PPIM 2026

PIPELINE PIGGING & INTEGRITY MANAGEMENT

JANUARY 20-22

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Tuesday - January 20, 2026

5:00 *Exhibition open*
Reception sponsored by intero

Wednesday - January 21, 2026

7:00 *Registration open*
Breakfast sponsored by CRITICAL INFRASTRUCTURE

1.0 Plenary - Opening Session

Session chair: Josiah SooTot, ExxonMobil

8:00 **Opening remarks**
Ben Stroman, CLARION

8:05 205 **Ten-Year Analysis of Reportable Pipeline Accidents: Trends, Risk Factors, and Lessons Learned**
Alvaro Rodriguez[1]
[1]PHMSA, Oklahoma City, USA

8:35 *Young Pipeline Professional Annual Recognition Award Presentation*

8:50 186 **Talent Pipeline - A Comprehensive Review of the Talent Management and Career Journeys in the Pipeline Industry**
Michelle Unger[1], Jan Frowijn[2], Hena Rehman[3]
[1]ROSEN Group, Newcastle upon Tyne, UK, [2]ROSEN Group, Houston, USA, [3]Enbridge, Houston, USA

9:20 154 **Has the Industry Forgotten How to Weld?**
Michael Rosenfeld[1], Bill Amend[1]
[1]RSI Pipeline Solutions, New Albany, USA

9:50 *Refreshment Break*

1.0 Plenary - Opening Session - *cont'd*

Session chair: Sergio Limón, Blade Energy Partners

10:50 **State of the Industry Report**
Tyler Campbell [1]
[1]Pipeline & Gas Journal, Houston, USA

11:05 250 **An Improved Fracture Model for Assessing Crack-Like Flaws in Pipelines**
Ted Anderson[1], Robert Dodds[2], Thomas Dessein[3]
[1]TL Anderson Consulting, Cape Coral, USA, [2]Consultant, Longmont, USA, [3]Integral Engineering, Edmonton, Canada

11:35 231 **An Operator's Practical Approach for Evaluating and Prioritizing ILI-Reported Dent**s
Rick Wang[1], Connie Meksavanh[1], Tao Hu[1], Jaspal Deol[1]
[1]TC Energy, Calgary, Canada

12:05 124 **Advances in API 1163 Level 3 ILI Validations**
Jed Ludlow[1], Jason Skow[2], Ryan Stewart[2]
[1]T.D. Williamson, Salt Lake City, USA, [2]Integral Engineering, Edmonton, Canada

12:35 *Lunch*

Wednesday - January 21 (*cont'd)*

Time	1.1 Unpiggable or Difficult-to-Inspect 1	2.1 Geohazards 1	3.1 Cracks	4.1 Corrosion
	Session chair: Keith Leewis, L&A Inc.	*Session chair: Jing Ma, DNV*	*Sergio Limón, Blade Energy Partners*	*Session chair: Jerry Rau, JTrain*
14:00	115 **Predicting Corrosion Severity on ILI Remnant Pipe Using Extreme Value Analysis** Haotian Sun[1], Nick Bullen[1], Andrew Carss[1], Colin Dooley[1], Sergiu Lucut[1] [1]TC Energy, Calgary, Canada	168 **A Deep-Dive into the PHMSA Significant Incident Database and What it Tells us About Trends in Pipeline Geohazards** Alexander McKenzie-Johnson[1], Rhett Dotson[2] [1]Tricoast Geoservices, The Woodlands, USA, [2]D2 Integrity, Tomball, USA	130 **Longitudinally Misaligned Pipeline Stacked Crack Interaction Using 3-D Crack Meshes – Part II** Ryan Holloman[1], Mark Neuert[2], Greg Thorwald[2], Michael Turnquist[1] [1]Quest Integrity, Boulder, USA, [2]Enbridge, Edmonton, Canada	255 **Joint-Based versus Segment-Based CGRs – A Case Study** Zaki Hassan[1], Brian Krieg[2], Joshua Kuennen[2], Jeffrey Donnelly[2], Adriana Nenciu[2], Stacy Hickey[2], Mattew Ellinger[2] [1]DNV, Columbus, USA, [2]CenterPoint Energy, Evansville, USA
14:30	320 **A Comparative Study of ICDA and ILI in Subsea Pipelines** Pedro Rincon[1], Yougui Zheng[1], Adam Maggio[2], Ryan Meyer[2], Eric Pierce[2] LeeAnn Escobar[2] [1]Shell Global Solutions (US) Inc, Houston, USA, [2]Shell Exploration & Production Company, New Orleans, USA	267 **Automated and Continuous Evaluation and Ranking of Geohazards by Comparing Bending Strain Features Against Geohazard Inventory and Inspection Records** Chad Sutherland[1], Caroline Scheevel[2], Todd Zawacki[3] [1]Cambio Earth, Calgary, Canada, [2]BGC Engineering, Golden, USA, [3]Enbridge, Nashville, USA	200 **Finding the Edge of Crack & Seam Welds in the Field with Direct High-Resolution ILI Measurements** Greer Simpson[1], Corey Richards[1], Marshall Lu[1] [1]DarkVision, North Vancouver, Canada	296 **Even Faster RSTRENG: Further Optimization of the Effective Area Method for Plausible Profile Corrosion Assessments** Tristan MacLeod[1] [1]Kiefner and Associates, Ames, USA
15:00	284 **Advancing Seam Integrity on Difficult to Inspect Pipelines: Robotic Inspection of Vintage ERW Pipeline for SSWC, Lack of Fusion, and other Longitudinal Weld Anomalies** Michael Kobelak[1], Ryan Trapp[2] [1]Intero Integrity Services, Toronto, Canada, [2]Pacific Gas and Electric Company, Oakland, USA	163 **When Did the Slope Start Moving … Varved Clays, Pipelines, and Landslides** Nick LaPlant[1], Todd Bown[2] [1]National Grid, Syracuse, USA, [2]GZA GeoEnvironmental, Buffalo, USA	144 **Development and Implementation of a State-of-the-Art Seam Weld Fatigue Cracking Integrity Management Program** Michael Turnquist[1], Rachel Brossman[2], Miguel Martinez[2] [1]Quest Integrity, Boulder, USA, [2]PBF Energy, Cerritos, USA	209 **Bridging Overline Surveys and ILI Tools with Corrosion Computer Modeling** Christophe Baete[1], Keith Parker[2] [1]Elsyca, WIjgmaal, Belgium, [2]Enbridge, Stockbridge, USA
	1.2 Unpiggable or Difficult-to-Inspect 2	**2.2 Circumferential Stress Corrosion Cracking**	**3.2 Materials Testing & Verification 1**	**4.2 Integrity Management 1**
	Session chair: Josh Busby, Energy Transfer	*Session chair: Jim Marr, Marr Associates*	*Session chair: David Futch, Acuren*	*Session chair: Mark Piazza, API*
15:30	192 **Managing Internal Corrosion Threat in Unpiggable Pipelines and Facility Deadlegs: An Update on Industry Standards and What the Data Tells Us** LeeAnn Escobar[1], Leslie Ward[2] [1]Shell, New Orleans, USA, [2]Kiefner and Associates, Houston, USA	319 **Management and Validation of CSCC Using Multiple ILI Technologies** Rick Gonzales[1], Katrina Dwyer[1], Sergio Limón[2] [1]Xcel Energy, Denver, USA, [2]Blade Energy Partners, Salt Lake City, USA	242 **Field Simulation Material Property Verification Trial** Samuel Kindel[1], Brent Vyvial[2] [1]Enbridge, Houston, USA, [2]Stress Engineering, Houston, USA	281 **Leveraging Causal Models and Data Fusion to Assess Pipeline Integrity in the Presence of Ground Movement** Colin Schell[1], Ernest Lever[1], Katrina Groth[2] [1]GTI Energy, Des Plaines, USA, [2]University of Maryland, College Park, USA
16:00	227 **Overcoming the Unpiggable: Full-Length Internal Inspection of Crude Oil Filled Marine Terminal Loading Lines Using ART Scan and Robotic Crawlers** Paul Chittenden[1], Bryce Davey[1], Nicholas Bartal[2] [1]TSC Subsea, Houston, USA, [2]Buckeye Partners, Houston, USA	114 **Testing and Validation Methodologies of MFL ILI Technologies for the Detection of CSCC and Off-Axis Cracks and Crack-like Features** Nima Parsibenehkohal[1], Rachel Brossman[1], Ron Thompson[2], Richard Kania[3], Andrew Corbett[3], Guillermo Solano[3] [1]PBF Energy, Cerritos, USA, [2]Novitech, Toronto, Canada, [3]KanEnergyPartners, Calgary, Canada	139 **Using Composition Data to Improve the Accuracy of Nondestructive Strength Estimates** Peter Martin[1], Nathan Switzner[1], Joel Anderson[1], Emily Brady[2], Pooya Delshad[3], Peter Veloo[3] [1]RSI Pipeline Solutions, New Albany, USA, [2]Exponent, Houston, USA, [3]Pacific Gas and Electric, San Ramon, USA	243 **The LTS Futures Project – An Update of a UK Operator's (SGN) Experience of Assessing the Feasibility of Repurposing their Natural Gas Transmission System to Transport Hydrogen** Gary Senior[1], Gemma Simpson[2], Andrew Cosham[3] [1]Pipeline Integrity Engineers, Newcastle upon Tyne, UK, [2]SGN, Edinburgh, UK, [3]Ninth Planet Engineering, Newcastle upon Tyne, UK
16:30	*Conference Day 1 concludes*			
16:30	*Exhibition Reception*			

Thursday - January 22, 2026

Time				
7:00	*Breakfast, Registration open*			
	5.1 Inline Inspection 1	**6.1 Geohazards 2**	**7.1 Risk Assessment & Management** *sponsored by* WELDFIT	**8.1 Integrity Management 2**
	Session chair: Jim Marr, Marr Associates	*Session chair: Gary Krichau, Northern Natural Gas*	*Session chair: Keith Leewis, L&A Inc.*	*Session chair: Bryan Melan, Tide Water Integrity Services*
8:00	222 **Development and Validation of a Novel Gas Crack Detection Tool using Guided Waves** Yvan Hubert[1], Debartha Bag[1], Michael Haas[2], Joaquin Aparicio[3], Marianne Solberg[3], Thomas Hennig[3], Rogelio Guajardo[4] [1]Enbridge, Houston, USA, [2]NDT Global, Stutensee, Germany, [3]NDT Global, Bergen, Norway, [4]NDT Global, Barcelona, Spain	221 **Using Axial Strain Data to Improve Slope Remediation Projects** Sylvain Cornu[1], Teko Hanvi[2], Jared Kowis[2], Heidi Manicke[3], Doug Dewar[3] [1]NDT Global, Stutensee, Germany, [2]Enbridge, Houston, USA, [3]Pembina, Calgary, Canada	136 **Be Content to Begin with Doubts: a Discussion of What to Expect When Comparing Deterministic and Probabilistic Integrity Assessment of Pipeline Corrosion Metal Loss** Susannah Turner[1], Jack Davies[1], Fraser Gray[1], Tim Turner[1] [1]Highgrade Associates, Newcastle upon Tyne, UK	182 **Real-Time Detection of Mechanical Impact on Pipelines via CP – Part II** Maher Kassir[1], Carine Lacroix[2], Aaron Rezendez[3], David Xu[3] [1]SPADE, Paris, France, [2]NaTran R&I, Paris, France, [3]Pacific Gas and Electric Company, Oakland, USA
8:30	188 **Development of ILI Tool and Specifically Robust UT Probes for the Assessment of Crack Type Anomalies in Ammonia Carrying Pipelines** Daniel Bugger[1], Colton Shannon[2], Martin Fuchs[3], Dr. Thomas Hennig[3] [1]NDT Gobal, Stutensee, Germany, [2]Sunoco, San Antonio, USA, [3]Sonotec, Halle, Germany	256 **Screening and Mitigation Criteria of IMU Bending Strain for Geohazards Management** Yong-Yi Wang[1], Banglin Liu[1], David Warman[1], Teko Hanvi[2] [1]Center for Reliable Energy Systems, Dublin, USA, [2]Enbridge, Houston, USA	305 **Coding, Context, and Convergence: Let's Write the Next Chapter in Pipeline Risk Management** Kelly Thompson[1] [1]Williams, Tulsa, USA	207 **Are Pipeline Accidents Causally Linked to the Decade the Pipeline Was Installed?** Tod Barker[1] [1]PHMSA, Washington D.C., USA
9:00	135 **Low-Pressure High-Speed Gas: Adaptive Speed Control Outside of Their Traditional Use Cases** James Barlow[1], William Deschamps-Robertson[1], McKenzie Kissel[2] [1]Onstream, Calgary, Canada, [2]Calgary, Calgary, Canada	244 **Monitoring Pipelines in Landslide-Prone Areas with an Automated Strain Gauge Data Analysis Tool: "Strain Gauge Module™"** Debora Martogi[1], Arash Mosaiebian[2], Ali Ebrahimi[2], Amir Ahmadipur[2] [1]Geosyntec Consultants, Houston, USA, [2]Enbridge, Calgary, Canada	116 **An Overall Quantitative Risk Measure to Prioritize First-Time Assessments** Haotian Sun[1], Nick Bullen[1], Andrew Carss[1], Greg Sargent[1], Chance Wright[1] [1]TC Energy, Calgary, Canada	162 **Assessing the Integrity of Ultra Deep Pipeline River Crossings - a Novel Drone-Based Electromagnetic Solution** Denise Earles[1], TBA[2] [1]Skipper NDT, Houston, USA, [2]Targa Resources, Houston, USA
9:30	*Refreshment Break*			
	5.2 Inline Inspection 2	**6.2 Geohazards 3**	**7.2 Repair**	**8.2 Engineering Assessment**
	Session chair: Josh Busby, Energy Transfer	*Session chair: Rhett Dotson, D2 Integrity*	*Session chair: Fan Zhang, Phillips 66*	*Session chair: Tom Bubenik, DNV*
10:30	206 **Using Advanced Inline Inspection (ILI) to Prioritize Girth Weld Features** Matt Romney[1], David Sunwall[1] [1]T.D. Williamson, Salt Lake City, USA	285 **Automated Landslide Impact Detection Through Machine Learning Analysis of Pipeline IMU Bending-Strain Data** Aron Zahradka[1], Owen Bunce[2], Chad Sutherland[3], Jared Kowis[4] [1]Cambio Earth, Victoria, Canada, [2]BGC Engineering, Calgary, Canada, [3]Cambio Earth, Calgary, Canada, [4]Enbridge, Houston, USA	269 **Challenges, Considerations, and Practical Solutions for Installing Pipeline Repairs** Greg Morris[1], Tara McMahan[1], Matt Boring[1], Melissa Gould[1], Bill Bruce[1] [1]DNV, Dublin, USA	261 **A Comparative Methodology for the POE Assessment of Corrosion vs. Crack Defects** Lucinda Smart[1] [1]Kiefner and Associates, Ames, USA
11:00	204 **Integrating ILI Results to Evaluate Pipeline Expansions in Seamless and ERW Pipe** Rob Greene[1], Rhett Dotson[1], Nima Parsi[2] [1]D2 Integrity, Houston, USA, [2]PBF Energy, Torrance, USA	121 **Visualization and Screening of IMU Data for Strain-Based Integrity Assessment** Ali Fathi[1], Garret Meijer[1] [1]Enbridge, Edmonton, Canada	158 **Study to Validate the Design of Carbon-Epoxy Technology used to Reinforcement Crack-Like Features** Travis Greenstreet[1], Chris Alexander[2], Jim Souza[3], Osbaldo Chavez[4], Sammy Goodgion[4], Steven Siever[4] [1]Acuren, Magnolia, USA, [2]Acuren, Magnolia, Texas, USA, [3]WrapMaster Global, Longview, USA, [4]WrapMaster Global, Longview, Texas, USA	152 **Engineering Critical Assessment of Facilities and Lap Welded Pipe** Scott Riccardella[1], Peter Veloo[2], Roger Royer[3], TJ Prewitt[4] [1]Structural Integrity Associates, Denver, USA, [2]Pacific Gas and Electric Company, San Ramon, USA, [3]Structural Integrity Associates, State College, USA, [4]Structural Integrity Associates, Columbus, USA
11:30	240 **Enhancing Pipeline Integrity with Vibroacoustic Technology: A Case Study of Real-Time PIG Tracking and Leak Detection** Adnan Chughtai[1], Rodolfo Santos[1], Joshua May[1], Casey Lajaunie[2], Gary Winfrey[2], Fabio Chiappa[3], Ana Paula Gomes[3], Marco Marino[3], Gerardo Califano[3], Valeria Vandone[3], Massimiliano Biagini[3], Ilenia Romagnoli[3] [1]SLB, Houston, USA, [2]Enbridge, Houston, USA, [3]Enivibes, Milan, Italy	307 **Enhancing Pipeline Geohazard Management through the use of a Novel In-Line Inspection Micro-Magnetic Hysteresis Technology (MHT) for Direct Axial Stress Measurement of Pipelines** James Bainbridge[1], Rebecca Senior[1] [1]ROSEN Group, Calgary, Canada	211 **The Case of the Permanency of Composites - Testing, Analysis, and Case Study** Tim Mally[1], Joshua Duell[1], Casey Whalen[1] [1]Henkel, Houston, USA	153 **SAWL Seam Peaking – Is it a Pipeline Integrity Threat?** Michael Rosenfeld[1], Benjamin Zand[1], Adam Steiner[1], Simon Slater[2] [1]RSI Pipeline Solutions, New Albany, USA, [2]ROSEN Group, Houston, USA
12:00	*Lunch*			

	Thursday - January 22 *(cont'd)*			
	5.3 Dents 1	**6.3 Selective Seam Weld Corrosion**	**7.3 Stress Corrosion Cracking**	**8.3 Integrity Management 3**
	Session chair: Fan Zhang, Phillips 66	*Session chair: Bryan Melan, Tide Water Integrity Services*	*Session chair: Jim Marr, Marr Associates*	*Session chair: Tom Bubenik, DNV*
13:30	318 **Automating Level 3 Dent Assessment: A Consistent and Scalable Framework for Deterministic and Probabilistic Finite Element Analysis** Amandeep Virk[1], Muntaseer Kainat[1], Chike Okoloekwe[2], Michael Elkins[3], Nader Yoosef-Ghodsi[3], Saheed Akonko[3] [1]Integraframe, Edmonton, Canada, [2]Enbridge, Edmonton, Canada, [3]Trans Mountain Corporation, Calgary, Canada	119 **Pushing the Boundaries of SSWC Detection, Identification, and Characterization with Magnetic ILI Technology** **Greg Baker[1], Geoff Hurd[1]** [1]Enduro Pipeline Services, Calgary, Canada	173 **Managing Complex SCC Through Combining ILI Inspections and Applying Advanced Data Analytics** Cécil Adam[1], Manuel Hernández[2], Jordi Aymerich[3], Thomas Mrugala[4] [1]SPMR, Lyon, France, [2]NDT Global, Houston, USA, [3]NDT Global, Calgary, Canada, [4]NDT Global, Stutensee, Germany	248 **A Case Study on the use of Flaw Spools for ILI Validation** Ben Hanson[1], Christopher De Leon[1], Nima Parsibenehkohal[2], Rachel Brossman[2], Santiago Urrea[3], Roberto Yanez[3] [1]D2 Integrity, Houston, USA, [2]PBF Energy, Torrance, USA, [3]NDT Global, Houston, USA
14:00	311 **Advancements in Dent and Stress Raiser Measurement Accuracy Through Historical Dig Database and Industry Pull Testing** Anthony Tindall[1], Jeff Sutherland[2], David Classen[3] [1]Baker Hughes, Cramlington, UK, [2]Baker Hughes, Calgary, Canada, [3]Baker Hughes, Houston, USA	216 **Enhanced Identification of Selective Seam Weld Corrosion with MFL-C Ultra In-Line Inspection** Andres Gonzalez Franchi[1], Simon Slater[1], Alberto Zepeda[1], Omar Ramirez[1], Carlos Berrones[1] [1]ROSEN Group, Houston, USA	259 **From Digs to Data: Integrating ILI and Environmental Insights for SCC Predictive Modeling** Syed Aijaz[1], Michael Gloven[2], Andy Florence[2] [1]TC Energy, Houston, USA, [2]Pipeline-Risk, Denver, USA	151 Learnings from Seven Successful Years of Phased Array Inline Inspections Thomas Hennig[1], Gerhard Kopp[1], Alessandro Morandini[1], Peter Haberl[1] [1]NDT Global, Stutensee, Germany
14:30	194 **A Recommended Dent Screening and Assessment Framework for API 1183** Thomas Dessein[1], Ahmed Abdelmoety[1], Ayman Abbas[1], Gustavo Gonzalez[2] [1]Integral Engineering, Edmonton, Canada, [2]ExxonMobil, Houston, USA	316 **Keeping on the "Straight and Narrow" for Selective Seam Weld Corrosion ILI Inspections** Anthony Tindall[1], Cassidy Ryan[2], Jeff Sutherland[3] [1]Baker Hughes, Cramlington, UK, [2]Baker Hughes, Houston, USA, [3]Baker Hughes, Calgary, Canada		157 Accelerating Technology Adoption: A Framework for Modernizing Integrity Management Chris Alexander[1], Buddy Powers[1] [1]Acuren, Magnolia, USA
15:00	*Refreshment Break*			
	5.4 Dents 2	**6.4 Geohazards 4**	**7.4 Materials Testing & Verification 2**	**8.4 ILI Analysis**
	Session chair: Yohann Miglis, Kinder Morgan	*Session chair: Alex McKenzie-Johnson, Tricoast Geoservices*	*Session chair: Krista Heidersbach, Brown Corrosion Services*	*Session chair: Brian Jiminez, Energy Transfer*
15:30	275 I**mproved Framework for Fatigue Life Prediction of Unconstrained Plain Dents and Dents Interacting with Gouges, Weld and Corrosion** Shree Krishna[1], Rick Wang[2], Ravi Krishnamurthy[2] [1]Blade Energy Partners, Houston, USA, [2]TC Energy, Calgary, Canada	148 **Mechanistic Modeling and Threshold-Based Alerts for Weather and Outside Force Threat Management** John Norman[1], Elena Arroway[1], Katherine Kraft[1] [1]Teren, Lakewood, USA	304 **Identification of Composition Measurement Errors and their Effects on Calculated Pipe Grade** Janille Maragh[1], Pooya Delshad[2], Peter Martin[3], Peter Veloo[4] [1]Exponent, Menlo Park, USA, [2]Applied Technology Services, San Ramon, USA, [3]RSI Pipeline Solutions, Columbus, USA, [4]Pacific Gas and Electric Company, Oakland, USA	110 **Incorporating In-line Inspection Signal Data Review for Optimization of Asset Integrity Management and Continual Improvement** Nima Parsibenehkohal[1], Chuntao Deng[1], Matthew Lewis[2], Lisa Barkdull[2] [1]PBF Holding Company, Cerritos, USA, [2]Quest Integrity, Stafford, USA
16:00	276 **What's that noise??? Dealing with ILI Caliper Data Issues** Shanshan Wu[1], Joe Bratton[1], Rick Wang[2] [1]DNV, Dublin, USA, [2]TC Energy, Calgary, Canada	169 **Case Studies Evaluating a New IMU Solution for Geohazards** Rhett Dotson[1], Karim Kabbara[2], Dan Fletcher[3], Jeff Haferd[3] [1]D2 Integrity, Houston, USA, [2]Marathon Petroluem, Findlay, USA, [3]Fiberbuilt Manufacturing, Calgary, Canada	127 **Addressing Variation in Laboratory Toughness Testing for Vintage Pipelines Using Planing-Induced Microfracture** Ryan Lacy[1], Intisar Rizwan i Haque[1], Simon Bellemare[1], David Futch[2] [1]MMT, Natick, USA, [2]Acuren, Magnolia, USA	197 **Automatic Feature Prioritization for Ultrasonic Metal Loss Analysis Using AI** Victor Ferrer[1], Gerard Jover[1], Katja Träumner[2], Thomas Meinzer[2] [1]NDT Global, Barcelona, Spain, [2]NDT Global, Stutensee, Germany
16:30	260 **A Comprehensive Engineering Assessment Procedure for Dent Coincident with Secondary Features** Udayasankar Arumugam[1], Ravi Krishnamurthy[1] [1]Blade Energy Partners, Houston, USA	293 **Updated Correlations of IMU Bending Strain Features with Geohazards Based on Pipe-Slope Orientation** Caroline Scheevel[1], Jim Hart[2], Bailey Theriault[3], Casey Dowling[4] [1]BGC Engineering, Minneapolis, USA, [2]SSD, Reno, USA, [3]Geosyntec Consultants, Bedford, USA, [4]BGC Engineering, Golden, USA	292 **Measuring Fracture Toughness of Line Pipe Using Miniature Test Coupons** Kenneth George[1], Sergio Limón[1], Daniel Gutierrez[2], Ryan Milligan[2] [1]Blade Energy Partners, Houston, USA, [2]Phillips 66, Houston, USA	312 **Friend or Foe – Responsibly Applying Machine Learning and AI Techniques to In-line inspection for Pipeline Integrity Assessment** Jeff Sutherland[1], Stuart Clouston[1] [1]Baker Hughes, Calgary, Canada
17:00	*Conference adjourns*			

