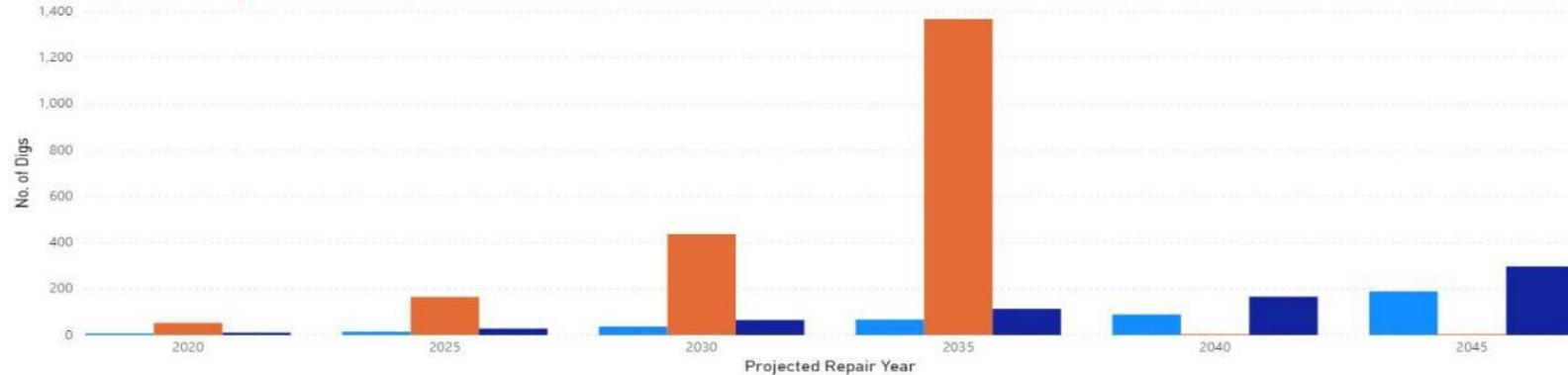
Dig Program Forecast for System:

Avg. Cost / Dig

\$30,000

No. of Digs by Projected Repair Year and AID\_NAME

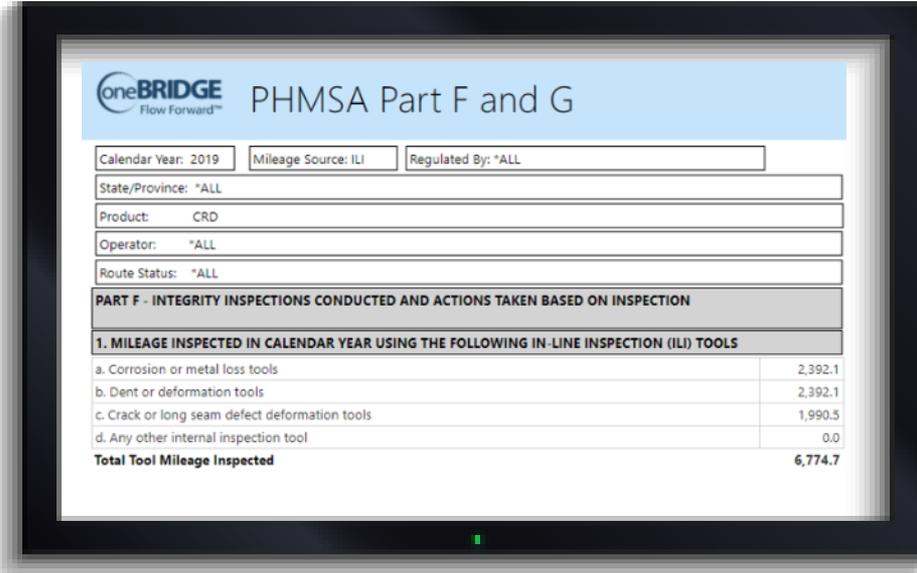
AID\_NAME ● JD Test Growth ● JD Test Growth 6mil ● JD Test Growth Half-Life