110

Incorporating In-line Inspection Signal Data Review for Optimization of Asset Integrity Management and Continual Improvement

Nima Parsibenehkohal[1], Chuntao Deng[1], **Matthew Lewis**[2], Lisa Barkdull[2]

[1]PBF Holding Company, Cerritos, USA. [2]Quest Integrity, Stafford, USA

Contact-point corrosion, also known as corrosion under pipe supports (CUPS) presents an ongoing integrity threat and inspection challenge to operators of gas and liquid processing facilities, refineries and compressor stations globally. Contact corrosion most often occurs within difficult-to-access areas such as tightly spaced pipe racks, full encirclement supports, concrete wall or deck penetrations, and air-soil interfaces. The technology now exists for rapid quantitative corrosion measurement within these difficult applications utilizing axially and circumferentially transmitted guided waves.

This novel, low-profile scanning technique is robust and tolerant of pipe surface condition while providing reliable corrosion profile analysis in areas inaccessible by other inspection methods. This presentation will discuss the advantages of guided wave quantitative corrosion measurement and how it can serve to enhance existing inspection programs.

Matthew Lewis is the manager of the Pipeline Analysis Services within Quest Integrity's Advanced Engineering Group. He has an Associate of Applied Science degree in Corrosion Technology. Matthew has worked in the in-line inspection (ILI) industry since 2004 and has expertise in the analysis of multiple ILI tool technologies.

Nima Parsibenehkohal is a Corrosion and Integrity Engineer with over 15 years of experience in the pipeline industry. He specializes in pipeline integrity and risk assessment, In-Line Inspection (ILI) analysis, and conducting fitness-for-service for defect assessment.

Chuntao Deng is a Senior Staff Integrity Engineer at PBF Energy with 20+ years in pipeline integrity, corrosion modeling, and quantitative risk analysis. Licensed Professional Engineer (APEGA). Author of papers on consequence modeling, risk analysis, and reliability-based assessments. Holds a Ph.D. in Chemical and Biological Engineering from the University of British Columbia.

Lisa Barkdull has more than 30 years' experience in the pipeline service industry. She holds a M.S. degree in Statistics from the University of Houston – Clear Lake. Throughout her career, she has been involved in various aspects of pipeline integrity, primarily focusing on in-line inspection (ILI) data analysis and engineering assessment. Ms. Barkdull is well versed in the application of multiple ILI technologies, integrity management planning of pipeline assets, and application of engineering critical assessments.

114
Testing and Validation Methodologies of MFL ILI Technologies for the Detection of CSCC and Off-Axis Cracks and Crack-Like Features

Nima Parsibenehkohal[1], Rachel Brossman[1], Ron Thompson[2], Richard Kania[3], Guillermo Solano[2]

[1]PBF Energy, Cerritos, USA. [2]Novitech, Toronto, Canada. [3]KanEnergyPartners, Calgary, Canada

This paper summarizes the testing of the magnetic based in-line inspection (ILI) systems for the detection and sizing of circumferential and off-axis stress corrosion cracking (CSCC) and crack like and metal loss features. The objective of the testing program was to determine the optimal testing setups, types of defects and manufacturing methods and their applications. Pipe sections utilized for testing contained synthetic and man-made crack-like features and metal-loss features as well as natural defects from cutouts, which were then used to test and validate the tool specification to demonstrate compliance with API 1163.

During the evaluation and development of the ILI system for detecting CSCC, the use of high sensor density and high sampling rates from the combined AMFL and CMFL modules showed signal changes that were potentially attributable to the variations in material permeability.

Nima Parsibenehkohal see #110

Rachel Brossman has over 15 years of experience in the pipeline industry. She started her career at ExxonMobil and currently leads the Integrity Engineering Department for PBF Energy, overseeing Pipeline Integrity, Facility Integrity, and Corrosion Control for all U.S. assets. Rachel's expertise includes in-line inspection (ILI), regulatory compliance, hydrotesting, and pipeline integrity management, with a focus on risk-based methodologies, data-driven decision making, and asset lifecycle performance. Rachel holds a B.S. in Mechanical Engineering from the University of Florida.

Richard Kania is the founder of KanEnergy Partners Inc. He is a pipeline professional with over 30 years of experience in the Oil & Gas industry where he specializes in all aspects of pipeline integrity management. He was instrumental in the development and implementation of EMAT ILI. Recipient of the ASME Global Pipeline Award for Development and introduction of EMAT for TC Energy (2018) and PRCI Distinguished Service award (2022).

Ron Thompson is the Co-Founder and President of Novitech LLC. Ron is responsible for Research and Development, guiding the management teams to achieve company goals, and overseeing the evolution of our Technology. He holds certifications in all principal NDT disciplines, and is a metallurgical technologist, non-destructive testing specialist and executive, with over 35 years of experience in the oil and gas pipeline industry sector.

Guillermo Solano is the Director of Integrity and Customer Service at Novitech LLC. Guillermo is a professional Engineer with over 20 years of accumulated knowledge and experience in the pipeline maintenance and inspection service industry. His primary responsibilities are the development of technical reports and presentations, process enhancement, project management and execution, as well as budget and cost oversight.

115

Predicting Corrosion Severity on ILI Remnant Pipe Using Extreme Value Analysis

Haotian Sun, Nick Bullen, Andrew Carss, Colin Dooley, Sergiu Lucut

TC Energy, Calgary, Canada

Remnants are uninspected pipe segments left behind after an inline inspection (ILI) due to the physical configuration of the pipeline or execution constraints. Remnants are associated with normal gas flow and are commonly found in facilities between launcher and receiver sets, where tool access is limited. Assessing the potential severity of corrosion on these remnants is important for maintaining pipeline integrity.

Extreme value analysis (EVA) was applied to estimate the maximum external corrosion depths and the associated failure pressure ratios (FPRs) of remnants, utilizing ILI and excavation data from the inspected portions of pipelines to inform predictions. The probabilistic framework of EVA enabled the selection of desired output percentiles (e.g. 95th percentile) and confidence levels. Model validation was performed using "virtual remnants", which iteratively treated 20 m segments along the pigged portion of pipelines as if they were remnants, resulting in hundreds to thousands of data validation points for each pipeline.

This paper presents the application of the model to three case studies of actual remnant pipe segments that were excavated, demonstrating the model's accuracy, robustness, and practical utility. The paper also highlights the role of EVA in risk-informed decision making for proposed integrity work, and in guiding the selection of appropriate assessment methods. Overall, the findings demonstrate the value of the application of EVA and probabilistic modeling in advancing the integrity management of transmission pipelines.

Haotian Sun is an EIT registered in Alberta, Canada who has worked in the Risk & Technical Governance team at TC Energy for two years. He is interested in developing advanced methodologies for pipeline integrity and risk management. He owns a B.A.Sc. in civil engineering from Queen's University and a Ph.D. in structural engineering from the University of Western Ontario. He has published several journal papers and conference papers at IPC.

Nick Bullen is the Team Lead for TC Energy's Unassessed Pipe team. He is a professional engineer registered in Alberta and Arizona and holds an AMPP Cathodic Protection Technologist (CP3) certification. Nick has over 13 years of experience in the pipeline industry, with roles in engineering design, field engineering, construction management, and integrity. His integrity experience has focused on cathodic protection, inline inspection, and a variety of other integrity assessment methods. In his current role, Nick leads a team of engineers responsible for prioritizing and scoping baseline integrity assessments and pipe replacement projects in Canada and the United States.

Andrew Carss is a Pipeline Integrity Engineer with TC Energy's Unassessed Pipe team. A professional engineer registered in Alberta, he holds a Master of Science in Chemical Engineering and has over 10 years of pipeline industry experience. He is experienced in risk assessment, facility pipeline integrity, ECDA processes, and developing integrity plans for gas storage, make-piggable, and remnant piping assets. In his current role, Andrew specializes in advancing robust integrity management strategies for complex and challenging pipeline systems.

Colin Dooley is the Manager of the Risk & Technical Governance team within the Pipeline Integrity department at TC Energy. Colin has over 20 years of experience in the pipeline industry focusing on pipeline integrity, facility engineering and natural gas operations. In his current role, Colin leads a specialized integrity team that focuses on quantitative risk assessment (QRA), probabilistic and reliability-based analysis, machine learning and other advanced data analytical techniques.

Sergiu Lucut has held roles in integrity threat management and risk engineering at TC Energy since 2015 with a focus on corrosion and SCC. Sergiu previously worked in an academic research setting and is a published author on matters of machine learning, feature detection and classification.

116
An Overall Quantitative Risk Measure to Prioritize First-time Assessments

Haotian Sun, Nick Bullen, Andrew Carss, Greg Sargent, Chance Wright

TC Energy, Calgary, Canada

Quantitative risk assessment (QRA) is a key component of TC Energy (TCE)'s pipeline integrity management program. For natural gas pipelines, risk is typically expressed through two key measures: Individual Risk (IR), which assesses the risk to a person who may be near the pipeline, and Societal Risk (SR), which evaluates the risk to nearby communities. Both IR and SR primarily focus on rupture scenarios, overlooking the potential risk of leaks migrating underground to nearby structures. To address this gap, TCE developed a model to evaluate the risk of gas migration from leaks (i.e. Gas Migration Risk).

The evaluation of these risk measures ensures TCE maintains its pipelines to safe and consistent risk levels. That said, the acceptance of these risks is based on localized criteria from the perspective of localized risk receptors (e.g. nearby people), which can make it difficult to understand the cumulative risk of a pipeline. To overcome this issue, TCE developed the risk measure of Cumulative Safety Risk (CSR), which integrates the cumulative risks from SR, IR and Gas Migration into a single overall risk measure. This risk measure improves the risk-prioritization of first-time assessments and other mitigations covering long distances (e.g. entire pipelines, assessment paths, etc.).

This paper demonstrates the innovative application of CSR in the prioritization of making pipelines piggable, including its role in optimizing the determination of potential assessment paths. It also highlights how CSR is incorporated into advanced data analytics that enables automation in managing TCE's unassessed pipe program.

Haotian Sun see #115

Nick Bullen see #115

Andrew Carss see #115

Greg Sargent, P.Eng., leads the System-Wide Quantitative Risk Assessment program at TC Energy. He has over 30 years of experience in process safety & risk management in the energy and petrochemical industries. He holds a B.Sc. in Mechanical Engineering from the University of Alberta.

Chance Wright is a Senior Quantitative Risk Engineer at TC Energy with ten years of experience in pipeline risk management. His areas of focus include risk assessment for third-party damage and system wide risk evaluation. In 2017, Chance obtained a BSc. in Mechanical Engineering from the University of Alberta.

119

Pushing the Boundaries of SSWC Detection, Identification, and Characterization with Magnetic ILI Technology

Greg Riversmith, Geoff Hurd

Enduro Pipeline Services, Calgary, Canada

Selective Seam Weld Corrosion (SSWC) has been an industry recognized pipeline integrity threat for nearly as long as pipe corrosion itself has been. Historically, this threat has proven to be difficult to resolve, and ILI technologies have experienced considerable challenges distinguishing between ordinary (non-preferential) corrosion at the long seam, and it's more aggressive preferential SSWC counterpart. A suite of PRCI research studies have made significant advances in the understanding SSWC with focuses ranging from SSWC pipe susceptibility, to in-ditch NDE confirmation capabilities, to understanding long seam failure ramifications for both ordinary (non-preferential) corrosion and SSWC. The success of these recent R&D studies indicates considerable promise that SSWC may one day be managed more cost effectively and precisely – if the industry can develop reliable ILI commercial abilities to detect and distinguish SSWC from ordinary corrosion occurring at the long seam.

Circumferential MFL technology has long been identified as a potential solution to SSWC, but many early ILI designs failed to resolve the narrow, axially aligned SSWC. To push the limits of CMFL technology, a prototype tool was designed with the express intent of targeting SSWC. The prototype design was considered strictly from first principles and inherited no commercial ILI system influences whatsoever. Once built, the system was enrolled in an open invitation R&D test pull initiative (conducted by PRCI at the TDC) whose singular focus was evaluating ILI performance for SSWC. The results achieved by the prototype tool within this study were compelling – and to the best of the author's knowledge – would represent a "step change" performance improvement for characterizing SSWC features should the performance be replicated under in-service pipeline conditions.

This paper will present the full pull test trial results for the prototype system including – for full transparency – data from the only false calls made by the system during the pull test project. NDE results will also be presented to provide context for the natural long seam phenomena which was detected as a result of those ILI false calls.

Greg Riversmith has been an R&D Scientist for 24 years, having spent the last 14 in the pipeline inspection industry. He has a Master of Science in Physics (with a specialization in magnetics) from the University of Calgary and currently heads all R&D development efforts at Enduro Pipeline Services.

Geo Hurd has over 24 years in pipeline inspection, specializing in ILI data. With a B.Sc. in Geomatics Engineering, he began his ILI career in inertial mapping and advanced through caliper, MFL, and UT analysis. Geoff has led multidisciplinary teams and now focuses on product line development at Enduro Pipeline Services.

121
Visualization and Screening of IMU Data for Strain-Based Integrity Assessment

Ali Fathi, Garret Meijer

Enbridge, Edmonton, Canada

Inertial Measurement Unit (IMU) surveys are extensively used in pipeline integrity programs. The data they provide is crucial for monitoring pipe movement, managing geohazards, and broader strain-based integrity management of pipelines, including other threats such as corrosion, cracks, and geometry features.

While IMU technology is well-established in the industry for its unique capabilities, challenges remain in efficiently using IMU data. These include issues with pipeline strain data extraction, inconsistencies in IMU data reporting among vendors, and the complexity of strain-based integrity assessment in general. Due to these challenges, the integration of IMU data into pipeline fitness-for-service assessments is a complex process, requiring manual review by strain specialists. When a high volume of features are reported—typically hundreds for each pipeline segment—the process becomes time-consuming, costly, and prone to human error.

Through an example(s), this paper describes Enbridge\'s IMU data visualization and screening software tool that closes gaps in the use of IMU data for strain assessment and strain-based management of geohazard and other ILI integrity features.

Some of the key features of this tool are:

1. Improved IMU data visualization
    1. Display three sets of IMU data (current, previous, baseline) showing plan, elevation, azimuth, pitch, vertical strain, horizontal strain, and total strain, with adjustable zoom options.
    2. Show data changes by comparing current and previous IMU datasets.
    3. Display a location map with the pipe route, strain features, and girth weld locations.
    4. Integrate and display other integrity features (e.g., dents, cracks, metal losses), and other integrity assessment data (e.g., geohazards, high consequence areas, NDE excavations) on the strain plots and location map.
    5. Navigate through strain data using items like distance, girth weld/joint ID, strain feature, ILI feature, geohazard site, high consequence area, and excavation.
2. On-demand strain calculation
    1. Resample IMU data at specific intervals and shift the data for better alignment between datasets for improved calculated strain change
    2. Calculate strain with user-defined gauge length for consistent and appropriate strain data smoothing.

121 Cont'd

3. Automatic conversion of strain values to a consistent sign convention for all IMU tools/vendors to eliminate confusion regarding bend direction.

4. Semi-automatic and manual removal of bends and GW misalignment from strain data.

5. Save filtered strains for further processing.

3. Strain screening
    1. Generate strain, and strain change data for GW and pipe joints individu ally, which can be used for ILI features integrity assessment (dent, metal loss and cracks)
    2. Screen for potentially high-risk strain features for additional review, using wrinkling, girth weld rupture and compliance strain criteria with user-defined action thresholds (capacity vs. demand).
    3. Generate notification for potentially geohazard related or abnormal strain activities for further reviews.
    4. Generate summary report indicating strain features needing further review.
    5. Generate detailed assessment report for all reported strain features with evaluation results for individual joints and GWs unity checks.
    6. Risk based strain growth forecast based on historical strain growth, probability of future strain activity and consequence of failure.

This program does not fully automate the strain assessment process, but by properly screening the IMU data and streamlining the process, it can reduce assessment time, enhance safety, and optimize geohazard management resources.

Ali Fathi is a Pipeline Engineering Specialist with 20 years of research and practice in strain-based design and assessment for pipelines geo-hazard management.

His journey in pipeline integrity began with his PhD research on pipeline structural integrity at the University of Alberta. Over the years, including his current role at Enbridge, Ali has focused on advancing the strain-based assessment process and enhancing pipeline performance in areas affected by geohazards.

Garret Meijer is a Pipeline Deformation Specialist with over 25 years of research and industry experience in strain-based design, analysis of tubular structures, and material evaluation and modelling. Garret is now focused on improvement and optimization of pipeline dent assessment following extensive involvement in characterization of materials and elastic-plastic evaluation of tubulars and threaded connections in thermal production wells and assessment of composite material for use in pipelines.

124
Advances in API 1163 Level 3 ILI Validations

Jed Ludlow[1], Jason Skow[2], Ryan Stewart[2]

[1]T.D. Williamson, Salt Lake City, USA. [2]Integral Engineering, Edmonton, Canada

The second edition of API 1163, In-line Inspection Systems Qualification, was published in 2013 and introduced the idea of Level 3 in-line inspection (ILI) validation, where field measurements are compared to ILI measurements to arrive at an as-run assessment of ILI performance. However, it provided little concrete guidance on how to conduct such a validation. The third edition of API 1163, published in 2021, made some headway on this by presenting a brief overview of two approaches to Level 3 validation using either statistical tolerance intervals or Bayesian regression.

Much has changed in the five years since the third edition was published! Operator experience with both Level 2 and Level 3 validations sparked two PRCI projects aimed at providing additional insight into the behaviors of the techniques and guidance on their application. We present an overview of recent advances in Level 3 ILI validation techniques specifically designed to address performance questions that are difficult to answer by Level 2 techniques, including:

- What is the "best estimate" of how the ILI system performed in this pipeline run?
- What is a conservative estimate of performance that bounds all the field uncertainty and the sampling uncertainty?
- Can we remove field measurement uncertainty from the ILI performance estimate?
- Can we apply a linear calibration fit as part of the estimate?
- Why do the Level 2 and Level 3 techniques provide different guidance, and what are the implications?

Jed Ludlow, Chief Technologist, T.D. Williamson, has 30 years of experience in various multidisciplinary engineering roles across energy, healthcare, medical device, and aerospace industries. His current role is full-stack ILI technologist. He has participated in research for various pipeline organizations and has authored several papers for industry conferences.

Jason Skow, Principal Consulting Engineer, Integral Engineering, has 24 years of experience in the oil & gas industry, focusing on integrity management, data analytics, and risk & reliability. He has participated in industry research with PRCI, PHMSA, and INGAA, and authored several papers and reports.

Ryan Stewart, Consulting Engineer, Integral Engineering, has 6 years of oil & gas experience, focusing on measurement, statistics, and machine learning. He participated in PRCI research, like the IM-1-06 project developing the ILI validation spreadsheet. He has also authored several papers at IPC on coating performance, material verification and facility integrity.

127

Addressing Variation in Laboratory Toughness Testing for Vintage Pipelines Using Planing-Induced Microfracture

Ryan Lacy[1], Intisar Rizwan i Haque[1], Simon Bellemare[1], **David Futch**[2]

[1]MMT, Natick, USA. [2]Acuren, Magnolia, USA

Reliably determining toughness is critical for ensuring the integrity and safety of pipeline infrastructure and is a necessary component for most Engineering Critical Assessments (ECAs). This paper presents findings from a Joint Industry Project (JIP) where a large lab-to-lab variation in fracture toughness (K) was first identified by comparing direct K values from Compact Tension (C(T)) testing with K values derived from upper-shelf Charpy V-Notch (CVN) data. While direct K-testing is a true measurement of cracking resistance, this case example highlights how adaptations of ASTM E1820 from the testing of large nuclear steel samples to the use for pipeline steel can lead to different results when samples are sent to different labs, an issue that is less prevalent with simpler CVN tests. While this paper focuses on pipe body toughness, the principles can also be applied to seam toughness.

This investigation was further motivated by clear outliers observed when correlating laboratory K values with features extracted from the novel planing-induced microfracture NDE technique. A key NDE feature, derived from the normalized geometry of the resulting microfracture, showed a strong linear trend with toughness for most samples. A subsequent root-cause analysis identified multiple compounding errors in the anomalously low test results, including the use of incorrect Young\'s Modulus values in the J-integral calculation and, most significantly, a difference in C(T) specimen geometry that fundamentally altered crack-tip constraint. This paper details this data validation process and highlights how such procedural and geometric issues can undermine the development of reliable NDE solutions.

The resulting refined NDE model, based on the strong correlation between the NDE technique and validated K values, offers a pathway towards more consistent and reliable toughness assessments. It proves valuable for predicting toughness where historical test records are conflicting or missing. This work makes two key contributions: first, it demonstrates a practical method for validating complex fracture mechanics test data using more common CVN results as a screening tool. Second, it shows how a validated NDE approach can provide a reliable in-situ benchmark, offering a path to bypass the uncertainties of traditional lab testing related to specimen geometry and constraint and ultimately ensuring safer pipeline integrity management.

Ryan Lacy, Director of Commercialization, is an experienced mechanical engineer, manufacturer, and project manager. At MMT, he aims to improve existing NDE technologies and create the next generation of material verification tools. Before joining MMT, Ryan worked and studied at Boston University, designing and manufacturing research and development apparatus, while earning an MBA/MS.

Dr. Intisar Rizwan I Haque, Ph.D., Manager of Data Analytics, is an experienced electrical engineer and data scientist with expertise in developing AI-powered solutions for various applications, including biomedical, clinical, and energy infrastructure. His work at MMT involves developing machine learning models to predict steel pipe material properties, ensuring the structural integrity of oil and gas pipelines.

Dr. Simon Bellemare, Ph.D., CEO, is a materials scientist with a Ph.D. from MIT with 20 years of experience. This includes 12 years of working as an engineering consultant and expert for several design, investigation, and repair projects related to asset integrity. At MMT, he heads the development of next-generation pipeline material verification solutions.

David Futch, Materials Engineering SME, has oil and gas industry experience since 2012, specializing in materials, welding, and corrosion in a midstream pipeline setting. At Acuren, he guides clients through failure analysis programs, repair techniques, material degradation phenomena, material selection, and welding-related issues.

130

Longitudinally Misaligned Pipeline Stacked Crack Interaction Using 3-D Crack Meshes – Part II

Ryan Holloman[1], Mark Neuert[2], Greg Thorwald[1], Michael Turnquist[1]

[1]Quest Integrity, Boulder, USA. [2]Enbridge, Edmonton, Canada

Longitudinally overlapping crack-like flaws that exist in the same radial plane are referred to as stacked cracks. Depending upon the crack sizes, applied loads, and material properties, stacked cracks can interact to reduce burst pressure below an individual stacked crack. In a previous investigation [1], idealized, surface-breaking stacked cracks were examined without any longitudinal offset between the outer diameter and inner diameter cracks. This study extends the work and investigates the effect of a longitudinal misalignment between cracks, which is more representative of stacked cracks identified via pipeline inline inspection (ILI) or in-ditch non-destructive evaluation (NDE). In addition, the effect of crack length is explored more deeply compared to the previous study.

Closely located cracks are often evaluated using interaction criteria, such as those provided by API 579-1/ASME FFS-1 Fitness-for-Service (API 579) Part 9, which specify how and when multiple nearby cracks can be combined into a single crack for the purpose of an integrity assessment. When applied to stacked cracks, the interaction criteria can often lead to recategorizing stacked cracks as a through-wall crack, which requires urgent response from a pipeline operator.

Here, additional interaction criterion improvements were developed for stacked cracks based on the results of elastic-plastic finite element analysis (FEA) models of multiple combinations of stacked crack sizes. These interaction criteria will provide pipeline operators with additional insight when analyzing stacked cracks by reducing the excess conservatism associated with legacy methods.

[1] Pipeline Stacked Crack Interaction Burst Pressure Analysis Using 3-D Crack Meshes; Ryan Holloman, Greg Thorwald, Michael Turnquist, Mark Neuert, Pipeline Pigging and Integrity Management Conference, Feb 12-16, 2024, Houston, TX.

Ryan Holloman is a Senior Engineer at Quest Integrity. Ryan has 12 years of professional experience in the oil and gas industry with expertise in fracture mechanics, fitness-for-service, and finite element analysis. He holds a Ph.D. in materials science and engineering from the University of Virginia.

Mark Neuert received his undergraduate degree in Mechanical Engineering from the University of Alberta in 2008 and completed PhD in Mechanical Engineering at Western University in London, Ontario in 2016. He has 9 years of experience in the field of pipeline integrity, having spent 4 years consulting with C-FER technologies and an additional 5 years at Enbridge working in their Pipeline Integrity department. Mark's academic and professional experience has included performing finite element analyses and probabilistic risk assessments of several pipeline threats including metal loss, geometry, and crack-like features.

Greg Thorwald is a principal engineer at Quest Integrity in Boulder, Colorado, USA. He uses finite element analysis for structural, fracture, and fatigue crack growth assessments in a variety of fitness-for-service consulting projects. He is the lead developer of the commercial FEACrack software, an automated parametric 3D crack mesh generation program used to compute crack front stress intensity and J-integral values needed for assessments. He contributes to the Signal Fitness-for-Service software, which was used in this elbow metal loss assessment. Greg earned a Ph.D. in aerospace engineering from the University of Colorado. He is a contributing member of the API/ASME FFS committee for API 579.

Michael Turnquist is a Principal Engineer with Quest Integrity's Advanced Engineering group in Boulder, Colorado. In his 15 years with Quest, Michael has developed a deep knowledge in fracture mechanics, fitness-for-service, and pipeline integrity management. Currently, Michael manages Quest Integrity's Pipeline Engineering Critical Assessment group which supports pipeline operators worldwide. Michael has a BS degree in Civil Engineering and a MS degree in Structural Engineering from the University of Colorado, Boulder.

135

Low-Pressure High-Speed Gas: Adaptive Speed Control Outside of Traditional Use Cases

James Barlow[1], Mukund Belavadi[2], Simon Crompton[2], William Deschamps-Robertson[1], McKenzie Kissel[1], Mark Ryan[2]

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In today's economic environment, Operators are reluctant to reduce the throughput in their pipelines. This can be at odds with the Inspection technology ideal performance window. With this in mind, adaptive speed control systems were developed in the mid 1990's to allow the MFL tool to operate at its ideal velocity in gas transmission bullet lines (~2000 psig at 10 m/s). This paper outlines the development of an adaptive speed control system that is capable of operating at both extremes of pressure. This system has proven itself at high pressure high flow gas lines and more recently on low pressure high flow lines an area traditionally ignored by ILI vendors for these systems.

A case study will be shared showing how operators with gas gathering systems consisting of low-pressure lines and tight fittings, that generally result in poor ILI tool dynamics, can be overcome with the use of a speed control system. This allows high quality integrity decisions to be made without restricting product throughput.

James Barlow has been working in the Pipeline Inspection Industry for over 25 years. In that time he has designed Pipeline Inspection Tools from 6" to 48". Some of his past unique and industry changing projects he has been a part of are, bringing axial strain inspections to the inline inspection industry in 2006, and introducing the first Hot Bitumen ILI tool for a 24 hour inspection in 150°C bitumen. Since 2016 he has been working for Onstream Pipeline Inspection developing the Tri-Stream MFL ILI fleet including the cruze control system.

Mukund Belavadi holds a Master's in Petroleum Engineering and has over 24 years in upstream drilling services, and more than 3 years in midstream integrity management. At Phillips 66, he leads and manages complex ILI projects for challenging gas gathering pipelines, driving cross-functional collaboration, risk mitigation, and introducing new technology solutions.

Simon Crompton, BEng (hons), began as an NDT technician. Over 12 years, he achieved a Level 3 certification in Transverse Magnetic Flux evaluation, developing procedures for Selective Seam Weld Corrosion and corrosion growth analysis. For the last six years, he's applied his knowledge of engineering and analysis to pipeline safety and reliability as an integrity engineer.

William Deschamps has been in the ILI industry for over 11 years with a role focused on mechanical design and operations applications for unique and challenging inspections. He graduated from SAIT's Mechanical Engineering Technology Diploma with a Mechanical Design major. He has been instrumental in leading the designs on several projects including 16" and 18" bidirectional, Small Diameter TriStream Conversion and the latest being 4"1.5D ultra-high resolution triaxial MFL, Caliper and IMU tools.

McKenzie Kissel is the Director of Technology at Onstream Pipeline Inspection. McKenzie is a professional engineer with an MBA over 15 years of ILI R&D experience. He graduated with his B.Sc in mechanical engineering from the University of Alberta and his MBA from the Haskayne School of Business at the University of Calgary.

Mark Ryan is Director of Gas Integrity for Phillips 66 with 15 years in midstream integrity management. He is leading initiatives to ensure pipeline safety, compliance, and operational excellence. He focuses on integrity management, risk mitigation, and strategic leadership to support reliable energy delivery.

James Vasquez has worked with Phillips 66 since 2021. James has been in the Oil and Gas Industry for the past 11 years. Currently he is a field integrity engineer supporting the mid-continent area from WY to the Permian. He coordinates integrity programs and oversees dig repair programs.

136

Be Content to Begin with Doubts: A Discussion of What to Expect When Comparing Deterministic and Probabilistic Integrity Assessment of Pipeline Corrosion Metal Loss

Susannah Turner, Jack Davies, Fraser Gray, Tim Turner

Highgrade Associates, Newcastle upon Tyne, UK

Deterministic integrity assessment uses characteristic values as inputs to a limit state equation. The output is a deterministic prediction of, for example, failure pressure or limiting anomaly dimensions for failure. We deal with uncertainties in the assessment by choosing appropriately conservative, characteristic inputs, and applying a safety factor or margin of safety to the result. This allows us to make integrity management decisions which are considered sufficiently safe and conservative. Different safety margins may be selected based on potential failure consequence, such that a deterministic assessment is not necessarily insensitive to risk. However, these assessments do not attempt to quantify probability of failure and may be criticised for leading to acceptance of an unquantified level of risk.

Probabilistic assessments using structural reliability techniques would claim to quantify uncertainty, giving a calculation of the probability of failure. A probabilistic assessment may essentially use the same limit state equation as a deterministic assessment, but with input parameters as distributed variables, including parameters to account for the uncertainty of the limit state model itself. The calculated failure probability is then compared with industry or company criteria to make integrity and risk management decisions.

This paper considers the sources of uncertainty in probabilistic assessments and discusses the extent to which calculated failure probabilities represent a true measure of the probability of failure. Case study comparisons are shown between deterministic assessment limits and the associated failure probability levels calculated using structural reliability techniques, for pipeline corrosion metal loss assessments. Observations are made regarding the comparisons and conclusions are drawn with respect to how this understanding can lead to improved decision making.

“If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties.” Francis Bacon 1605

Susannah Turner, Director and Senior Consultant, Highgrade Associates, is a director of Highgrade Associates and has 30 years’ experience in the Oil & Gas Industry having worked in pipeline operations, consultancy and research. Her recent work has concentrated on technically challenging pipeline integrity, risk and reliability studies, including development of risk-based inspection methodologies and application of structural reliability analysis techniques.

Jack Davies, Engineer, Highgrade Associates, has been working in pipeline integrity since graduating in 2019. His main focus has been on supporting integrity management activities including defect verification and validation analysis as well as assessment of ILI data and risk-based inspection planning. He has recently developed tools using Python for implementing probabilistic methods for integrity assessment.

Fraser Gray, Senior Engineer, Highgrade Associates, specializes in Risk and Reliability of pipelines and has over ten years of engineering consultancy experience in the Oil and Gas sector. Over this time Fraser has worked on a range of projects including both qualitative and quantitative risk assessments, structural reliability analysis, risk-based inspection studies, cost based analysis and pipeline integrity assessments.

139
Using Composition Data to Improve the Accuracy of Nondestructive Strength Estimates

Peter Martin[1], Nathan Switzner[1], Joel Anderson[1], Emily Brady[2], Pooya Delshad[3], Peter Veloo[3]

[1]RSI Pipeline Solutions, New Albany, USA. [2]Exponent, Houston, USA. [3]Pacific Gas and Electric Company, San Ramon, USA

This work builds on previous efforts to use nondestructive composition data to mitigate outlier yield strength results during Instrumented Indentation Testing (IIT).1 It is widely known that IIT yield strengths are generally within ±10 % of the associated tensile test (TT) values, but that some 'outlier' results can deviate by 25 % or more. The fundamental cause of these outlier results is unclear, making it difficult to anticipate the accuracy of a given measured result. However, an empirical association between these outliers and the steel composition was used to develop an algorithm that improves the accuracy of strength estimates based on nondestructive measurements of the Mn and C concentrations. The current work expands on the prior report by: i) increasing the number of pipes used to validate the algorithm, ii) using a statistical method to explore the robustness of the algorithm, and iii) evaluating the impact of the adjustments when the strength values are used as inputs to a probabilistic grade calculator.

For a set of 89 pipe joints, the adjustment decreases the number of IIT-measured yield strengths deviating by more than 10 % from the corresponding TT values from 32 to 13 joints (from 36 % to 15 %). The largest adjustments occur in pipes where the IIT-measured YS values exhibit the largest deviations relative to the TT values, and where the ratio of Mn/C exceeds 10. This is interpreted as an indication that the adjustment works most effectively on modern, high-grade pipe since this type of pipe is expected to have a high Mn/C ratio. Validation of the model shows the algorithm is robust and likely to be broadly applicable. Finally, the use of adjusted strength results as inputs to a probabilistic grade calculator yields improved accuracy of grade estimates relative to the use of un-adjusted (as-measured) IIT results. Potential implementation strategies will be discussed, along with the applicability to other strength measurement methods.

1. M Scales, et al., (2022) Materials, 15, 832.

Dr. Peter Martin is a Principal Engineer with RSI Pipeline Solutions. He has 8 years of experience supporting materials verification and failure analysis of natural gas pipelines, and over 30 years of experience in general materials engineering. Before joining RSI, Dr. Martin investigated thermal spray and additive friction-stir methodologies for repair of structural components as Research Faculty at The Rochester Institute of Technology. Prior to that he was a Senior Materials Engineer with Pacific Gas & Electric, where he performed failure analyses on electric and gas components, and assessed fitness for service of natural gas pipelines. Dr. Martin holds BS, MS, and PhD degrees in Materials Science and Engineering from Johns Hopkins University, has published over 30 refereed Journal articles, and holds six U.S. patents.

Nathaniel Switzner, PhD, PE, supports RSI Pipeline Solutions and teaches at the American University of Iraq, Sulaimani. His work centers on advancing pipeline integrity management through better application of non-destructive and destructive testing methods.

Joel Anderson is a Principal Engineer with RSI Pipeline Solutions. His activities include material verification, risk management and ILI accuracy analysis. He has 25 years' experience in all aspects of the pipeline industry including manufacturing, construction as well as numerous operators throughout the United States. He has authored numerous papers about risk, data analysis and fitness for service. He holds a Bachelor of Science in Civil Engineering from the University of Wisconsin.

139 Cont'd

Dr. Pooya Delshad is a Senior Materials Engineer at PG&E's Applied Technology Services, specializing in materials and corrosion analysis. Dr. Delshad leads failure analysis investigations and advanced materials testing for gas and electric transmission and distribution systems. With a focus on Engineering Critical Assessments, Dr. Delshad applies non-destructive evaluation techniques to verify material properties and ensure pipeline integrity.

Dr. Emily Brady specializes in materials verification and mechanical behavior characterization of materials in various industries, primarily in process, utilities, rail, and industrial environments. Dr. Brady utilizes both destructive and portable non-destructive evaluation equipment to perform these engineering analyses. Furthermore, she also assists clients in cases involving industrial and occupational safety, such as those involving machine guarding, lock-out/tag-out, and other safety protocols.

Dr. Peter Veloo is a Principal Gas Integrity Management Engineer at the Pacific Gas and Electric Company with 13 years' experience in pipeline and facilities integrity management. He presently focuses on MAOP reconfirmation, material property verification, and wildfire risk mitigation. He received a PhD in mechanical engineering from the University of Southern California.

144
Development and Implementation of a State-of-the-Art Seam Weld Fatigue Cracking Integrity Management Program

Michael Turnquist[1], Rachel Brossman[2], Miguel Martinez[1],

[1]Quest Integrity, Boulder, USA. [2]PBF Energy, Cerritos, USA

Effective pipeline integrity management requires a systematic, data-driven approach to identifying, assessing, and mitigating integrity threats across multiple pipeline systems. This paper presents the development, implementation, and lessons learned from a comprehensive integrity management program tailored to address the seam weld fatigue cracking threat. Developed by PBF Energy and Quest Integrity, the program integrates engineering critical assessment, probabilistic modeling, and ongoing metric tracking to prioritize susceptible pipeline segments and optimize reassessment schedules.

Cracking threat characterization begins by quantifying susceptibility of all pipeline segments to the threat of fatigue crack growth of seam weld manufacturing flaws. Susceptibility is determined based on rigorous review of pipeline failure history, historical hydrostatic pressure testing, relevant inline inspection data, pipe properties, and historical and planned future operation.

The results from the susceptibility analysis are used to prioritize pipeline segments for further action, such as baseline fatigue analysis, more rigorous probabilistic analysis, or reassessment. The analytical methods contained within the program utilize the most technically robust fracture mechanics models and industry-leading approaches to computing remaining life and probability of failure related to the seam weld fatigue cracking threat.

As fatigue analyses and reassessments are performed over time, pipeline segment prioritization is constantly tracked and updated to support optimal visibility of upcoming required actions. Furthermore, consistent, periodic review of analysis inputs informs if an updated analysis and/or reassessment interval is necessary. This ensures continuous data integration and increased confidence in the current action plan.

The integrity management program discussed herein ensures that PBF Energy maintains compliance with regulatory requirements, as outlined in 49 CFR 192/195, as well as best practices contained within API RP 1176. This paper outlines the program structure, the data required to quantify key metrics, and the continuous refinement process, all of which are critical to the effective management of the seam weld cracking threat across multiple pipeline systems.

Michael Turnquist see #130

Rachel Brossman see #114

Miguel Martinez is with PBF Energy in Cerritos, California.

148

Mechanistic Modeling and Threshold-Based Alerts for Weather and Outside Force Threat Management

John Norman, Elena Arroway, Jake Opdahl

Teren, Lakewood, USA

Effective management of weather-related geohazards is critical for maintaining pipeline integrity, public safety, and operational reliability. However, traditional approaches often rely on static models and reactive workflows, limiting the industry's ability to address these evolving risks systematically. This research program investigates the application of mechanistic terrain stability modeling, integrated with real-time environmental data and automated, threshold-based notifications, to advance evidence-based, risk-informed decision-making across pipeline operations.

This research uses a factor-of-safety framework, grounded in geotechnical engineering, to model how soil shear strength and slope interact to determine terrain stability at the individual hillslope-level across varied landscapes. The workflow developed in this program transforms these data into actionable terrain units with shared stability characteristics (geostrata), which are then paired with NOAA precipitation thresholds to identify when and where rainfall conditions may trigger slope failures relevant to pipeline corridors.

Validation using over 24,000 documented landslide events across varied geographic settings demonstrated true positive rates exceeding 80% with low false-positive rates (<14%), indicating the methodology's effectiveness in identifying at-risk slopes while minimizing unnecessary alerts. Case study applications illustrate how this framework enables targeted inspections, prioritization of mitigation efforts, and confident deferral of non-essential actions in areas verified as low risk, leading to optimized resource allocation and enhanced system resilience. The maturity of this research ensures it can be readily integrated into integrity programs to enhance operational readiness.

John Norman leads the development of statistical and mechanistic spatial models at Teren to inventory, measure, and predict geohazard threats, natural resources, change detection, and terrain and hydrologic conditions for pipeline operators and federal agencies. His analytics integrate 25 years of experience as a geomorphologist, soil scientist, and quantitative spatial ecologist with statistical and machine learning methods to assess and prioritize hazards across large landscapes. John's work enables operators to proactively identify and mitigate geohazard threats, advancing safe and resilient infrastructure management while supporting data-driven decision-making across complex environmental conditions.