AID_NAME Projected Repair Year	JD Test Growth		JD Test Growth 6mil		JD Test Growth Half-Life	
	No. of Digs	Dig Program Cost	No. of Digs	Dig Program Cost	No. of Digs	Dig Program Cost
2020	7	\$210,000	53	\$1,590,000	11	\$330,000
2025	15	\$450,000	165	\$4,950,000	28	\$840,000
2030	37	\$1,110,000	436	\$13,080,000	65	\$1,950,000
2035	67	\$2,010,000	1366	\$40,980,000	114	\$3,420,000
2040	89	\$2,670,000	1	\$30,000	166	\$4,980,000
2045	189	\$5,670,000	1	\$30,000	296	\$8,880,000
<b>Total</b>	<b>404</b>	<b>\$12,120,000</b>	<b>2022</b>	<b>\$60,660,000</b>	<b>680</b>	<b>\$20,400,000</b>

# Regulatory Compliance

- Regulatory Compliance per System (\$)
  - Currently – \$255.78/system
  - 60 hours – 1 audit/year
  - 346 hours to produce the PHMSA F&G
  - OBS customers (avg) – \$43,103\*
- Potential savings –  $406 * \$63/\text{hour} = \$25,578$
- How can CIM help
  - Automatic generation of PHMSA F&G, Yearly, etc.
  - Shorter duration and less resources required per audit



The screenshot shows a software interface for generating PHMSA Part F and G reports. It includes a header with the 'oneBRIDGE Flow Forward' logo and the title 'PHMSA Part F and G'. Below the header are several filter fields: 'Calendar Year: 2019', 'Mileage Source: ILI', 'Regulated By: \*ALL', 'State/Province: \*ALL', 'Product: CRD', 'Operator: \*ALL', and 'Route Status: \*ALL'. The main content area is titled 'PART F - INTEGRITY INSPECTIONS CONDUCTED AND ACTIONS TAKEN BASED ON INSPECTION' and contains a table for '1. MILEAGE INSPECTED IN CALENDAR YEAR USING THE FOLLOWING IN-LINE INSPECTION (ILI) TOOLS'. The table lists four categories of inspection tools and their corresponding mileage values.

PART F - INTEGRITY INSPECTIONS CONDUCTED AND ACTIONS TAKEN BASED ON INSPECTION	
1. MILEAGE INSPECTED IN CALENDAR YEAR USING THE FOLLOWING IN-LINE INSPECTION (ILI) TOOLS	
a. Corrosion or metal loss tools	2,392.1
b. Dent or deformation tools	2,392.1
c. Crack or long seam defect deformation tools	1,990.5
d. Any other internal inspection tool	0.0
<b>Total Tool Mileage Inspected</b>	<b>6,774.7</b>



## PHMSA Part F and G

Calendar Year: 2019    Mileage Source: ILI    Regulated By: \*ALL

State/Province: \*ALL

Product: CRD

Operator: \*ALL

Route Status: \*ALL

### PART F - INTEGRITY INSPECTIONS CONDUCTED AND ACTIONS TAKEN BASED ON INSPECTION

#### 1. MILEAGE INSPECTED IN CALENDAR YEAR USING THE FOLLOWING IN-LINE INSPECTION (ILI) TOOLS

a. Corrosion or metal loss tools	2,392.1
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d. Any other internal inspection tool	0.0
<b>Total Tool Mileage Inspected</b>	<b>6,774.7</b>

#### 2. ACTIONS TAKEN IN CALENDAR YEAR BASED ON IN-LINE INSPECTIONS

a. Based on ILI data, total number of anomalies excavated in calendar year because they met the operator's criteria for excavation	
1 Pipeline Segment COULD AFFECT AN HCA	173
2 Pipeline Segment COULD NOT AFFECT AN HCA	237
b. Total number of anomalies repaired in calendar year that were identified by ILI based on the operators's criteria, both within a segment that could affect an HCA and outside of a segment that could affect an HCA	
1 Pipeline Segment COULD AFFECT AN HCA	123
2 Pipeline Segment COULD NOT AFFECT AN HCA	88
c. Total number of conditions repaired WITHIN A SEGMENT THAT COULD AFFECT AN HCA meeting the definition of:	
Liquid Immediates	0
Liquid 60-Day	2
Liquid 180-Day	11
Liquid Others	41