Elena Arroway is a Geospatial Data Scientist at Teren, where she applies advanced analytics and machine learning to deliver actionable geohazard insights for pipeline operators. With a background in remote sensing and terrain analysis, Elena specializes in transforming complex environmental data into operational intelligence that supports integrity management and resilience strategies. She has contributed to industry advancements in post-wildfire risk modeling and precipitation-induced geohazard forecasting, helping operators prioritize actions that protect infrastructure and communities. Elena is passionate about bridging data science and practical field operations to advance safe, efficient, and proactive pipeline management across the industry.

Jake Opdahl leads Teren's Energy division, where he focuses on leveraging cutting-edge data science and geospatial analytics to solve complex challenges in pipeline infrastructure and energy operations. With over 20 years of experience in the energy sector, Jake is a recognized leader in using innovative technologies to improve pipeline safety, operational efficiency, environmental risk management, and regulatory compliance. Jake holds a degree in natural resources and GIS and is committed to shaping the future of energy through data-driven, proactive risk management strategies.

151

Learnings from Seven Successful Years of Phased Array Inline Inspections

Thomas Hennig, Gerhard Kopp, Alessandro Morandini, Peter Haberl

NDT Global GmbH, Stutensee, Germany

Phased array ultrasonic testing (PAUT) has emerged as a transformative technology in the field of non-destructive testing (NDT), offering unparalleled flexibility, precision, and adaptability across a wide range of applications—from medical diagnostics to the inspection of critical infrastructure in the energy and transportation sectors. Over the past two decades, the evolution of phased array systems has been marked by significant advancements in hardware miniaturization, computational capabilities, and software-driven imaging techniques. These developments have enabled not only real-time visualization in clinical environments but also high-fidelity structural assessments in industrial contexts, where accurate flaw detection and characterization are paramount.

One of the most impactful features of PAUT in industrial NDT is its ability to perform absolute depth sizing of cracks using tip diffraction echoes. This technique, unlike amplitude-based methods, is inherently less sensitive to surface conditions and coupling inconsistencies, making it a robust solution for geometry-independent flaw evaluation. As a result, tip echo-based sizing has become a widely accepted standard in sectors such as oil and gas, nuclear power, and aerospace.

Despite these advantages, deploying phased array systems in autonomous or resource-constrained environments presents unique challenges. Inline inspection tools, for instance, must operate within strict temporal and energy budgets while maintaining high data quality. The need to perform multiple measurements using varied aperture configurations and delay laws—often at medium inspection speeds—can introduce acoustic clutter and increase data processing demands.

This paper presents a structured approach to optimizing phased array measurement strategies under such constraints. By systematically analyzing the trade-offs between acquisition complexity, signal-to-noise ratio, and inspection throughput, the authors propose a methodology for selecting measurement configurations that maximize data utility while minimizing operational overhead. Furthermore, the study explores how multi-configuration datasets can be leveraged to construct high-resolution digital twins of inspected components. These digital models capture critical geometric features such as weld seams, wall thickness variations, and cross-sectional profiles, offering valuable input for integrity management programs (IMPs) and long-term asset monitoring

Thomas Hennig holds the position of the CTO at NDT Global. He is working since almost 20 years in inline inspection tool development where he initially focused on MFL Hardware and Software development. Throughout his career, Thomas has led interdisciplinary teams for UT WT Data analysis, Software and algorithm development. Today, Thomas is pivotal in the ongoing research and development of NDT Global's extensive fleet and technology development. Thomas supports the worldwide organization with extensive knowledge of inline inspection technologies.

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Alessandro Morandini is with NDT Global GmbH in Stutensee, Germany.

Peter Haberl is with NDT Global GmbH in Stutensee, Germany.

152
Engineering Critical Assessment of Facilities and Lap Welded Pipe

Scott Riccardella[1], Peter Veloo[2], Roger Royer[3], Jeff Milligan[3]

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An engineering critical assessment (ECA) is a regulatory accepted method for reconfirming the maximum allowable operating pressure (MAOP) of pipelines. The ECA process involves evaluating:

- Relevant material properties,
- Operational history and environment,
- Prior assessments,
- In-service degradation,
- Possible failure mechanisms, and
- Defect characteristics (prior, current and future).

These factors are analyzed for the loadings and operating conditions relevant to potential threats with additional assessments performed to mitigate the risk from these threats. This process was successfully applied and found beneficial in evaluating facility and station piping throughout the PG&E system. Unique threats were identified with lap welded pipelines requiring specialized Non-Destructive Examination (NDE) processes and a fracture mechanics evaluation for identified defects. The paper will discuss the PG&E ECA process, specialized NDE methods, and specialized evaluation for lap welded defects that was applied.

Scott Riccardella is the Executive Director of the Pipeline Integrity Compliance Solutions (PICS) team for Structural Integrity Associates. For the last seventeen years, Mr. Riccardella has served as a consultant on a wide range of integrity management, assessment, fracture mechanics and Material Verification projects for several major pipeline operators. He is a NACE certified Cathodic Protection Level 2 and holds an engineering degree from the U.C. Santa Barbara and an MBA from U.C. Irvine.

Dr. Peter Veloo see #139

Roger Royer is with Structural Integrity Associates in State College, PA.

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153
SAWL Seam Peaking – Is it a Pipeline Integrity Threat?

Michael Rosenfeld, Benjamin Zand, Adam Steiner

RSI Pipeline Solutions LLC, New Albany, USA

SAWL line pipe is inherently predisposed to exhibiting angular misalignment at the seam joint, referred to as “peaking” or “rooftopping”. Line pipe product specifications do not control peaking except to the extent that it may affect other controlled pipe geometry such as outer diameter or roundness. The geometric condition has occasionally been observed to be a contributing factor to SAWL seam failures. The occurrence of a few such failures associated with peaking has raised interest in the circumstances in which peaking could pose an integrity threat in liquid service, natural gas service, nontraditional product service (for example, hydrogen), or conversions of service. This study considers past incidents, geometric controls in manufacturing, sensitivity of service conditions to the effects of peaking, and what ILI methods are available to manage the condition where it presents a potential threat.

Michael Rosenfeld, PE, is Chief Engineer at RSI Pipeline Solutions LLC. His 46-year career includes 38 years in the pipeline industry in the areas of pipeline integrity, fitness for service, failure analysis, research, standards development, and training. Prior to RSI he worked at Battelle, Kiefner & Associates, and Applus.

Benjamin Zand, PhD, PE is Principal Engineer at RSI Pipeline Solutions LLC. Dr. Zand has over two decades of expertise in pipeline integrity, advanced numerical analysis, and geomechanical engineering. His pipeline-related experience includes FFS assessments, fracture mechanics, and stress analysis of pipelines subjected to external and geotechnical loadings.

*Adam D. Steine*r, PE, is a Senior Engineer at RSI Pipeline Solutions with 18 years of experience in oil and gas pipeline integrity. Registered in multiple states since 2011 and a member of the ASME B31.4 committee, he specializes in pressure cycle fatigue analysis, reliability assessments, and integrity management

154
Has the Industry Forgotten How to Weld?

Michael Rosenfeld, Bill Amend

RSI Pipeline Solutions, New Albany, USA

Girth welds have evolved over nearly 100 years to be reliable elements of the pipeline. Girth weld reliability is founded on established protocols for testing and qualifying welders, testing and qualifying welding procedures, and performing nondestructive examination in the field. There is evidence of increasing rates of girth weld failures in pipelines. After screening out large-scale geohazard events, the normalized rate of pipeline incidents attributable to modern girth welds (those made in the past 2 decades) is now approaching the rate of such incidents prior to field radiography. This paper examines factors that may be contributing to this counterproductive trend.

Michael Rosenfeld see #153

Bill Amend, P.E. (Metallurgical Engineer) is Technical Advisor at RSI Pipeline Solutions. He has a total of 46 years' experience serving on the staffs of pipeline operators and consulting organizations. His areas of technical focus include welding engineering, integrity management of early generation pipelines, failure analysis, and technical training

157

Accelerating Technology Adoption: A Framework for Modernizing Integrity Management

Chris Alexander, Buddy Powers

Acuren, Magnolia, USA

As North America's high-pressure pipeline systems continue to age, the need for timely deployment of advanced technologies has never been more critical. The industry has seen tremendous innovation, ranging from enhanced in-line inspection tools and real-time monitoring systems to composite repair methods and advanced materials. However, widespread adoption remains slow due to regulatory complexity, commercialization challenges, and operational risk aversion.

This paper introduces the Technology Adoption Process (TAP), a structured framework developed to accelerate technology deployment and support the industry's broader integrity management goals. TAP identifies and integrates four key dimensions: Technology Readiness Level (TRL), Regulatory Acceptance Level (RAL), Commercial Readiness Index (CRI), and Operational Readiness Level (ORL). Together, these elements provide a roadmap for technology providers, pipeline operators, regulators, and investors to work collaboratively from concept through full-scale deployment.

The paper will include practical examples and lessons learned in bringing together key stakeholders through initiatives such as the Composite Technology Advancement Group (CTAG) platform that facilitates Joint Industry Programs (JIPs), networking events, and technical training. These initiatives demonstrate how technology can be validated, communicated, and scaled in a way that aligns with the pipeline industry's need for practical, field-ready solutions for integrity management.

Readers will be provided with a clear understanding of how to navigate the regulatory, commercial, and operational challenges that often stall innovation and how to proactively engage in shaping the future of pipeline integrity. As public scrutiny grows and infrastructure demands increase, the TAP framework offers a timely solution to transform technological potential into operational reality.

Dr. Chris Alexander, PE, currently serves as General Manager, US Engineering at Acuren. He was previously Founder and President of ADV Integrity, Inc. prior to its acquisition by Acuren in April 2024. Chris has more than 30 years' experience in designing, evaluating, and testing a wide range of technologies, including the use of composite materials in repairing high pressure pipelines and offshore risers. His work has involved finite element analysis, in situ monitoring, and full-scale destructive testing. Chris received his B.S., M.S., and Ph.D. degrees in Mechanical Engineering from Texas A&M University. He is a licensed Professional Engineer in the state of Texas and has authored more than 150 technical papers and made presentations internationally on a wide range of subjects.

Buddy Powers is with Acuren Inspection in Magnolia, Texas

158

Study to Validate the Design of Carbon-Epoxy Technology Used to Reinforcement Crack-Like Features

Travis Greenstreet[1], Chris Alexander1, Jim Souza[2], Osbaldo Chavez[2], Sammy Goodgion[2], Steven Siever[2]

[1]Acuren, Magnolia, Texas, USA. [2]WrapMaster Global, Longview, Texas, USA

A full-scale test program was conducted to evaluate the performance of a carbon-epoxy composite repair system for reinforcing crack-like defects in 14-inch × 0.219-inch, Grade X46 LF-ERW (low-frequency electric resistance weld) pipe. Six pipe samples were fabricated from this vintage 1960-era pipe material removed from service. Each sample featured a 3-inch-long axial crack-like defect machined in the ERW seam using electric discharge machining (EDM). Prior to testing, all samples were pre-cycled to initiate cracking at the base of the EDM notches, resulting in final crack depths of approximately 50% of the actual wall thickness.

Of the six test samples, two remained unreinforced to serve as controls, while four were reinforced using the carbon-epoxy system. A fracture mechanics-based design methodology, calibrated against the failure pressure of the unreinforced cracks, was used to determine the optimal composite thickness, calculated to be 0.220 inches.

The repair thickness successfully reinforced one sample through short-term burst testing and another through 25,000 fatigue cycles, simulating approximately 100 years of service under moderate cyclic loading. Encouraged by this performance, the remaining two fatigue samples were subjected to an extended 50,000-cycle runout. One sample completed 43,265 cycles before failure; the other completed the full runout and a subsequent burst test.

This study provides two key contributions to the pipeline industry. First, it validates a fracture mechanics-based design approach for optimizing composite reinforcement. Secondly, it demonstrates that the PermaCarbon carbon-epoxy system offers a minimum design life of 100 years under moderate cyclic conditions.

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162

Assessing the Integrity of Ultra Deep Pipeline River Crossings – a Novel Drone-Based Electromagnetic Solution

Medhi Laichoubi

Skipper NDT, Houston, USA

River crossings are a concern for pipeline integrity management due to heightened safety risks from limited visibility, vessel traffic, and complex construction operations. These conditions create a need for precise localization and monitoring strategies. Geospatial positioning at ultra-deep crossings (>65 ft / 20 m) remains technically challenging with standard methods, as hazardous and time-consuming data collection often results in high positional tolerances and low data density.

This paper presents a case study focused on detecting and mapping the exact position of a 6" natural gas pipeline beneath the 45 ft (14 m) Houston Ship Channel. The line had an uncertain position based on as-built drawings, creating geospatial risk for nearby construction.

Challenges included mapping under deep water and across onshore embankments, while navigating around barges and cranes without interrupting line throughput. To address this, Skipper NDT deployed its drone-based electromagnetic solution, integrating GPS, IMU, and altimeter sensors.

Key developments in UAV electromagnetic interference mitigation were required, including a 2–3x improvement in signal-to-noise ratio through spatial characterization of the fluxgate sensor noise. This enhancement extended the maximum detection range from 46 ft (14 m), demonstrated in 2022 on a NaTran pipeline (Laichoubi et al., PTC Berlin 2023) [1], to 100 ft (30 m) in the current case.

These results demonstrate the feasibility of above-ground inspection for horizontal directional drilling (HDD) and ultra-deep crossings, such as the Mississippi River. The study also compares mapped pipeline geometry to an In-Line Inspection reference to assess accuracy at those depths.

.*Mehdi Laichoubi* is an Aerospace Engineer and Chief Technical Officer (CTO) at Skipper NDT. He leads R&D programs related to Unmanned Aircraft Systems (UAS) in the following areas:

- Design of embedded systems for airborne magnetic measurement,
- Magnetic data interpretation applied to buried pipeline networks and facilities,
- Algorithmic and geolocalisation.

Mehdi is the Inventor of patents related to Skipper NDT's technology and the author of papers on 3D mapping of buried pipelines. He holds a Master's degree in Aerospace Engineering from Pennsylvania State University and a Master of Engineering in Energy from École Centrale in France.

163

When Did the Slope Start Moving...Varved Clays, Pipelines, and Landslides

Nick LaPlant[1], Todd Bown[2]

[1]National Grid, Syracuse, USA. [2]GZA GeoEnvironmental, Buffalo, USA

Following a week of heavy rain, on May 16, 2000, a landslide occurred in the village of Delmar, NY, just outside of the City of Albany. During the landslide, a portion of the slope between Delaware Avenue (Route 443) and the Normans Kill failed and moved northwards to the Normans Kill creating a 300 ft long and 70 ft deep scarp. The landslide flow carried soil into the Normans Kill, damming it which prompted the City of Albany to relocate that section of the river.

In May of 2024, a regional natural gas utility operator whose right-of-way is located adjacent to the properties affected by the 2000 landslide reached out for assistance in identifying the current stability state of their property.

At this time, a landslide scarp (tension crack), approximately 140 feet wide with measured displacement between 2 to 6 inches was present within an asphalt parking lot situated above the utility right-of-way. Initially, the project started with a desktop analysis, involving the review geotechnical data memorandums from a subsurface investigation performed by others in response to the 2000 landslide event. Using the historic test borings, material index and strength data (peak and residual), the stability of the right-of-way slope was assessed under several case conditions for global and localized stability. Model case conditions reported factors of safety below unity for a circular failure along multiple critical slip surfaces. Automated slope monitoring instrumentation was installed along the right-of-way, and an operations and management plan were put in place by the utility operator.

This presentation will conclude with a case study documenting the progression from desktop analysis to a slope instrumentation program, development of an instrumentation monitoring plan for the utility operator to safely operate their natural gas pipeline with real-time data, and how the project team responded to the geohazard in comparison with the recently issued American Petroleum Institute's (API) Recommended Practice 1187 "Pipeline Integrity Management of Landslides". The project team's decisions made on how to proceed occurred just before API released this guidance. Comparison of the decision-making process utilized when compared with API's recommended practice serves as an honest, comparative case study in the efficacy of the API document.

Nick LaPlant has nearly 20 years of experience in civil engineering with much of that time spent designing and contracting large-scale earthwork projects. Nick took his geotechnical expertise to National Grid where he currently manages civil tasks in Upstate New York for natural gas projects.

Todd Bown is a senior project manager and engineering geologist at GZA GeoEnvironmental with over 20 years of experience leading challenging geotechnical and environmental projects. A licensed professional geologist in NY, PA, AL, and NH, he holds degrees in Earth Science and Geotechnics from SUNY Buffalo State and Missouri S&T.

168

A Deep-Dive into the PHMSA Significant Incident Database and What it Tells us About Trends in Pipeline Geohazards

Alexander McKenzie-Johnson[1], Rhett Dotson[2]

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The pipeline industry's focus on geohazards and other natural force threats has intensified dramatically in recent years. A surge in geohazard-focused papers, guidance documents, recommended practices, and PHMSA advisories reflects this growing attention. This paper presents an independent, in-depth review of the PHMSA Significant Incident Database with the objective of identifying noteworthy trends in natural force incidents, focusing on the years 1985 through 2024, when both complete datasets and narrative descriptions are available.

The findings were surprising and thought-provoking. The rate of reported incidents with a high degree of certainty that natural forces were a primary or contributing factor declined from a peak of approximately 11 incidents per year from 1990 to 1994 to about 3.6 incidents per year from 2020 to 2024. At first glance, this finding appears to be counter to the general narrative that geohazard incidents are increasing and suggests that growing industry interest in pipeline geohazards is largely being caused by heightened awareness of the hazard, rather than an actual increase in incidence.

However, a detailed analysis reveals a more nuanced picture. The decline in overall incident rate appears to be largely driven by a reduction in flooding-related events (hydrotechnical hazards). In contrast, landslide-related incidents nationally show a slight upward trend during the period of record, but with a sharp increase in the Appalachian region since the mid-2000s. In this region, reported landslide incidents increased from about one every three years during the twenty years from 1985 to 2004 to an average of one per year between 2005 and 2024, with a peak of five incidents in 2018 alone.

This research suggests that changes in the rate of natural force incidence, when looking at long-term trends, may be attributed to changes in construction practices. The decline in flooding related events is likely due to the greatly increased use of horizontal directional drilling (HDD) for replacement and installation of pipelines at river crossings, while the increase in Appalachian area landslide incidents is likely, at least in part, due to increased pipeline development in an inherently landslide susceptible region. However, on a cautiously optimistic note, incident rates for the five-year period from 2020 to 2024 are the lowest of any five-year period reviewed, possibly providing an early indicator that the increasing adoption of proactive geohazard management programs in recent years may be resulting in positive impacts.

The paper will summarize these findings and others from the deep-dive review of the Significant Incident Database, including the relative frequency of leaks and ruptures by geohazard type, and how pipeline characteristics, such as age, diameter, and SMYS, correlate with reported geohazard incidents.

Alexander McKenzie-Johnson is the President and Chief Geologist of Tricoast Geoservices Inc., based in the Woodlands, Texas. Alex has over 24 years of experience as a professional geologist, mostly focused on identification, assessment, and management of pipeline geohazards. Alex has been the primary author or a key contributor to numerous guidance documents on management of pipeline geohazards, notably being the primary author of the content for API RP 1187 on landslide management for pipelines.

168 Cont'd

Rhett Dotson is a professional engineer with 20 years of experience in the pipeline industry. Rhett has expertise in helping operators use data collected from in-line inspection, analysis, and full-scale testing to manage the threats associated with mechanical damage, weather and outside forces, and vintage pipe materials. During his time as a consultant, Rhett has performed detailed numerical assessments for geohazards and dents incorporating information from ILI and in-situ sources. While working for an ILI vendor, Rhett oversaw the technical execution and service development for all bending strain and geometry services in North America and Mexico. He has authored papers evaluating the repeatability of assessments based on these services and helped operators with the management of their weather and outside force threats using these technologies. Rhett has contributed to the development of API RP 1183 and is a member of the ASME B31.8 Operations and Maintenance subcommittee

169
Case Studies Evaluating a New IMU Solution for Geohazards

Rhett Dotson[1], Karim Kabbara[2], Dan Fletcher[3], Jeff Haferd[2]

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The use of inertial measurement unit (IMU) technology on board in-line inspection (ILI) technology has increased rapidly since the early 2000s. Initially, IMU technologies were incorporated onto combo tools for the purpose of improving feature locations and reducing excavation costs. However, IMU technology has matured to the point where many operators now conduct ILI assessments for the sole purpose of gathering IMU data and using this data to perform geohazard assessments. Unfortunately, deploying IMU technology onboard a conventional combo tool can incur significant costs, particularly if tracking is required or product velocities need to be adjusted. A new purpose-built IMU platform has been developed in response to these challenges. This IMU platform is designed to be utilized with minimal resource requirements during launching or receiving and does not require tracking. Three case studies were performed with an operator partner in 2025 using this technology with the expressed purpose of validating the technology. The case studies were conducted in pipelines with numerous bending strain features identified with multiple prior combo tools. This paper presents an overview of the technology, a description of the case studies, and the results of those case studies. Additionally, operators are provided with guidance on best uses for the technology and future developments.

Rhett Dotson see #168

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173
Managing Complex SCC Through Combining ILI Inspections and Applying Advanced Data Analytics

Cécil Adam[1], **Manuel Hernández[2],** Jordi Aymerich[3], Thomas Mrugala[4]

[1]SPMR, Lyon, France. [2]NDT Global, Houston, USA. [3]NDT Global, Calgary, Canada. [4]NDT Global, Stutensee, Germany

Pipeline operators have historically dealt with multiple threats in their assets. Stress corrosion cracking (SCC), which can be axial, circumferential, and even have complex morphologies (i.e. spider web) has been a predominant threat.

Successfully managing this complex threat starts with the selection of the most advanced In-line Inspection technology. Multiple data sets based on high-resolution ultrasonic tools (e.g. axial and circumferential crack inspections) can be combined to further understand how the pipeline network is affected. Through advanced signal to signal analysis, comparing feature profiles across different years, statistical evaluation of historic SCC data, and the development of new algorithms and methodologies tailored to the specific challenge of each pipeline, operators can improve their Integrity Management Programs. These advanced studies enable a better characterization of threats affecting their pipelines, improved mitigation solutions, and optimized repair plans.

These activities require collaboration between the ILI vendor and pipeline operator. For the ILI vendor, understanding the pipeline context results in more customized ILI reports for the pipeline operator. For the operator, working closely with the vendor improves understanding of the ILI reports. Working together allows the operator to improve their Integrity Management Programs.

This paper details the SCC management solution for the Société du Pipeline Méditerranée-Rhône (SPMR) system in France in collaboration with NDT Global.

Manuel Hernández is a Pipeline Integrity Engineer at NDT Global. He earned his degree in Geological Engineering in Spain and joined NDT Global in 2017 as an UT crack analyst. Over the past 8 years, Manuel has achieved an advanced certification in both axial and circumferential crack detection. In his current role within the Integrity Services department, Manuel has been performing engineering assessments for operators across Europe, US and Canada for the last 4 years. His expertise extends to learning UT wall measurement and geometry analysis, where he has applied his comprehensive knowledge to assess and interpret a variety of ILI data sets.

Cécil Adam joined SPMR end of 1993, becoming Chief Operations Officer in 2007. From 1997 onwards, he has implemented integrity management in SPMR and conducted various strategic projects such as implementation of a Geographical Information System and revamping of firefighting system in SPMR main tank farm. Since 2015, Cécil is Chairman of the French Joint Industry Research Program working on pipeline integrity management. Cécil is also SPMR representative at the Pipeline Operators Forum.

Jordi Aymerich is a Pipeline Integrity Engineer specialized in ultrasonic crack detection, currtently holding a Level III – Shear Wave (ANSI/ASNT ILI PQ-2020). Jordi's background is in Industrial Technology Engineering, Master's degree in Thermal Engineering and has experience delivering in ILI reports and customer requests including recommendations and integrity consulting.

Thomas Mrugala graduated from the Technical University of Karlsruhe (KIT) in 2000 with a degree in industrial engineering. He worked in the mechanical and electrical engineering industries before moving into pipeline services. Thomas joined NDT Global in 2013 as Area Sales Manager and is currently Director of Commercial Sales - Europe. He has over 12 years' experience in the pipeline industry and has a proven record of accomplishment in business development.

182
Real-Time Detection of Mechanical Impact on Pipelines via CP – Part II

Maher Kassir[1], Carine Lacroix[2], Aaron Rezendez[3], David Xu[3]

[1]SPADE, Paris, France. [2]NaTran R&I, Paris, France. [3]Pacific Gas & Electric Company, Oakland, USA

In 2025, additional field work has been carried out using the SPADE system on the NaTran (GRTgaz) and PG&E pipeline networks in France and the U.S.A., respectively, to validate the system for identifying and locating mechanical damage and illegal tapping on an operating pipeline in real time.

Based on data established in field work, new findings on identifying mechanical impact from changes in the cathodic protection current can now be reported. The technology, incorporating RMU instrumentation, provides permanent capability to locate the point of mechanical impact with greater accuracy than was previously established. Accordingly, a system has been designed and developed to generate an electrical signal that is equivalent to the signal of an impact by an excavator. In addition, the algorithms have been improved to detect lightning strikes. The user interface has been further developed to include a dashboard with user-friendly data management capability for pipeline operators to manage pipeline integrity, reduce costs, improve safety, and enhance environmental protection.

In summary, the results from the additional field work that will be discussed in the presentation will provide pipeline operators with increased confidence that this new technology can be reliably used. The SPADE system provides a unique cost-effective capability for identifying and locating in real time mechanical damage and illegal tapping on an operating pipeline system.

Maher Kassir has over 20 years of experience in pipeline integrity and cathodic protection. He is the co-founder of SPADE and the co-founder of Skipper NDT, specializing in 3D pipeline mapping and geolocation via UAS. He holds a Bachelor's degree from McGill University and a Master's degree from Columbia University.

Carine Lacroix is a pipeline integrity specialist at NaTran (formerly GRTgaz), with extensive experience in cathodic protection and advanced monitoring technologies. She has contributed to multiple innovation and field-deployment projects across the gas transmission network.

Aaron Rezendez is a pipeline operations and integrity specialist at PG&E, with experience in field operations, asset monitoring, and the deployment of advanced technologies to enhance pipeline safety and reliability.

David Xu is a corrosion and integrity engineer at PG&E with expertise in cathodic protection, pipeline monitoring, and advanced assessment technologies.

186

Talent pipeline – A Comprehensive Review of the Talent Management and Career Journeys in the Pipeline Industry

Michelle Unger[1], Jan Frowijn[2]

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The pipeline industry is a critical yet often overlooked sector within global energy infrastructure, facing workforce challenges that demand urgent attention. While extensive career trend studies exist for Oil & Gas (O&G), as well as for renewable energy sectors, the pipeline industry remains underexplored, despite its integral role in energy security and sustainability. According to the Global Energy Talent Index Report (GETI 2025), while many workers in O&G are considering career changes, a majority intend to remain within the sector, with a notable shift toward renewables. Career progression is increasingly driven by individual choices, skills, and networks, highlighting the need for companies to offer clear development opportunities whilst also complying with standards and regulations recommending a qualified, trained, and experienced workforce. Misconceptions, generational attitudes, and socio-political influences further complicate talent attraction and retention. Additionally, the integration of digitalization, data analytics, and artificial intelligence (AI) is reshaping operational processes and redefining the skills required in the pipeline integrity sector.

This paper examines the modern evolution and growth of the pipeline industry, focusing on the influence of technological advancements, workforce trends, and career planning. It presents a first-of-its-kind study, capturing insights from industry professionals, HR leaders, and employees through focus groups, interviews, and data analysis. Drawing on comparative data from a range of published industry sources, this study provides pipeline operators and talent managers with critical perspectives to navigate workforce sustainability and equip employees with the skills needed to drive the energy sector. By framing career management as an adaptive process, the paper offers a roadmap, framework and key findings to assist in developing long-term workforce strategies, recognizing that more professionals increasingly want their work to make a positive impact on climate change and society.

Michelle Unger is the Vice President of Strategic Industry Engagement for the ROSEN Group. She is a Leadership and Workforce Development Executive Coach, Educator, and Pipeline Engineer with over 25 years' global experience bridging technical excellence and people performance in the pipeline industry. Specialising in future-ready workforce strategy, Michelle has designed award-winning leadership programs, led ANAB-accredited pipeline integrity certifications, and built scalable frameworks translating complex technical roles into measurable competencies. Through coaching, consultancy, and strategic planning, Michelle aligns talent with strategy. She is an EMCC-accredited Senior Practitioner Executive coach.

Jan Frowijn is ROSEN's Chief Operating Officer for the Americas, with more than 25 years of experience in technology-driven industries, primarily in the energy sector. His career spans leadership roles in Finance and Operations across Europe, North America, and South America. Jan has a strong interest in leadership development and is an ICF-certified coach. He works with emerging leaders, first-time managers, mid-level leaders, and senior executives, and also supports individuals navigating career transitions. His coaching approach combines strategic thinking, practical leadership insight, and a commitment to helping others grow confidently in their roles.

188
Development of ILI Tool and Specifically Robust UT Probes for the Assessment of Crack Type Anomalies in Ammonia Carrying Pipelines

Daniel Bugger[1], Colton Shannon[2], Martin Fuchs[3], Thomas Hennig[1]

[1]NDT Gobal, Stutensee, Germany. [2]Sunoco, San Antonio, TX, USA. [3]Sonotec, Halle, Germany

The in-line inspection (ILI) of pipelines used to transport anhydrous ammonia is challenging since several components that make up a typical ILI tool used for the inspection of oil and gas pipelines are not compatible with the anhydrous ammonia. Magnetic Flux Leakage (MFL) and Deformation (DEF) tools have been developed in the past to assess anhydrous ammonia pipelines for corrosion and deformation anomalies. However, assessing for crack type anomalies has never been possible as no ammonia compatible ultrasonic ILI tool has been developed. Feasibility studies have in the past been undertaken to address this problem but so far none of these investigations has resulted in a successful ultrasonic ILI tool build for inspection of ammonia carrying lines. As a result, the operators of these pipelines have been conducting ultrasonic ILI inspections using water to navigate the tool through the line during a hydrotest. This process is not only expensive, but it also causes months of interruptions in flow due to repairs and other factors related to the procedure. The opportunity to be able to conduct ultrasonic (crack) ILI inspections during the normal operation of this ammonia pipeline system would result in a significant cost saving for the client.

Pipeline operator, Sunoco LP, transports the anhydrous ammonia through 7 states, which is used primarily as a fertilizer to the Corn Belt region. Demand for decarbonized ammonia is expected to increase globally, which will expand the market for ammonia in the future.

Findings of the project conducted by NDT Global on behalf of Sunoco to build an ultrasonic ILI tool capable of detecting and sizing axial cracks, in particular fields of stress corrosion cracks (SCC) in ammonia carrying pipelines, will be shown in the paper.

A main thread in the development process was the design of robust ultrasonic probes. Due to the aggressive nature of ammonia, especially to plastic materials and the two-phase states (fluid and gaseous), the conventional design used for the inspection of oil pipelines proved not to be suitable. Therefore, the main goals of the development were to find ammonia resistant materials and the design of a fully enclosed and gas tight housing. Build the UT probe ensuring optimized acoustic characteristics to deliver UT data during an ILI run with ammonia as the medium. After various iterations a final specification was released and verified in laboratory and on-site testing. On-site testing was in a launcher and in a section of ammonia carrying pipeline. The development of the UT probes was carried out in close cooperation with the developer and manufacturer of ultrasonic transducers, SONOTEC GmbH.

The paper will report on the investigation and qualification program to establish an ILI ammonia service and on the first commercial run executed on a target pipeline section identified by the pipeline operator. Performance capabilities are derived in accordance with API 1163 – methodology and outcome are discussed.

Daniel Bugger holds a Master of Science degree in Project Management and has been working for NDT Global GmbH since 2023. At NDT Global, he is responsible for various development projects in the field of in-line inspection (ILI) with the technologies UC, UG, UM and Eddy Current. He is also responsible for the development of the first UC tool for liquid anhydrous ammonia pipelines. In addition to ammonia, Daniel Bugger also has experience with other challenging media such as oxygen and hydrogen, where he has created guidelines for valves with a focus on suitable materials and the development of ball valves.

188 Cont'd

Martin Fuchs has a diploma in engineering and has been working as a development engineer at SONOTEC GmbH since 2017. His technical expertise lies in the field of non-destructive testing (NDT), with a particular focus on the development and characterization of ultrasonic transducers. At SONOTEC, he is primarily responsible for projects aimed at developing innovative ultrasonic transducers for demanding industrial testing applications, including in-line inspection (ILI) of pipelines. Martin Fuchs is an active member of the subcommittee for Air-Coupled Ultrasonic Transducers (UA ACUT) of the German Society for Non-Destructive Testing (DGZfP), where he has contributed to the development of key guidelines.

Colton Shannon holds a Bachelor of Science degree in Mechanical Engineering and a Master of Business Administration degree. He has 15 years of experience in integrity and reliability roles and has been working for Sunoco LP since 2017. At Sunoco LP, Colton is currently responsible for the Pipeline Integrity and Facility Integrity team with a goal of ensuring mechanical integrity on the pipelines, facility piping, and pressure vessels. He has extensive experience managing the integrity program for the 2,000 mile Ammonia System and has been involved with furthering the development of inspection methodologies in anhydrous ammonia.

Thomas Hennig see #151

192
Managing Internal Corrosion Threat in Unpiggable Pipelines and Facility Deadlegs: An Update on Industry Standards and What the Data Tells Us

LeeAnn Escobar[1], **Leslie Ward[2]**

[1]Shell, New Orleans, USA. [2]Kiefner and Associates, Houston, USA

Deadlegs in piping systems create a high risk for internal corrosion because of their no-flow or low-flow condition. Within the Midstream industry, designs continue to include deadlegs, so facility integrity management programs must manage the threat of internal corrosion. Due to recent failures, there is a growing interest in providing more guidance on what integrity management programs should include to address the internal corrosion threat to deadlegs. The AMPP SC 15 Pipelines and Tanks committee is sponsoring TR21604 Managing Internal Corrosion in Midstream Deadlegs.

This paper will discuss the outline of the new AMPP document and address the status of previously discussed issues from the PPIM 2025 paper #224, Managing Internal Corrosion Threat in Unpiggable Pipelines and Facility Dead Legs.

Additionally, this paper will discuss the challenges of finding specific data regarding deadleg failures and how to determine if we are reducing the likelihood of deadleg failures.

Leslie Ward is a multi-certified API Inspector who joined Kiefner in June 2024. She received her degree in Civil Engineering from Auburn University. Ms. Ward began her career in downstream refining, where she developed her expertise in mechanical integrity. She has been a voting member of the API CRE SCIMI since 2012 and is currently the API RP 576 Task Group Chair. Previously, she worked for Enbridge GTM, implementing a new Facility Integrity program. Ms. Ward co-founded Women in Mechanical Integrity.

LeeAnn Escobar is a Senior Materials & Corrosion Engineer at Shell. She holds a BS in Materials Science & Engineering from the University of Wisconsin-Madison. LeeAnn joined Shell in 2003 and is currently supporting Deepwater offshore production assets. During her career so far, she has also worked in Onshore US production, as well as Pipeline Integrity. LeeAnn has been involved in the development and execution of corrosion management systems, including materials selection, production chemistry, failure investigations, inspection, and repair.

194
A Recommended Dent Screening and Assessment Framework for API 1183I

Thomas Dessein[1], Ahmed Abdelmoety[1], Ayman Abbas[1], Gustavo Gonzalez[2]

[1]Integral Engineering, Edmonton, Canada. [2]ExxonMobil, Houston, USA

The API 1183 committee is reviewing the structure of the Recommended Practice (RP) for the assessment and management of dents and may include a Finite Element Assessment (FEA) screening method for fatigue assessment option under the Level 2 category in the next edition.

This paper proposes a dent assessment framework that incorporates such a screening method, which uses an FEA mesh generated to match the measured profile of the dent. The screening method does require iterations to account for the re-rounding that occurs as internal pressure is raised to match the pressure at the time of the inspection but provides a more rapid assessment than an equivalent Level 3 FEA. In contrast, a Level 3 FEA assessment explicitly models the non-linear indentation process and accurately captures the full stress state and plastic deformations in the dent.

The recommended framework leverages the Level 1 and shape parameter-based Level 2 methods in API 1183, when these are applicable, to limit the number of dents requiring FEA and uses the Level 2 FEA method to further screen dents and limit the number of costly Level 3 FEA that are required. The shape parameter approaches are only applicable to single peak dents that are aligned with the pipe axis and are not interacting with other nearby dents. Several authors have also raised concerns about their accuracy and applicability to sharp and skewed single peak dents.

The process is fully automated so that the level 2 FEA can be used at low cost rather than the shape parameter approaches in cases where there is low confidence in their accuracy. Automation is at the center of the proposed approach to perform efficient screening analysis; it also enables practical implementation of the Level 2 FEA to perform probabilistic assessments when combined with surrogate function methods.

This work describes the methods used to reliably apply smoothing of the caliper data, such that the peak depth and character of the dent is not lost and demonstrates the screening process for a pipeline. The recommended procedure for filtering dents for Level 2 and 3 FEA, and the process for calculating a probability of failure using FEA is proven to deliver clarity and efficiencies for future application of the methods in API 1183.

Thomas Dessein has twenty years of experience working in design and consulting roles with a focus on simulation techniques, defect assessment, fracture mechanics, finite element analysis techniques, and risk & reliability. In recent years, Thomas has worked with oil & gas operators to apply probabilistic and machine learning models to support and improve their integrity management programs across a range of assets. He has authored several papers and taught courses on defect assessment and risk assessment.

Ahmed Abdelmoety has a background in computational mechanics and numerical simulation techniques of structures from his M.Sc. studies. In recent years, Ahmed obtained his Ph.D. in structural reliability of dented pipelines and worked with oil & gas operators to apply probabilistic methods and numerically simulate and assess pipe dents. He also developed finite element-based tools for automated fatigue and strain assessment of pipe dents.

Ayman Abbas is a Mechanical Engineer in Training (EIT) with experience in characterizing the measurement accuracy of in-line inspection tools and assessing pipeline cracks and dents. He has developed software to perform data processing on caliper measurements to perform strain and fatigue assessments.

194 Cont'd

Gustavo Gonzalez is a Pipeline Engineer with 20 years' experience in the design, integrity, and lifecycle management of pipelines around the world. Areas of interest include In-Line Inspection (ILI), Fitness-for-Service (FFS), and probabilistic assessments. Over the past decade, has led the implementation of ILI validation initiative and probabilistic models to enhance pipeline integrity management programs.

197
Automatic Feature Prioritization for Ultrasonic Metal Loss Analysis using AI

Victor Ferrer[1], Gerard Jover[1], Katja Träumner[2], Thomas Meinzer[2]

[1]NDT Global, Barcelona, Spain. [2]NDT Global, Stutensee, Germany

Ultrasound In-Line Inspections (ILI) technologies are a well-established inspection method providing pipeline vendors with a high probability of detection, identification, sizing and reporting of anomalies. In recent years, several automatic algorithms have been proposed to detect and identify relevant anomalies while trying to avoid flagging nonrelevant indications or noise (analysis false positives). Regardless, manual analysis is still needed to discard those false positives and to adjust highlighted areas to the feature itself. Despite the high efficiency analysis step that these automatic algorithms provide, in the presence of a large number of false positive indications, meeting the required priority notification timelines is challenging.

In this paper, we will present an automatic ranking algorithm based on predicted feature depth for ultrasound metal loss technology. By 1.) leveraging deep learning (DL) technology, 2.) biasing the algorithm for deep but rare features (more precise on critical deep features) and 3.) mimicking human analysis, a conservative and easy to use algorithm (no parameters) was developed. It allows manual analysis to focus on a subset of initial indications ranked as potential actionable anomalies and thus reducing priority notification time. By knowing beforehand which are the most important actionable anomalies, a stricter quality checking can be used during human analysis.

Víctor Ferrer studied electrical engineering at University of Catalonia and did a PhD in the field of heart rate variability at its electronics department. After moving to the industry as machine learning specialist, he joined NDT Global in 2021 as senior machine learning engineer. In his career in the industry, Víctor has systematically applied state-of-the-art deep learning and machine learning techniques to automatically detect and predict relevant information on images and signals. Specifically, in ILI business, Víctor has applied this knowledge across NDT Global to transform processes from highly manual to machine supported to make them more robust, reliable and efficient.

Gerard Jover is an AI Engineer with over 3 years of professional experience in designing, developing, and deploying artificial intelligence and machine learning models. After his bachelor's in data engineering, Gerard joined NDT Global in 2021 working in the Data Platform team and moved to the Data Science and AI group in 2022. His work spans across the full AI pipeline, from data collection and preprocessing to model training, optimization, and deployment, with a focus on scalable and efficient solutions. Over the years, Gerard contributed significantly in developments to automate pipetally generation as well as feature detection and classification in ultrasound metal loss and crack technology.

Katja Träumner has worked more than 10 years in the in-line inspection industry, with a career that spans various roles connected to the systematic improvement of data analysis. Starting as a researcher at NDT Global, she worked hands-on together with the algorithm development and software team to apply techniques to allow the change from manual to machine supported analysis. Over the years, she was promoted into the team lead and manager role, working both inside the Research & Development and the Operational Data Analytics department. Since 2022, Katja is Head of Data Science and AI with responsibility for pushing the transformation of methodologies and algorithms forward to enhance robustness, reliability, and efficiency during ILI data analysis and to assure that new technologies are smoothly integrated into the processing lines. Katja holds a Diploma in physics and a PhD in natural sciences. Before joining NDT Global, she led a research group at the Karlsruhe Institute of Technology focusing on the parametrization of atmospheric turbulence

Thomas Meinzer is Head of Data Analytics & SME at NDT Global. As a UT ILI specialist he is responsible for best quality data analytics services for all different kinds of application scenarios related to the various technologies offered by NDT Global. Thomas' background is electrical engineering. After spending more than three decades in the UT ILI business with his main focus on corrosion detection, Thomas knows exactly how to serve and advise pipeline operators best in various types of pipeline maintenance challenges.

200

Finding the Edge of Crack & Seam Welds in the Field with Direct High-Resolution ILI Measurements

Greer Simpson[1], Corey Richards[1], Marshall Lu[1], Aaron Schwing[2], Jason Moritz[2]

[1]DarkVision, North Vancouver, Canada. [2]Flint Hills Resources, Wichita, USA

Pipeline operators are significantly de-risking the detection and assessment of anomalies in their pipelines with a new direct imaging ILI technology. This paper focuses on novel methods to directly image and measure the unique morphology of complex and interacting anomalies found in the field. Field validated results include the classification and measurement of misaligned and over/under trimmed weld profiles, short lack-of-fusion (LoF) penetrators, and hook cracks in welds. Additionally, stress corrosion cracking (SCC) and complex laminations with surface breaking features are showcased from field data.

Lab validation of manufactured flaws is also conducted to benchmark the imaging and sizing performance of complex defect classes. Findings are compared against industry standard inspection methods including metrology-grade laser scanning, handheld phased-array ultrasound, and TOFD-based inspection techniques.