#### 3. MILEAGE INSPECTED AND ACTIONS TAKEN IN CALENDAR YEAR BASED ON PRESSURE TESTING

a. Total mileage inspected by pressure testing in calendar year	0.0
b. Total number of pressure test failures (ruptures and leaks) repaired in calendar year, both within a segment that could affect an HCA and outside of segment that could affect an HCA	
c. Total number of pressure test ruptures (completed failures of pipe wall) repaired in calendar year WITHIN A SEGMENT THAT COULD AFFECT AN HCA	
d. Total number of pressure test leaks (less than complete wall failure but including escape of test medium) repaired in calendar year WITHIN A SEGMENT THAT COULD AFFECT AN HCA	

# PHMSA Yearly

**oneBRIDGE** Flow Forward™ PHMSA Yearly

Calendar Year: 2019 Regulated By: \*ALL

State/Province: \*ALL

Product: \*ALL

Operator: \*ALL

Route Status: \*ALL

**Part B - Miles of Pipe By Location**

Total Segment Miles That Could Affect HCA's	
Onshore	
Offshore	
<b>Total Miles</b>	

**Part D - Miles of Pipe By Material and Corrosion Prevention Status**

Steel Cathodically Unprotected	
	<b>Total Miles</b>
Total	

**Part E - Miles of Electric Resistance Welded (ERW) Pipe By Weld Type And Decade**

	High Frequency	Low Frequency	Total Miles
1940 - 1949		3,178.04	<b>3,178.04</b>
1950 - 1959		6,920.50	<b>6,920.50</b>
1960 - 1969		8,780.96	<b>8,780.96</b>
1970 - 1979	4,693.34		<b>4,693.34</b>
1980 - 1989	3,826.07		<b>3,826.07</b>
1990 - 1999	6,649.95		<b>6,649.95</b>
2000 - 2009	2,218.66		<b>2,218.66</b>
2010 - 2019	3,929.68		<b>3,929.68</b>
Pre - 1940		65.47	<b>65.42</b>
<b>Total</b>	<b>21,317.71</b>	<b>18,944.91</b>	<b>40,262.62</b>

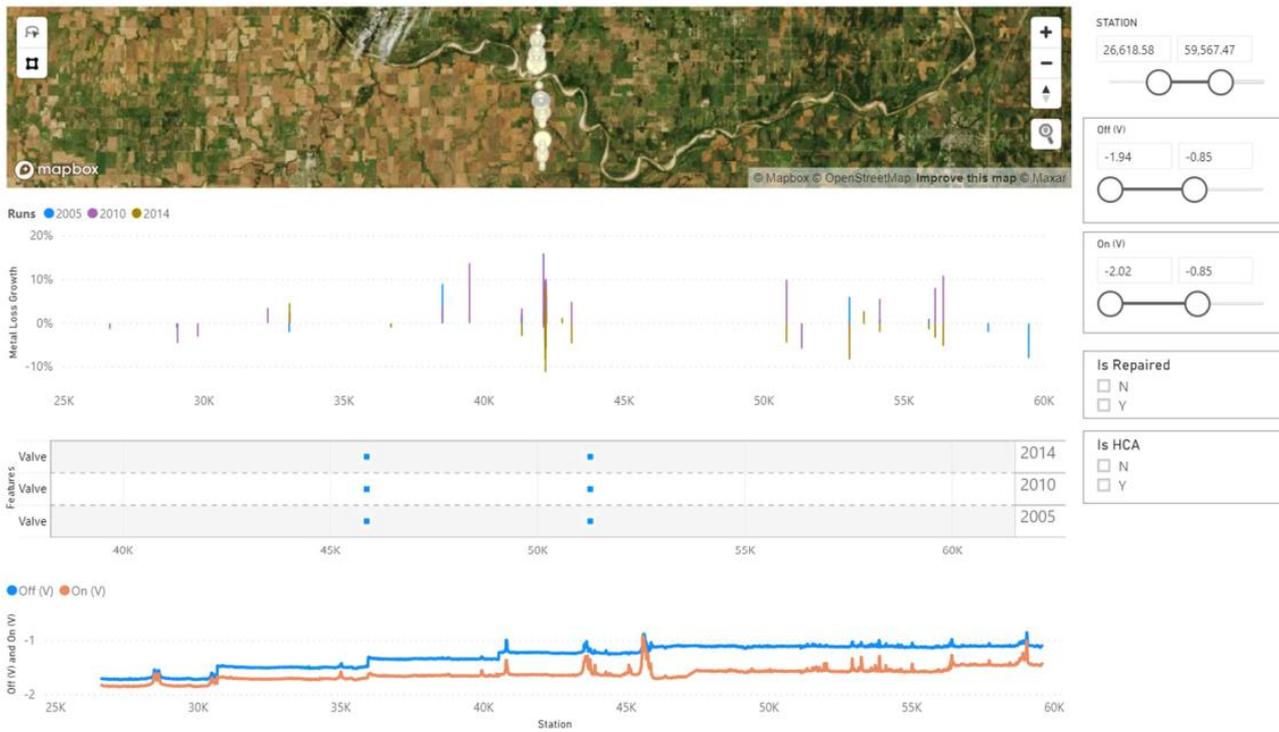
**Part H - Miles of Pipe By Nominal Pipe Size (NPS)**