First introduced at PPIM 2025, this high-resolution direct imaging ILI technology directly measures metal loss, axial cracks, and changes in pipe wall geometry, all in a single run. The result is a single, unified, high-fidelity 3D dataset that simultaneously resolves anomalies missed with traditional detection capabilities and enables every anomaly to be comprehensively evaluated for geometric, metal loss, and crack-like components. Operators are leveraging the tool's technology to inspect their lines down to 0.01in resolution at 6.7mph inspection speeds to confidently identify and analyze the exact morphology and severity of threats. The resulting methods outlined in this paper significantly reduce false positives, lower the uncertainty of anomaly measurements, and improve the detection and identification of anomalies that pose a high risk to critical infrastructure.

Greer Simpson, P. Eng, is the Director of Product for DarkVision – a technology company focused on developing, manufacturing, and deploying high-resolution acoustic imaging solutions for downhole and pipeline inspection applications. Greer oversees the technical and strategic roadmap of DarkVision's product lines, including the expansion of the technology into new regions and market verticals. Prior to DarkVision, Greer served as a Production Engineer for multiple upstream operators in Western Canada.

Corey Richards is an Electronics Engineering Technologist with over 16 years of experience in inline inspection (ILI) and pipeline integrity, including 15 years with ROSEN. Over his career, he has held roles in field operations, sales, and management, including leadership of departments focused on unpiggable pipeline solutions and pipeline cleaning with turnkey field services. During a five-year tenure in Germany, Corey also supported business growth across Asia and Oceania. Currently based in Calgary, Corey serves as the Director of Business Development at DarkVision, Corey is advancing cutting-edge inline inspection and direct imaging technologies.

Marshall Lu Bachelor of Applied Science in Mechanical Mechatronics Engineering from the University of British Columbia. His role as the Product Manager of DarkVision's inline inspection service oversees the technical development and application of in-line high-resolution direct imaging inspections of pipelines. Over his career, he's held various testing and application engineering roles focused on products and services for the oil and gas industry.

Aaron Schwing joined Koch Industries Pipeline Division in 1996 after earning a Bachelor of Science degree in Electrical Engineering from Oklahoma State University. He has held numerous individual contributor and leadership roles in the areas of SCADA, Automation, Engineering, and Asset Integrity & Reliability. In his current role, Aaron is responsible for Flint Hills Resources Pipelines & Terminals Mechanical Integrity and Reliability programs covering ~4000 miles of pipelines and facilities.

200 Cont'd

Jason Moritz is a registered Professional Engineer in the State of Illinois with 15 years of experience in the pipeline industry. He graduated from Iowa State University in 2008 with a Bachelor of Science in Construction Engineering. At Flint Hills Resources, Jason serves as a Senior Integrity Engineer within the Pipelines and Terminals Mechanical Integrity and Reliability group. For over the past 10 years, he has focused on managing the implementation of Integrity Management programs for Flint Hills Resources' pipeline network

204

Integrating ILI Results to Evaluate Pipeline Expansions in Seamless and ERW Pipe

Rob Greene[1], Rhett Dotson[1], **Nima Parsibenehkohal**[2]

[1]D2 Integrity, Houston, USA. [2]PBF Energy, Torrance, USA

A pair of 2022 and 2024 ultrasonic geometry ILI assessments identified thirteen expansions in a liquids pipeline installed in 1970. The expansions were reported in both seamless and ERW pipe. The identification of the expansions was unexpected and raised two concerns. First, it was necessary to determine whether these expansions were caused by a historical hydrotest. Second, it was necessary to determine whether the features represented an integrity threat. The project investigated the expansion calls by integrating 2020 MFL-A and geometry inspection results from a second vendor who completed a separate ILI. The data integration included an in-depth signal review of the areas of reported expansion with both vendors. This case study demonstrates how multiple ILI datasets using different technologies can be analyzed together to assess an uncommon feature type. Ultimately, the analysis concluded that the features were not consistent with expansions and were not considered injurious to the integrity of the pipeline. This paper will be helpful for operators who encounter uncommon features and are looking to leverage existing high resolution ILI data to provide further context to the features beyond a comparison of the reported results in a pipe tally.

Rob Greene is an ILI Data Specialist with over ten years of experience in the pipeline industry. Rob has expertise in analyzing ILI signal data and is formerly a certified level two Axial MFL and Caliper analyst with an ILI vendor. He has worked for a natural gas operator selecting features for remediation and developed data integration tools to combine previous ILI results, remediation findings, repair records, and current ILI results. As a consultant, Rob leads the dent team at D2 Integrity, focusing on finite element analysis related to 192.712(c) regulations for natural gas operators and dent fit for service analysis for liquids operators. Rob has seen firsthand the challenges of integrating data from multiple sources and reporting standards from unique vendors and ILI technologies. He has previously authored a paper on the combination of multiple caliper datasets to improve the accuracy of circumferential strain measurement in low-resolution tools.

Rhett Dotson see #168

Nima Parsibenehkohal see #110

205
Ten-Year Analysis of Reportable Pipeline Accidents: Trends, Risk Factors, and Lessons Learned

Alvaro Rodriguez

DOT/PHMSA, Oklahoma City, USA

This paper presents a data-driven analysis of reportable pipeline accidents and incidents in the United States from 2015 to 2024, utilizing data from the Pipeline and Hazardous Materials Safety Administration (PHMSA). The primary objectives are to understand the causes of these failures and their consequences, identify the risk factors involved, and observe trends that may signal the need for corrective action. Through a combination of statistical evaluation and case studies, the analysis reveals recurring failure modes, contributing causes, and possible vulnerabilities within pipeline operations.

The over-riding goal is to highlight areas for potential improvement to help reduce operational risk and strengthen integrity management practices. The findings offer an in-depth understanding of lessons learned, providing operators with valuable insights into underlying damage mechanisms and contributing conditions. This knowledge supports the development of more effective mitigation programs, particularly in the areas of corrosion control and comprehensive risk management. By sharing these results, the paper aims to contribute meaningfully to the ongoing effort to enhance pipeline safety and reliability across the industry.

Alvaro Rodriguez is an Accident Investigator with PHMSA's Accident Investigation Division in Oklahoma City, joining in 2019. He holds a B.S. in Chemical Engineering from Universidad de America and earned his M.S. and Ph.D. from The University of Akron. His doctoral research focused on corrosion inhibition and protective coatings. Prior to PHMSA, he was a Postdoctoral Fellow at NETL, evaluating corrosion mitigation technologies for natural gas pipelines. Alvaro brings experience in electrochemical research, project leadership, and industry collaboration. Outside of work, he enjoys astronomy, running, salsa dancing, poetry, and is an active member of Toastmasters International

206
Using Advanced Inline Inspection (ILI) to Prioritize Girth Weld Features

Matt Romney, David Sunwall

T.D. Williamson, Salt Lake City, USA

A pair of 2022 and 2024 ultrasonic geometry ILI assessments identified thirteen expansions in Pipeline owners and operators continually seek innovative strategies to ensure the safe and reliable operation of their assets. One emerging focus area is the assessment of threats associated with girth welds—critical components in pipeline integrity. This paper presents an advanced methodology for girth weld threat analysis and prioritization, designed to strengthen pipeline integrity management practices.

The approach utilizes the MDS™ Pro platform, integrating a suite of in-line inspection (ILI) technologies—including Spiral Magnetic Flux Leakage (SMFL), Low-field and high-field Axial MFL, and Geometry (GEO) —to detect and characterize anomalies such as misalignments, heavy welds, and circumferential planar defects.

Each weld is subjected to detailed data analysis, followed by application of a comprehensive prioritization model. This model evaluates anomaly severity based on feature dimensions—length, width, and depth—and assigns priority scores accordingly. The prioritization framework further accounts for interacting threats such as bending strain, cracking, dents, and metal loss.

Case studies are presented to demonstrate the model's effectiveness in identifying high-risk welds. Non-destructive evaluation (NDE) results confirm the model's predictive capability, including prioritizing several welds that were later shown not to meet current post-construction quality standards. This innovative methodology enables operators to manage costs, while focusing on remediation efforts, reducing operational risk, and upholding pipeline safety and regulatory compliance.

Matt Romney is the Product Line Director for Pipeline Integrity at T.D. Williamson, where Matt drives the strategic vision and development of cutting-edge In-line Inspection (ILI) technologies that safeguard global energy infrastructure. With more than 15 years of experience spanning engineering design and product management, Matt combines deep technical expertise with market insight to deliver solutions that set new benchmarks for pipeline safety and performance. Matt oversees a diverse technology portfolio, including traditional MFL and geometry tools as well as advanced systems like MDS™ Pro, MDS Flex, and Electromagnetic Acoustic Transducer (EMAT) platforms—innovations that enable operators to detect and mitigate threats with unprecedented precision. Matt's leadership focuses on transforming complex engineering challenges into scalable, industry-ready solutions aligned with evolving regulatory and operational demands. Holding a bachelor's degree in mechanical engineering from Arizona State University and a master's from the University of Utah, Matt also earned Product Management certification from AIPMM.

David Sunwall is an Integrity Engineer at TDW with 7 years of pipeline integrity experience including integrity engineering, data science, and data analysis. He's currently focused on advanced analysis and interpretation of inline-inspection data. He received degrees in Geoscience (MSc) and Geophysics (BSc) from Montana Tech of the University of Montana.

207
Are Pipeline Accidents Causally Linked to the Decade the Pipeline Was Installed?

Tod Barker

U.S. Department of Transportation – Pipeline and Hazardous Materials Safety Administration, Washington D.C., USA

The integrity of pipeline infrastructure is a critical component of ensuring public safety and environmental protection in the transportation of hazardous materials. This study examines whether the decade a pipeline was installed has a statistically significant relationship with the frequency and causes of pipeline failures. Using data reported to the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA), we analyzed incident and annual report datasets for onshore, steel pipelines across both the Hazardous Liquid and Gas Transmission sectors, covering installations from 1910s through 2024.

The project was initiated to evaluate how pipeline vintage – defined by the decade of original installation – affects incident trends, particularly the root causes of failure. Data preparation included filtering out non-steel materials and offshore pipelines to ensure consistency and comparability. Incident reports were grouped by installation decade, and failures were categorized by primary cause, including corrosion, material failure of the pipe or weld, equipment failure, and excavation damage.

The analysis revealed a pronounced and statistically significant increase in corrosion-related incidents in pipelines installed between 2010 and 2019 within the Hazardous Liquid sector. Corrosion failure rates for this decade were found to be more than ten times higher than those recorded for pipelines installed in the prior decade (2000 – 2009), with the number of operators affected increasing by a factor greater than six. These corrosion incidents were predominantly internal (> 80%), and most occurred in pipelines transporting crude oil. The Gas Transmission sector did not exhibit the same trend; corrosion incidents in pipelines of the same vintage (2010 – 2019) declined compared to earlier decades.

The findings from this study raise important questions about the root causes behind the spike in corrosion failures among newer Hazardous Liquid pipelines. They suggest that newer installations may not be immune to corrosion-related issues and that assumptions about newer pipelines being inherently more reliable should be revisited. The results underscore the need for enhanced surveillance of internal corrosion in pipelines installed after 2010.

This study provides a foundation for future research and regulatory review and offers practical insights for operators seeking to prioritize inspection resources and mitigate emerging integrity threats based on pipeline vintage.

Tod Barker is with the PHMSA Office of Pipeline Safety in the Program Development Division as an Accident Investigator. Tod began working with PHMSA as an Operations Research Analyst (Data Analyst) in April 2023 and moved to PHMSA's Accident Investigation Division in 2025. Tod is based out of Utah and previously worked for TD Williamson (TDW). Tod has an extensive background in the oil and gas pipeline industry including finite element analysis of material strength and magnetic circuit analysis. Tod also completed a design of experiments to determine the sensitivity of a magnetic circuit to various core materials as part of his Green Belt in Design for Six Sigma. Tod has been focused on pipeline safety for more than 20 years, beginning in 2005 at TDW. His first role at TDW was working in the mechanical engineering department designing in-line inspection tools for the assessment of pipeline integrity. In 2009 he was chosen to lead engineering development for TDW's multiple dataset tools and is a co-inventor of the SpirALL® MFL inspection tool design patent. Tod moved to Product Management in 2015 with business line responsibility for corrosion, geometry, and mapping in-line inspection technologies.

209
Bridging Overline Surveys and ILI Tools with Corrosion Computer Modeling

Christophe Baete[1], Keith Parker[2]

[1]Elsyca, WIjgmaal, Belgium. [2]Enbridge, Stockbridge, USA

Pipeline's integrity is typically assessed by overline cathodic protection (CP) surveys and in-line inspection (ILI) runs. The overline surveys are based on ON/OFF potential readings at discrete test station locations. The criterion of -850mV OFF potential according to NACE SP 0169 standard and 15V AC voltage according to NACE SP 177 is only indicative for the corrosion risk of the pipeline and measurements are limited in space and time. They do not provide corrosion rates for determining the severity of the corrosion attack. ILI runs require feature recognition and mapping for corrosion growth rate calculations and do not reveal the root cause of the observed features.

Physic based computer modeling bridges the CP surveys with ILI runs by converting the potential readings to corrosion rates. Corrosion rate is calculated from the computed current density at coating defects that are sized based on the corrosion feature size (width x length). The computer models are calibrated by comparing the simulated pipe-to-soil potentials and AC voltage with the voltage reads. Metal loss and corrosion growth rate is calculated after rerunning the model with the latest annual surveys. As such the impact of events that jeopardize pipeline's integrity is quantified allowing operators to correct their corrosion prevention strategy.

A case study will be discussed on a 85 mi long 12" pipeline with fusion bonded epoxy (year 2014) and coal tar enamel (year 1965) coating under DC and AC interference from third party systems. Computer models were utilized to compute metal loss and the risk for stress corrosion cracking based on historical CP data. Results were compared with latest ILI run.

Christophe Baeté has a master's degree in chemistry & biochemistry with an additional qualification in Environmental Management. Christophe has experience as a corrosion expert for more than 25 years. He implemented corrosion monitoring techniques based on electrochemical noise and electrochemical impedance spectroscopy and developed methodologies to determine the remaining life of underground structures with a track record of more than 2000 cases. Presently, Christophe is Manager Corrosion Engineering at Elsyca and project leader of several PRCI-funded projects on AC corrosion, HVDC interference, dynamic DC stray current interference and AC coupon performance.

Keith Parker has been an external corrosion specialist for more than 35 years. At Enbridge Pipelines, his expertise is in steering the External Corrosion Prevention (ECP) team towards industry leadership in corrosion prevention. His ambition is to pioneer a reliability-based corrosion management approach that enhances safety, reliability, and efficiency with minimal operational and environmental impact. Leading with over three decades in the corrosion field, Keith's focus lies in optimizing system integrity through innovative strategies, including the integration of digital twins and cutting-edge data collection methods. His team efforts are dedicated to sustaining the pipeline's integrity and ensuring that every decision contributes to the longstanding resilience of Enbridge infrastructure.

211

The Case of the Permanency of Composites – Testing, Analysis, and Case Study

Tim Mally, Joshua Duell, Casey Whalen

Henkel, Houston, USA

Since the 1990's composite repairs have been used to permanently repair regulated transmission pipelines in the US and around the world. Under current regulations, Title 49 CFR 192.713 and 195.585 require that a repair method "permanently restore the serviceability of the pipe." Many of the composites that were installed in the 1990's and the serviceability of each repair is now being called into question, and whether this serviceability is truly "permanent." This paper will discuss the meaning of permanency as it relates to pipelines that full under the regulations mentioned above. The paper will detail the testing, analysis, case studies, and the resultant validation process that will help pipeline operators to evaluate composite repairs that are in the ground. The testing presented includes long-term strength, cyclic fatigue, and defect specific considerations, among others. The case study will demonstrate the performance of a fiberglass composite repair after 25 years of service, including a burst test and remaining strength of the composite after 25 years. The paper will provide recommendations for how to evaluate composite repairs both in the ground, and as candidates to be installed for the future.

Tim Mally is the Director of Pipeline Integrity for Henkel, working within the CSNRI Composites business unit for the last 15 years. As a mechanical engineer, Tim focuses on educating pipeline operators on the technical aspects of permanent composite repairs, helping them with their repair procedure updates, proper composite adoption and implementation, regulatory compliance and document preparation, research and development of new composite applications, and validation testing for new pipeline anomalies.

Casey Whalen is the Global Engineering Manager at Henkel, working within the CSNRI group, which focuses on composite repair solutions for piping and pipeline infrastructure. Since entering the industry in 2012, Casey has specialized in pipeline defect analysis and the application of composite materials for structural reinforcement, with deep expertise in standards such as CSA Z662, ASME B31.4, ASME B31.8, and ISO 24817. He serves on the ASME PCC-2 Committee, contributing to the development of standards for non-metallic repairs, and has presented at numerous technical conferences. Casey authors and maintains CSNRI's proprietary design software, helping to advance the analytical capabilities and practical applications of composite repair systems. He is also actively involved in aligning technologies and expanding repair capabilities across Henkel's broader portfolio.

Joshua Duell is an engineer with over 20 years of experience, with over 18 of those directly tied to midstream integrity, repair and line intervention. Currently serving as the Principal Engineer for Henkel-CSNRI, Joshua is focused on driving the development of composite repairs. Joshua holds a Master of Science degree in Mechanical Engineering from The University of Tulsa where he wrote his thesis on the development of Carbon Composite Pipe Repairs, and his undergraduate in Mechanical Engineering from John Brown University. He has held previous roles for Williams and TD Williamson. Joshua is well-versed in industry standards including ASME, API, and DOT regulations, and is passionate about advancing safe, innovative engineering solutions in the energy and infrastructure sectors.

216

Enhanced Identification of Selective Seam Weld Corrosion with MFL-C Ultra In-Line Inspection

Andres Gonzalez Franchi, Simon Slater, Alberto Zepeda, Omar Ramirez, Carlos Berrones, Nick Brazier

ROSEN, Houston, USA

Selective Seam Weld Corrosion (SSWC), also known as metal loss preferentially affecting a detected longitudinal seam, poses a time-dependent pipeline integrity threat that often progresses more rapidly than adjacent pipe body corrosion. Most commercial ILI systems have limited capability for detecting and clearly identifying SSWC. By employing advanced in-line inspection (ILI) technologies such as High-Resolution Circumferential Magnetic Flux Leakage (MFL-C Ultra), operators can distinguish preferential corrosion from general corrosion, thereby supporting more targeted and effective remediation strategies.

Over the past 5 years, ROSEN has built a robust database from more than 120 pipelines susceptible to SSWC, spanning over 3,000 miles and encompassing a wide variety of pipe types, diameters, grades, and wall thicknesses across both vintage and modern systems. This dataset provides a foundation for the understanding of SSWC while enhancing ILI data evaluation methodologies.

This paper outlines trends and insights from case studies and data analysis, including comparisons between ILI anomaly reports and field findings, identification of pipe types most susceptible to SSWC based on mileage and year of construction, and recognition of anomalies commonly misclassified as SSWC. The study also emphasizes the importance of combining field verification with MFL-C Ultra evaluations to accurately identify, assess and mitigate SSWC risks.

The findings have contributed to improvements in the tool’s Probability of Identification (POI) by reducing uncertainty in classification—shifting focus from ‘Possible’ SSWC calls to more definitive ‘Likely’ and ‘Unlikely’ outcomes.

Andres Gonzalez Franchi has over 10 years in oil & gas integrity management for onshore and subsea assets covering various integrity approaches (fitness-for-service, corrosion diagnosis and growth studies, geometric, crack and fatigue assessment, repairs recommendations, pipeline threat analysis, implicit and explicit finite element analysis, and life extension studies). He has a bachelor’s degree in mechanical engineering from Universidad Central de Venezuela and a master’s degree in Pipeline Engineering from Newcastle University in the United Kingdom.

Omar Ramirez holds a B.S. in Mechanical Engineering from Universidad de Los Andes, Venezuela and an M.S. in Mechanical Engineering from The University of Tulsa. He has over ten (10) years of experience in the Pipeline industry, including seven (7) years in testing, characterizing and designing composite repairs and three years as a Pipeline Integrity Engineer, specializing in defect assessment of integrity threats such as dents, corrosion and cracks. Omar Ramirez is also a licensed Professional Engineer in Texas.

Alberto Zepeda is a dedicated and innovative engineer specializing in pipeline integrity and corrosion management. He currently serves as a Pipeline Integrity Engineer at ROSEN, where he focuses on the evaluation and mitigation of threats to pipeline systems. His expertise includes inline inspection technologies, corrosion growth assessment, integrity data analysis, and anomaly characterization with a particular emphasis on Selective Seam Weld Corrosion (SSWC). He holds a Bachelor’s degree in Mechanical Engineering from the University of Houston and is currently pursuing his Master’s degree in the same field at the University of Houston.

216 Cont'd

Carlos Iván Berrones Mar is an Integrity Engineer at ROSEN, specializing in pipeline integrity and anomaly assessment. He holds a degree in Geological Engineering from Universidad Autónoma de Nuevo León, México. With more than a year of experience at ROSEN, Carlos has contributed to numerous Selective Seam Weld Corrosion (SSWC) service projects for clients in the USA and Canada, as well as Fitness For Purpose (FFP) evaluations in Mexico. His current work focuses on geometric anomalies, including bending strain and pipeline movement.

Nick Brazier has four years of experience at ROSEN, focusing on corrosion growth analysis, fitness-for-service evaluations, and selective seam weld corrosion. His work also includes supporting facility integrity projects, contributing to integrity management practices across the industry. Nick's goal is to support the development of innovative solutions that improve pipeline reliability and safety and continue to improve asset performance and risk mitigation in the industry.

Simon Slater is with ROSEN in Houston, Texas.

221

Using Axial Strain Data to Improve Strain Relief Projects

Sylvain Cornu[1], Teko Hanvi[2], Jared Kowis[2], Heidi Manicke[3], Doug Dewar[3]

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Landslides are a prevalent threat to pipelines and are actively managed through geohazard management programs. As the ground movement progresses and the loads on the pipeline increase, a pipeline operator must design and implement a mitigation plan. Mitigation may take many forms including stress relief by excavation, reinforcement of girth welds, or slope stabilization.

The strain mitigation design and timing will rely on estimating strain demand on the pipeline. ILI tools equipped with IMU can identify bending strain levels along the pipeline. If installed, strain gauges can monitor from the time of installation the longitudinal strain (axial and bending) at discrete locations. Additional information such as ground movement monitoring, slope inclinometer, or LiDAR helps to build a better picture of the soil interaction and the strain demand. However, historically it has been difficult to quantify the amount of axial strain present in the pipeline, since it often does not result in IMU bending strain changes and is often discrete and may not accumulate at the location of the strain gauge installation

In the case study presented, a complex slope at a river crossing presents two distinct areas of instability. A lateral slide at mid-slope oblique to the pipe and a longitudinal landslide at the bottom of the slope parallel to the pipe. The mid-slope, due to its oblique movement, was clearly identified in IMU bending strain data and monitored using repeat ILI inspection. The lower slope being parallel to the pipeline can potentially induce elevated compressive strains at the bottom of the slope. An FEA (Finite Element Analysis) model was developed and calibrated using the mid-slope bending strain to predict the axial strain components. A strain relief mitigation was initially planned to expose both sections of the slope based on the ILI and FEA results.

Prior to executing the strain relief, an additional technology was deployed to better estimate the axial strain component in the form of an ILI Strain tool capable of measuring both axial and bending strain. While the bending strain derived from the IMU and the Strain tool agreed in terms of location and magnitude, the axial strain profile predicted by the FEA seems to have overestimated the compressive axial strain at the bottom of the slope and underestimated the tensile axial strain mid-slope.

Considering the new data, the strain mitigation scope was revised to focus on the mid-slope section only in the absence of significant axial strain as measured by the ILI tool on the bottom slope. By deploying the additional ILI strain tool, the pipeline operator was able to target the mitigation effort and cost on the high-risk area in the mid-slope but also provided direct measurement in the bottom slope for ongoing monitoring efforts.

Sylvain Cornu holds a master's degree in mechanics and has been working as a research engineer for 15 years in the oil & gas industry developing new inspection technology. Primarily focused on Eddy current based measurement, the presenter has led the development of ILI tools to measure external load on pipeline induced by construction and geohazard.

Teko Hanvi is with Enbridge in Houston, Texas.

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222
Development and Validation of a Novel Gas Crack Detection Tool Using Guided Waves

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[1]Enbridge Inc., Houston, USA. [2]NDT Global, Stutensee, Germany. [3]NDT Global, Bergen, Norway. [4]NDT Global, Barcelona, Spain

In this paper, the authors discuss the development and validation of an inline inspection (ILI) crack detection tool for gas pipelines that uses guided waves (Lamb waves). The development is the result of the partnership between operator (Enbridge) and ILI vendor (NDT Global) as a consequence of the performance of the current available technologies. The goal of the development aimed to detect stress corrosion cracking (SCC) and cracks with improved identification and sizing accuracy.

The paper examines the use of Lamb waves for pulse-echo and pitch & catch measurement techniques to address SCC and cracks. It also describes results from small-scale tests conducted in a hyperbaric chamber with nitrogen as the coupling medium, as well as large-scale tests using natural gas in a purpose-built test rig. Both testing environments and feature types used during validation were selected to closely replicate real-world conditions, providing data necessary to confirm the system and service performance.

In the small-scale tests, the tool's performance was assessed and a preliminary specification established. The same sample features were evaluated in natural gas during the large-scale tests, allowing comparison between the two gases for future developments.

Validation results indicate that the data gathered by the tool can be used to accurately detect SCC and cracks, identify and size relevant features, and aids in the discrimination of non-linear features like corrosions as in many cases it is insensitive to them and these are not recorded. This characteristic is intended to reduce false positives and increase the reliability of the inspection process. The paper provides information on the development and validation activities, outlining the potential application of the tool for crack detection in gas pipelines.

Yvan Hubert is with Enbridge in Houston, Texas.

Debartha Bag is with Enbridge in Houston, Texas.

Michael Haas holds the position of Head of Sensor and Measurement Technology at NDT Global. He has been working for close to 20 years in the technology development of in-line inspection systems, with expertise in single element and phased array ultrasonics in liquid pipelines, gas-coupled ultrasonics, EMAT, MFL, data visualization and analysis, and signal conditioning. He leads an international team of engineers and scientists supporting the current operational business and driving future technology developments.

Rogelio Guajardo is Director of Product Manager Gas at NDT Global, with 16 years in the industry. Rogelio oversees the strategy and roadmap for the Gas division. Formerly, he led the global data analysis team, driving accurate results, and contributed to crack detection tool development for liquid pipelines. He participated in developments such as Enhanced Sizing, Eclipse UCx, Proton, and Cracks in Dents Diagnosis.

Joaquin Aparicio received his Physics degree from the University of Extremadura (Spain) in 2008, and his PhD degree from the University of Alcala (Spain) in 2014. From 2015 to 2018 he was a Post-Doctoral Researcher with JAMSTEC (Japan), and from 2018 to 2022, a Post-Doctoral Fellow with the University of Oslo (Norway). Joaquin joined NDT Global in 2022, and since 2023 he is the Team Lead of the Sensor and Measurement Technology Gas group, where he coordinates the technical activities related to the measurement principle of NDT Global's gas crack detection service. His research interests include acoustics and signal processing.

Thomas Hennig see #151

227

Overcoming the Unpiggable: Full-Length Internal Inspection of Crude Oil-Filled Marine Terminal Loading Lines Using ART Scan and Robotic Crawlers

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This paper describes the engineering development and field deployment of a tethered robotic internal inspection system capable of delivering ILI-grade data in such conditions. The system integrates a robotic crawler platform with an acoustic resonance-based inspection module to obtain full 360° wall-thickness measurements in pipelines containing crude oil, sludge, and asphaltene deposits.

The work was performed for a major terminal operator and involved two offshore loading lines forming part of a marine crude transfer system. Each line extended more than one kilometer and featured multi-bend geometry and a significant vertical riser section, requiring the inspection system to climb through substantial elevation change within the pipeline. The inspection was conducted from a single onshore entry point without the need for cleaning, flushing, or pipeline modification.

This case study demonstrates that pipelines once considered unpiggable can now be internally inspected with minimal disruption. The success of this campaign has prompted Buckeye to plan further inspections using the same approach, setting a new benchmark for integrity management in challenging environments.

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231

An Operator's Practical Approach for Evaluating and Prioritizing ILI-Reported Dents

Rick Wang, Connie Meksavanh, Tao Hu, Jaspal Deol

TC Energy, Calgary, Canada

Pipeline dents — caused by external forces impacting the pipeline surface — pose significant integrity risks due to their potential to trigger immediate or delayed failures. While In-Line Inspection (ILI) tools are commonly used to detect and manage dents, accurately evaluating and prioritizing critical injury dents that require immediate action remains a complex challenge.

This paper introduces a practical, combined assessment methodology for pipeline operators. It integrates dent strain damage criterion with ILI signal characteristics to effectively identify dents associated with corrosion, gouging, or cracking. Furthermore, an enhanced technique is presented to distinguish between plain dents and mechanical damage, particularly for topside dents. Case studies are included to illustrate the effectiveness of this integrated approach in identifying high-risk dents that require immediate attention, as well as the enhanced method for identifying mechanical damage.

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240

Enhancing Pipeline Integrity with Vibroacoustic Technology: A Case Study of Real-Time Pig Tracking and Leak Detection

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Pipeline inspection gauges (Pigs) are vital tools in maintaining and monitoring pipeline health by clearing material and fluid buildup within a line or in the case of in-line inspection (ILI) tools, offering insight on the condition of the pipeline. Manual pig tracking can be time and resource consuming as well as increased risk of injury to personnel due to pipeline right of way (ROW) and public road exposure. A means of accurately monitoring pig location and velocity in real time has the potential to save operational costs, reduce pipeline downtime, and eliminate costly reruns of tools that require consistent run velocities.

In this study, vibroacoustic technology (VT) was applied in a non-invasive and easily retrofittable layout, through the installation of vibroacoustic sensor blocks – comprising a pressure gauge, hydrophone, and accelerometer – at valve stations on PETR-TVIO 16, a 61.5-mile long, 30-in natural gas pipeline section, to monitor a cleaning pig campaign culminating in an IL I tool run. Leak tests were also run by throttling product from the pipeline through designed orifices to the atmosphere to simulate various diameter leaks between monitoring sensor blocks.

During the cleaning run manual tracking was unable to follow the cleaning pigs through the entire run as a result of accessibility issues, leading to uncertainty regarding the pig's location for 40 miles of the run; VT, on the other hand, was able to continuously track the pig through the run, providing tracking and the velocity of the pig every 2 minutes. While the ILI tool did measure location and velocity during the run, these data were available only after the run was completed and could not assist in the operation. The data collected by the ILI tool confirmed the tracking capability of the vibroacoustic sensor blocks. (NB: the ILI tool was tracked manually and the data correlated well with the VT tracking). Leak tests performed following a calibration phase detected simulated leaks using 1-, 0.5-, 0.37-, and 0.25-in-diameter orifices, with a 19.4-mile separation between the two nearest sensor blocks.

The study successfully monitored a pigging campaign and detected simulated leaks, demonstrating that VT presents a multifaceted value proposition for pipeline integrity and monitoring operations.

Adnan Chughtai is the Global Pipeline Integrity Business Manager at SLB, based in Houston, Texas. With over 13 years of industry experience, Adnan leads SLB's global portfolio of hardware and digital technologies in the pipeline market. He is responsible for driving market expansion, forging strategic partnerships, and advancing innovative solutions that address the evolving needs of pipeline operators worldwide. Holding a master's degree in aerospace engineering from the University of Manchester, Adnan combines deep technical expertise with a strategic market perspective to shape the future of pipeline integrity management.

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240 Cont'd

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242

Field Simulation Material Property Verification Trial

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This is based on a study that was performed by Enbridge in conjunction with Stress Engineering to compare the 3 most widely used in-situ material property verification tools based on realistic conditions on vintage pipe. There is plenty of historical work presented by the manufacturers of the equipment (MMT, Frontics, Plastometrex) however all of this was performed by experts in the field who also design the equipment.

The objective of the study was to produce realistic results by using trained NDE technicians to operate the equipment with the manufacturers only being allowed to provide non-contact support simulating what they could feasibly do during an excavation where they are not onsite. The results of the testing clearly show that it makes a difference, not necessarily in the tool material property results, but the compliance and test location selection.

The methodology applied was to treat this as if each of the 18 samples was a separate site. Have the NDE technician armed with their procedures and the information that we wanted a 49CFR192.607 compliant inspection. They were given all the time needed to perform the work and produce their reports with minimal interaction between the crews. Samples for destructive testing were sourced from the same locations as the in-situ methods to provide a direct test of their results.

The results of the testing showed that with the instructions given the technicians were able to perform the work, however a non-compliance issue occurred because the technicians had a question about the locations and instead of asking the Client/Operator they asked their manager and he gave a non-code compliant answer. The inspection should be in 2 quadrants however he instructed them to just do 2 locations site by side. There is also one joint where the seam was incorrectly identified by 2 of the technicians so their data for the seam location is not accurate as they were 180 degrees off the seam. The overall results of the in-situ testing vs the destructive testing supports the claims by the manufacturers and is in line with the data they provide, but the errors highlighted additional training needs for both NDE vendors and operators.

The implications based on the results are that although the tools are accurate and can give quality data, the human factors need to be controlled in order to maintain compliance.

Samuel Kindel is a pipeline integrity and NDE specialist at Enbridge, where he leads initiatives in ultrasonic testing, phased array, and in-line inspection (ILI). With over a decade of experience, he has held roles including Advanced Ultrasonics Manager and ASNT Level III across multiple disciplines. Samuel has also worked as a consultant and project lead, applying advanced inspection technologies to ensure pipeline safety and reliability. His expertise has been featured at major industry events.

Brent Vyvial is with Stress Engineering in Houston, Texas.

243
The LTS Futures Project – an Update of a UK Operator's (SGN) Experience of Assessing the Feasibility of Repurposing Their Natural Gas Transmission System to Transport Hydrogen

Gary Senior[1], Jane Haswell[1], **Gemma Simpson[2],** Nancy Thomson[2], Max Koronka[2], Andrew Cosham[3]

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The Local Transmission System (LTS) is the backbone of the United Kingdom (UK) energy network, delivering natural gas from the National Transmission System (NTS) to towns and cities across the country. The four Gas Distribution Networks (GDNs) operate approximately 11,000 km of high-pressure pipelines, operating at pressures above 7barg. The pipelines were originally designed to transport and store natural gas. The UK Hydrogen Strategy states that: "Low carbon hydrogen will be critical for meeting the UK's legally binding commitment to achieve net zero by 2050". Hydrogen behaves differently to natural gas, therefore it is necessary to assess how it affects the existing LTS infrastructure.

The LTS Futures Project is a first of a kind, £30 million, joint funded project between SGN, the UK energy market regulator OFGEM, and the other UK GDNs. The project is led by SGN and has repurposed a 30 km natural gas transmission pipeline to hydrogen for a live demonstration trial, which will inform the development of a Blueprint methodology for repurposing the LTS. The LTS Futures Project is researching, testing and collating evidence to understand the compatibility of LTS assets, pipelines, associated plant and ancillary fittings in hydrogen which will be captured in the Blueprint.

This paper provides details on the technical approach adopted by the project, the progress to date and the plan going forward.

Gary Senior has worked in the pipeline industry for over thirty years. Gary previously worked at the British Gas engineering research facility for 10 years, then was Lead Engineer for the 13,000 mile UK gas transmission network, and for the past 24yrs as a Principal Consultant with Pipeline Integrity Engineers, working on integrity studies, innovation projects and as Competent Person under UK and Irish legislation. Gary is a Chartered Engineer and a Fellow of IGEM and IMechE.

Dr. Jane Haswell is a Chartered Mechanical Engineer, who worked in the UK gas industry for over thirty years, in R&D and then transmission engineering support. Jane joined Pipeline Integrity Engineers in 2001 as Principal Consulting Engineer, and has worked in pipework and pipeline stress analysis, pipeline fatigue and fracture mechanics analysis and pipeline and installation risk. She is Chair of the IGEM/TD/1 Panel, and represents IGEM on the BSI PD 8010 Committee.

Nancy Thomson is a recognised industry leader with over 15 years' experience in pipeline integrity, spanning inspection, remnant life, risk assessments, R&D, design, construction and commissioning. This expertise has led Nancy to chair industry bodies standards groups, and participation in governments key groups established under the 10-point plan to deliver net zero. Leveraging her technical experience and strong interpersonal and relationship skills Nancy successfully secured £30 million of R&D and private funding to investigate repurposing and uprating over 11,000km of high-pressure pipelines to hydrogen across GB.

Gemma Simpson is a Chemical Engineer with an MSc in Fire and Explosion Engineering and the Live Trial Operations Manager for the LTS Futures project. Prior to joining SGN, Gemma was a project engineer delivering research and test programs related to the use of hydrogen.

Max Koronka is a project manager working as part of the LTS Futures project team delivering a first-of-a-kind project, repurposing a natural gas pipeline to transport hydrogen. Max has a background in offshore oil & gas and renewables material development and testing. He has broad experience in qualification test programmes and test development.

243 Cont'd

Dr. Andrew Cosham is an independent consultant. He has worked in the oil and gas industry for over thirty years. Andrew was previously employed by Atkins, Penspen/Andrew Palmer and Associates, and the Research & Technology Division of (the then) British Gas. Andrew is a Chartered Engineer and a Fellow of the Institution of Mechanical Engineers. He is a member of two technical committees of the British Standards Institution: PSE/17/2 - Transmission pipelines and WEE/37 - Acceptance levels for flaws in welds.

244
Monitoring Pipelines in Landslide-Prone Areas with An Automated Strain Gauge Data Analysis Tool: "Strain Gauge Module"

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The pipeline industry has been using vibrating wire (VW) strain gauges for monitoring pipelines traversing through landslides for the last 60 years. Strain gauges are typically installed in a rosette of three to four gauges at select locations along the pipe segment affected by the landslide. Data recorded from each gauge is typically collected in near real-time if the gauges are connected to a telemetry station that automatically transmits data from the site.

Strain gauges provide strain change measurements at pre-determined locations along the pipe segment since the installation of these strain gauges. In contrast, the Inertial Measurement Unit (IMU) bending strain plots provide continuous bending strain data along the segment of pipeline at the tool run date, and the strain change for subsequent IMU runs (e.g., every 1 to 10 years). Strain gauges allow pipeline operators to monitor strain accumulation on the pipe in between IMU runs and provide early notification if an intervention is needed to reduce the integrity risk on the pipeline due to a geohazard.

The strain gauge data plots are commonly presented as strain changes for each strain gauge's location (e.g., 3 o'clock, 9 o'clock, 6 o'clock, and/or 12 o'clock) and the difference between the strain changes of two gauges (i.e., divergence). This paper presents an automated data analysis tool (i.e., Strain Gauge Module) that processes and analyzes the strain gauge data in near real-time and converts the strain changes measured at various locations around the pipe into a strain change distribution around the pipe. The Strain Gauge Module tool calculates the maximum tensile and compressive bending strain change, direction of pipe bending, and changes in the axial strain that are typically not calculated from an IMU tool run. These data are then automatically visualized and plotted, which can be utilized by Geohazards Integrity Engineers to make informed decisions.

Sample case studies will also be presented in this paper to highlight the implementation of the Strain Gauge Module tool on pipeline monitoring in landslide-prone areas during the monitoring and mitigation stages (i.e., strain relief, engineering mitigation).

Debora Martogi, PhD, EIT, is an Engineer with 7 years of experience in engineering consulting, including 3 years in pipeline geohazards management. Her area of expertise includes geohazard instrumentation, data engineering and management, solutions engineering, and integration of bending strain data with geohazards and water crossing threats. Debora has contributed to several publications on geohazards, instrumentation, monitoring, and bending strain.

Arash Mosaiebian, P.Eng., PMP, is a Senior Pipeline Geohazard Engineer with over 15 years of international experience in geohazard management and geotechnical engineering. Arash has contributed to the development of tools for strain gauge data analysis and geohazard mitigation, supporting cost and time savings for pipeline operators. Arash has authored several technical publications and has been involved in implementing geohazard management programs, with a focus on advancing pipeline safety through collaborative, data-driven approaches.

Ali Ebrahimi, PhD, PE, is a Senior Principal Engineer with 18 years of experience. His practice primarily focuses on pipeline geohazard management, geotechnical engineering, and instrumentation technologies. He specializes in subsurface characterization, slope stabilization, ground improvement, and foundation design, with a strong focus on mitigating geological hazards affecting pipelines through innovative applications of LiDAR and IMU ILI technologies. Ali has led the development of advanced geotechnical and structural monitoring systems for critical infrastructure and currently manages a nationwide program overseeing thousands of daily data points. He has contributed to key industry publications, including AASHTO's Manual on Subsurface Investigations and INGAA's Guidelines for Management of Landslide Hazards for Pipelines.

244 Cont'd

Amir Ahmadipur, PhD, PE, is a geotechnical engineer with more than 7 years of experience in pipeline geohazards. His areas of expertise include geohazard mitigation design, geotechnical instrumentation and monitoring, data management, geotechnical analysis and design, and foundation engineering. He has designed and overseen geotechnical monitoring programs to ensure safe and reliable pipeline operations, integrating advanced technologies for data collection, processing, and interpretation. He has authored several technical publications related to geohazard mitigation and monitoring.

248
A Case Study on the Use of Flaw Spools for ILI Validation

Ben Hanson[1], Christopher De Leon[1], **Nima Parsibenehkohal[2]**, Rachel Brossman[2], Santiago Urrea[3], Roberto Yanez[3]

[1]D2 Integrity, Houston, USA. [2]PBF, Torrance, USA. [3]NDT Global, Houston, USA

This paper provides a case study on how a pipeline operator used a flaw spool to support ILI Tool Selection and ILI Performance Validation to meet regulatory requirements and remove a pressure restriction on a refined products pipeline in California. Federal regulation in the United States requires pipeline operators to abide by guidance in API STD 1163, namely 49 CFR 192.493 and 195.591.

Validating ILI performance can be costly if post-ILI digs are used as the basis for collecting data. A cost-effective alternative is to leverage the use of fabricated flaw spools if they are properly designed and fabricated. Historically, flaw spools are used by ILI service providers to establish their performance specifications and demonstrate ILI capabilities. These flaw spools are often fabricated with simple and blunt characteristics that do not represent the complex pipeline defects operators are assessing with ILI. Flaw spools created for crack-inspection technologies often utilize an electrical discharge machining (EDM) process that generates relatively blunt flaws which are not truly representative of the crack-like flaws found in pipelines. However, these EDM notches because they can produce distinct signal reflections. This case study utilized a flaw spool that more accurately mimicked the profile of hook cracks and axially oriented cracks. Typical EDM notches were used to represent lack of fusion.

This paper demonstrates how the flaw spool was able to provide confidence in NDT Global's UCx Eclipse ILI crack technology's performance including both probability of detection and probability of identification to discriminate between lack of fusion, hook cracks, and axial cracks. The results provide confidence confirmed the ILI technologies capabilities for cracking while also identifying select challenges. The results, in addition to field investigations, gave both the pipeline operator and regulators confidence in the integrity assessment and ultimately restoring operating pressure.