	2	3	4	5	6	7	8	10	12	14	15	16	18	20	22	24	28	30	36	42	Total	
Onshore	6.56	973.00	3,261.48	66.87	7,856.20	23.93	17,249.37	10,701.76	9,104.11	262.22	3.06	3,373.63	1,340.26	635.53	2.08	227.25	10.15	2,013.89	1.75	22.36	<b>57,134.97</b>	
Offshore																						
<b>Total</b>	<b>6.56</b>	<b>973.00</b>	<b>3,261.48</b>	<b>66.87</b>	<b>7,856.20</b>	<b>23.93</b>	<b>17,249.37</b>	<b>10,701.76</b>	<b>9,104.11</b>	<b>262.22</b>	<b>3.06</b>	<b>3,373.63</b>	<b>1,340.26</b>	<b>635.53</b>	<b>2.08</b>	<b>227.25</b>	<b>10.15</b>	<b>2,013.89</b>	<b>1.75</b>	<b>22.36</b>	<b>57,134.97</b>	

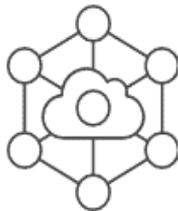
**Part I - Miles of Pipe By Decade Installed**

	1940 - 1949	1950 - 1959	1960 - 1969	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2009	2010 - 2019	Pre - 1940	Total
	5,428.81	12,632.34	11,636.03	5,901.65	4,374.62	7,024.48	2,296.20	5,992.23	1,846.60	<b>57,134.97</b>

# Other Inspections / ACVG DCVG/ CIPS/ CP



- Review all the anomaly and Review all the anomaly and feature data on your entire pipeline system.
- Gather insights from interacting threats and pattern detection, rather than relying on single data points.
  - Identifying Internal corrosion as a threat



Digitally transform IMP

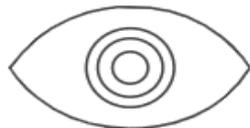


Interacting threats

- **Pit to pit measurement offers a much more accurate results**
  - **Elevate your confidence regarding integrity excavations.**
  - **Reduce the overall number of digs while making sure you dig in the right spot every time.**
- **Gain visibility into the entire pipeline—bubble up and drill down into the finest level of detail.**



**Confident excavations**



**Comprehensive visibility**

# QA &

**Hossein Khalilpasha , PhD , FIEAust**

*Principal Integrity Engineer – Asset Integrity Lead*

**m +61 473 397 559**

**e [hossein.khalilpasha@advisian.com](mailto:hossein.khalilpasha@advisian.com)**

**Tim Edward**

*President – OneBridge Solutions*

**m 587.416.6487**

**e [tedward@onebridgesolutions.com](mailto:tedward@onebridgesolutions.com)**

March 2-5, 2021 | PRCI Virtual Research Exchange