Ben Hanson has twenty years of experience in the pipeline industry with time working for consultants, operators, and contractors. Ben has expertise with in-line inspection validation, inspection technology review, and nondestructive testing. His current work focuses on dents, cracking, and ILI assessments. Ben has a B.S. in Mechanical Engineering from Iowa State University and an M.B.A from Rice University.

Christopher De Leon has 17 years of experience working in Pipeline Integrity and specifically with ILI technology. He currently serves as the Director at D2 Integrity, LLC. At D2 Integrity he provides consulting services to clients related to regulatory compliance, fitness for service, ILI best practice, and strategic advising. Prior to working at D2 Integrity, he started his career as an Integrity Engineer at Energy Transfer and later as Head of Integrity Solution and Advanced Diagnostics at ROSEN. Christopher also serves on various API technical committees working on best practices.

Nima Parsibenehkohal see #110

Rachel Brossman see #114

Santiago Urrea is the Director of Analytics and Integrity Solutions at NDT Global, where he brings over 10 years of experience in pipeline inspection and integrity management. He holds a bachelor's and master's degree in mechanical engineering, along with a Level III certification in shear wave analysis. Santiago has extensive global experience delivering in-line inspection (ILI) reports to pipeline operators, providing actionable recommendations and strategic integrity consulting. His leadership supports the development of advanced analytics solutions that enhance the safety, reliability, and performance of critical pipeline infrastructure.

248 Cont'd

Roberto Yanez is the Head of Data Analytics in the US at NDT Global, role in which he leads a group of ten Data Analytics Project Leads that work directly with Pipeline Operators. He has more than 15 years of experience of Oil & Gas Industry in which he has developed experience in several roles such as Project Manager, Data Analyst, Project Leader and Product Manager. He holds a Bachelor of Systems Engineering degree. He has developed extensive experience in ILI industry, regulatory and operator's specific requirements to provide insightful results from ILI data.

250
An Improved Fracture Model for Assessing Crack-Like Flaws in Pipelines

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Cracks and crack-like flaws pose a significant risk to the integrity of operating pipelines. A reliable method for predicting burst pressure and remaining life in pipelines that contain crack-like features is of paramount importance. Pipeline fracture models have evolved significantly since the early1970s, when Battelle developed the original Log Secant model. The PRCI MAT-8 fracture model, which was published in 2015, represented a significant advance over prior methods. The MAT-8 model was fit to approximately 200 3D finite element models of pipe joints with axial cracks. MAT-8 has seen widespread adoption in the pipeline industry over the past decade.

The authors recently completed a major study that generated over 2,000 3D finite element solutions for cracks in pipes. The new solutions, which will be incorporated into the 2026 edition of the API 579 Fitness-for-Service Standard, cover a wider range of cases than the original MAT-8 work. For example, the new solutions include circumferential cracks subject to axial and bending loads. For cases where the new solutions overlap with the existing MAT-8 solutions, the former are more accurate than the latter. Therefore, the authors believe that MAT-8 should be phased out in favor of the FEA-based crack assessment procedure in the new release of API 579.

Ted Anderson is an internationally recognized expert in fracture mechanics and fitness-for-service methods. He is the author of a best-selling book on fracture mechanics, which has been adopted as a required text in over 150 universities throughout the world. He is a founding member of the committee that writes and maintains the API 579 fitness-for-service Standard, and he is the developer of the PRCI MAT-8 pipeline fracture model. During his career, he has held positions at a number of organizations, including TWI, Texas A&M University, Quest Integrity, and Team Inc. He founded a consulting and software company in 1995, which was acquired by Quest Integrity in 2007. He holds a Ph.D. in metallurgy from the Colorado School of Mines.

Robert H Dodds' primary research efforts explore the processes and modeling of fracture in structural metals under static, dynamic and environmental loading. The work considers fracture at length-scales from full-size structural components, to small laboratory specimens, to the scale at which discrete features of the microstructure dominate. The research relies strongly on integrated experimental-computational approaches for validation and to transition research discoveries into engineering codes and standards.

Thomas Dessein see #194

255

Joint-Based versus Segment-Based CGRs – A Case Study

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In-line inspection (ILI) run-to-run comparisons are a cornerstone of pipeline integrity management. By tracking changes in measured metal loss (corrosion) anomalies between successive inspections, integrity personnel can pinpoint which anomalies are accelerating toward criticality and which may no longer warrant immediate excavation. This targeted insight not only helps to re-prioritize digs—removing lower-risk anomalies in favor of those growing the fastest—but also maximizes limited excavation budgets and minimizes overall system risk. Corrosion growth rates (CGRs) from ILI run-to-run comparisons can be derived using various workflows. For this study, the following methods were utilized:

- Statistical segmentation approach
    1. Establish CGRs on statistically prominent sections of the pipeline by grouping anomalies into regions of similar susceptibility, pipe-tally, and engineering judgment and assigning each section a single, characteristic CGR (typically the maximum historical CGR).
- Joint-based approach
    1. Establish CGRs for each individual pipe joint by directly comparing its reported anomaly depths between ILI surveys, calculating a unique CGR per joint based on the change in wall-loss over the inspection interval.

Both the statistical segmentation and joint-based approaches are regularly used within the industry to establish CGRs. The statistical segmentation method simplifies integrity planning by assigning one characteristic CGR per corrosion-susceptible region. However, because the approach is based on a chosen population statistic, it can veer into over-conservatism (triggering unnecessary excavations) or, conversely, under-conservatism if localized peak growth is masked. By contrast, the joint-based approach calculates a unique CGR for each pipe joint by directly comparing depth measurements between the subsequent ILI surveys. The joint-based approach often yields more realistic, localized corrosion growth estimates, albeit with greater scatter from measurement noise and stochastic behavior.

In this case study, the authors applied both approaches to ILI datasets from two consecutive inspections on the same pipeline asset. First, the authors generated characteristic segment CGRs by clustering anomalies via statistical models based on anomaly density, integrating pipe-tally transitions (grade, diameter, coating, welds, etc.), rationalizing the resulting sub-segments, and assigning each segment a CGR based on maximum or 95th percentile values. The authors then computed joint-specific CGRs by directly measuring wall-loss changes at every inspected joint between the subsequent ILI surveys. When both approaches were applied to evaluate remaining lives of ILI-reported metal loss anomalies, the statistical segmentation approach indicated a need for excavations at nearly 33% of ILI-reported corrosion anomalies, whereas the joint-based method cut that down to just 3%. Moreover, the joint-specific analysis uncovered several localized corrosion hotspots that the segmented approach smoothed over. This demonstrates that using segment-level rates for system-wide budgeting and inspection planning, paired with joint-specific CGRs for precise excavation prioritization, achieves the best balance of conservatism, risk mitigation, and resource allocation.

255 Cont'd

Zaki Hassan joined DNV after completing his bachelor's degree in mechanical engineering from Ohio University, where his early research centered on metal extrusion processes and metallurgical behavior. He is currently a Pipeline Engineer within DNV's Integrity Solutions & Compliance group, where he supports pipeline integrity assessments. Mr. Hassan also serves as the Columbus, Ohio Chapter Lead for Young Pipeline Professionals (YPP USA), where he coordinates industry engagement for emerging professionals in the region. He is actively involved in multiple Pipeline Research Council International (PRCI) initiatives, contributing to research activities that advance ILI technology performance, data integration, and integrity-assessment practices across the industry.

Matt Ellinger is a Principal Engineer within DNV's Integrity Solutions & Compliance team in Columbus, Ohio. He obtained his Bachelor of Science degree in Mechanical Engineering from The Ohio State University in 2006. Mr. Ellinger has over 19 years of pipeline integrity experience with a focus on ILI projects. Mr. Ellinger has authored 10+ papers on Integrity Management topics and has instructed various Clarion and SGA courses.

Joshua J. Kuennen is a Staff Engineer at CenterPoint Energy based out of Minneapolis, MN. He obtained his Bachelor of Science degree in Civil Engineering from The Iowa State University in 2011. Mr. Kuennen has over 14 years of transmission integrity management experience in the industry.

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256

Screening and Mitigation Criteria of IMU Bending Strain for Geohazards Management

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IMU is becoming one of the most widely used tools in geohazard management. IMU outputs, such as centerline position and bending strain, are used as an early go-to data source. It is a common practice to set a threshold strain value for screening the reported bending strain features to determine if further actions are needed. Integrating other data sources is often necessary to confirm the impact of a geohazard. A different mitigation threshold may also be applied when making mitigation decisions.

Effective screening and mitigation thresholds may be established based on the strain tolerance (strain capacity) of a pipeline segment. Underestimation of the strain capacity can lead to unnecessary mitigation work, while overestimation of the strain capacity can lead to mitigation work not being done in a timely manner. Incidents have occurred due to overestimation of strain capacity.

This paper shows the development of screening and mitigation criteria through example problems. The development process involves two key components. The first component is the estimation of total strain demand and proper handling of potential under- or over-estimation of total strain demand from reported IMU bending strain. The second component is establishing the strain demand limit using appropriately determined strain capacity.

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259

From Digs to Data: Integrating ILI and Environmental Insights for SCC Predictive Modeling

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Stress Corrosion Cracking (SCC) poses a significant threat to pipeline integrity, and Electromagnetic Acoustic Transducer (EMAT) tools are widely used to detect cracks as part of integrity assessments. However, EMAT inspections can be constrained by factors such as inspection frequency, tool availability, in-line inspection (ILI) tool performance, and operational challenges. In scenarios where alternative assessment methods—such as SCC Direct Assessment (SCCDA) or hydrostatic pressure testing—are not feasible, predictive modeling and machine learning offer a valuable opportunity to support SCC threat management. By leveraging data collected from pipeline digs, ILI runs, and environmental factors, these models can help prioritize future EMAT inspections and identify susceptible pipeline segments with the highest likelihood of SCC, enabling more targeted and efficient SCC threat management.

This paper presents TC Energy's collaboration with Pipeline-Risk (PLR) to develop a classification-based machine learning model aimed at predicting SCC likelihood across TC Energy's pipeline assets. The model integrates a wide array of data, including Magnetic Flux Leakage (MFL) inspection results, dig data (covering defects and coating), and environmental variables such as soil texture, temperature, and precipitation. The model was validated on a subset of pipeline systems and demonstrated strong predictive performance. This work highlights the value of machine learning in enabling data-driven threat assessments, offering insights into SCC-susceptible segments and supporting risk-informed decision-making.

Syed Aijaz is currently a pipeline integrity engineer with TC Energy where he supports the SCC threat management program and data-driven initiatives. Prior to TCE, he worked as an asset integrity consultant in the downstream sector. He is currently pursuing a master's degree in data science from UT Austin.

Michael Gloven leads Pipeline-Risk (PLR) providing AI based machine learning solutions supporting energy pipeline systems and utilities worldwide. With over 30 years of experience in the oil, gas, and water industries, Mike has founded, co-founded or led numerous technology companies with the objective of improving reliability, risk, integrity and compliance for asset owners and operators.

260

A Comprehensive Engineering Assessment Procedure for Dent Coincident with Secondary Features

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Dents and mechanical damage in pipelines present an immediate and potentially long-term threat to pipeline integrity, necessitating proactive management. A dent in the pipeline represents a permanent deformation caused by plastic strain; therefore, strain-based analysis is a more relevant approach to quantify dent severity. Several types of dents exist in pipelines, including plain dents and those associated with secondary features such as welds, corrosion, gouges, or cracks. Dents with coincidence features present two types of threats to the pipeline: (1) the potential risk of crack initiation or diminished integrity due to the presence of a weld flaw or reduced wall thickness in the metal loss volume of the dent; (2) delayed fatigue failure driven by internal pressure cyclic loading. ASME B31.8 states that the allowable strain limit for a dent associated with a weld is 4%, provided the weld is ductile and of good quality. However, it does not provide a dent-weld interaction criterion and its effect on the dent strain. When assessing dents with a depth of less than 6% OD associated with corrosion, they can be evaluated independently according to the ASME B31.8 deformation-induced strain criterion and the corrosion failure pressure criterion, as outlined in ASME B31G. Furthermore, API RP 1183 allows the operator to assess the impact of features that geometrically coincide with dents in integrity assessment and management.

This paper outlines the process for dent engineering assessment, including guidelines and procedures specified in 192.712(c) of the CFR. The assessment involves multiple analysis components. A detailed explanation of each component is provided, accompanied by real-world examples that cover input data, data integration and interpretation, threat identification, application of the material's stress-strain curve to evaluate the SLD and DFDI, fitness-for-service evaluation, and preventive and remedial actions. This assessment process will help pipeline operators reliably and comprehensively evaluate both short- and long-term integrity threats of dents associated with secondary features.

Uday Arumugam, Senior Engineering Advisor (Pipeline Integrity) at Blade Energy Partners Ltd, with 30 years of experience in the application of advanced engineering to complex pipeline integrity problems and upstream engineering. He has authored numerous journal and conference publications on pipeline integrity and advanced engineering mechanics. He has extensive experience in ECA of pipeline dents, dents with coincident anomalies, fatigue, material damage, and others.

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261
A Comparative Methodology for the POE Assessment of Corrosion vs. Crack Defects

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The probability of exceedance (POE) method refers to the likelihood that a defect exceeds a specific limit or threshold, such as pressure or depth. This concept is essential in risk-based pipeline management, as it helps operators to assess and mitigate potential failures before they occur. The approach also provides an advantage over integrity management decisions based on a deterministic criterion, where a limit threshold is based purely on a given defect size, rather than the probability that a defect could exceed a limit based on incorporating several variables beyond simply length and depth. Probability of exceedance is already commonly used for corrosion defects, partly because these have a more extended history of evaluation, and in-line inspection (ILI) technologies can report metal loss with better sizing accuracy, providing uncertainty limitations that are manageable.

Ultrasonic crack detection tools provide reasonably accurate sizing data for crack-like defects, while magnetic flux leakage (MFL) technologies in combination with stress measurement sensors are rapidly improving and can provide data that can be assessed similarly, minimizing the uncertainties in the sizing of defects found during the inspection. The evaluation methods for corrosion related defects, such as modified B31G or RSTRENG, are relatively simple compared with those for cracking defects, which require additional inputs, such as material toughness, and using fracture mechanics algorithms to determine the fitness for purpose of the anomalies. Standard corrosion POE methodologies typically depend on linear corrosion growth rates. The issue of crack growth is significantly more complex, since fatigue crack growth rates are largely dependent upon pressure cycling. However, approaching fatigue crack growth from a concept of the aggressiveness of benchmark cycles, an approximation can be provided for generalizing multiple scenarios for assessments.

This paper compares the methodologies for determining the probability of exceedance (POE) in pipelines for crack and corrosion defects and presents a case study to evaluate the data provided by an ultrasonic crack tool ILI technology. While more involved, establishing a POE methodology for cracking defects identified by ILI can help operators more accurately estimate the likelihood of rupture and leak, ultimately supporting more risk-informed integrity management decisions for pipelines.

Keywords for subject area: Crack Assessment and Management, Data Management, ILI Analysis, Risk Assessment and Management

Lucinda Smart is a Senior Engineer II with Kiefner and Associates, Inc in Ames, IA. She earned her MS in Mechanical Engineering from Iowa State University. She brings 16 years of experience in the oil and gas industry, working primarily with a wide array of analyses ILI data, including extensive tool validation, material validation procedure development, defect interaction guidance, corrosion growth rate evaluation, and regulatory audit support. Her work has been published and/or presented at several NACE, SGA, QNDE, IPC and PPIM conferences.

267

Automated and Continuous Evaluation and Ranking of Geohazards by Comparing Bending Strain Features Against Geohazard Inventory and Inspection Records

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Enbridge, BGC Engineering, and Cambio Earth have developed a system that enables the evaluation of geohazards using methods adapted from the INGAA Guidelines for Management of Landslides Hazards for Pipelines (August 17, 2020). The system allows for data to be continuously added from vendor bending strain reports and from geohazard professionals who are completing field or desktop-based inspections of hazards.

The data from both inputs are combined in real-time to calculate the rating of a geohazard site on a scale from one to seven that determines the required response by Enbridge's pipeline integrity team. The calculated ratings are stored first as 'pending' results that are available for either subject matter expert review or automated approval, depending on various criteria. Calculated ratings can be compared to historical ratings at the same location to identify whether changes have occurred at the location, or can be compared to other hazard sites (e.g. adjacent pipelines) to determine whether inconsistencies in ratings or to provide early identification of hazards that have not yet impacted the adjacent pipeline but pose a risk in the future which can be mitigated more cost effectively using early intervention.

The result is a system that reduces manual review effort, mitigates potential for unused data, and expedites the identification of potential issues. In addition, integration into a cloud hosted platform with GIS functionality has enhanced Enbridge's ability to access results and to drill-down into the underlying data (i.e. strain features, inspections) driving the rating both at present and over the site history.

Chad Sutherland is a civil engineer and software product manager who is passionate about improving the resiliency of infrastructure and the safety and well-being of the public. Throughout his engineering career, he has worked in the pipeline, mining, and transportation sectors on projects relating to operations, risk management, and environmental performance. Most of his work has been focused on geohazard risk management in the pipeline sector, where he has supported two major pipeline construction projects, completed geohazard assessments across numerous provinces and states, designed and supported construction of hazard mitigation works, and supported extreme hydrologic event monitoring and response programs. In his current role, he manages the development of software and services that are essential to effectively managing geohazard risks to pipeline operations.

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269
Challenges, Considerations, and Practical Solutions for Installing Pipeline Repairs

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The pipeline industry has developed a robust set of procedures for implementing repairs to pipelines at locations identified through various pipeline integrity assessment methods. Requirements for pipeline repairs are found in the federal regulations (49 CFR Part 192 and 195) and in industry codes, including ASME B31.4 and B31.8. A commonly cited reference for pipeline repairs is the Pipeline Research Council International (PRCI) Pipeline Repair Manual (the repair manual), latest edition, [1]. The repair manual describes various pipeline repair methods, including grinding, composite sleeves, full-encirclement steel sleeves (Type A and Type B), and bolt-on mechanical clamps. The manual also includes less frequently used repair methods such as hot tapping, encapsulating with fittings, and epoxy-filled sleeves.

The guidance provided in the repair manual addresses many of the situations commonly encountered during pipeline repairs. The purpose of this paper is to supplement that guidance by describing situations, some commonly encountered and some less frequently encountered, as short case studies. The paper will address some of the risks associated with each situation and recommend techniques that can be used to mitigate those risks during installation of pipeline repairs.

Examples of situations that will be addressed include:

- “Sweating” of an operating pipeline where a welded repair is planned. The sweating is caused by condensation of moisture from warm, humid air encountering a cooler operating pipeline. In the US, the phenomenon occurs more frequently in the summer months at locations downstream from pump or compressor stations where the pipeline has cooled to buried ground temperatures.
- Laminations detected on the carrier pipe, or other manufacturing defects such as ‘burned steel’ in lapweld pipe[2] within the landing zone of a sleeve circumferential weld.
- Considerations for recoating a pipeline after removal of rock or constraining object.
- Sealing the annulus between the carrier pipe and the sleeve of Type A steel reinforcing sleeves to prevent corrosion of the carrier pipe and sleeve.
- Evaluating the risks of fully welding or not fully welding a bolt-on mechanical clamp to the carrier pipe.
- Considerations and recommendations for applying hardenable filler material, when recommended or required, to fill the void or annular space between the carrier pipe and repair sleeve.

1. PRCI Pipeline Repair Manual – 2021 Edition

2. History of Line Pipe Manufacturing in North America, 1996

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269 Cont'd

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275

Improved Framework for Fatigue Life Prediction of Unconstrained Plain Dents and Dents Interacting with Gouges, Weld and Corrosion

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API RP 1183, along with various dent life prediction models (e.g., PRCI), provides a fatigue assessment framework for dents utilizing shape parameters. However, these shape parameters are complex to use when estimating the fatigue life of unconstrained dents and require high-quality ILI data for accuracy. The European Pipeline Research Group (EPRG)/API 579 employs a fundamental fatigue equation widely adopted for dent integrity assessments. Nonetheless, the existing EPRG equations tend to yield overly conservative predictions, which may lead to unnecessary excavation and repair operations. Furthermore, these equations fail to accurately capture the mean stress effects associated with the applied pressure cycles.

This paper presents a comprehensive review of the EPRG 1995/2000 fatigue life prediction models, followed by the proposal of an updated methodology for assessing the fatigue life of unconstrained plain dents. The refined model introduces a detailed, step-by-step approach to calculating the stress concentration factor for an unconstrained dent, incorporating the effects of both mean stress and stress amplitude on fatigue life. The influence of ovality, pipe geometry, and dent morphology, as well as their relative contributions to overall fatigue life, is analyzed through finite element modeling and validated with experimental data from previous studies. Experimental results from PRCI MD 4-2, MD 4-11, MD 4-14, MD 4-15, and additional datasets are utilized for the final model validation. This study further explores the verification of the modified EPRG equation and develops a methodological framework for validating fatigue life prediction models for unconstrained plain dents, including those with gouges, welds, and corrosion. Additionally, it establishes a life estimation framework for corrosion that may potentially evolve into crack formation.

Dr. Shree Krishna is a licensed professional engineer with fifteen plus years of research and industrial experience developing pipeline integrity solutions. Currently, he is focused on resolving engineering problems related to tubular and pipeline integrity, failure investigations, and complex pipeline engineering issues using micromechanical, finite element, and materials-specific experiments.

Rick Wang see #231

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276

What's That Noise? Dealing with ILI Caliper Data Issues

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Advancements in in-line inspection (ILI) tool technology have significantly improved the reliable detection and characterization of dents in pipelines. Are you reviewing the "raw" caliper signal data and incorporating it into your assessments? If you are (and you should) you've probably worked with data that requires intervention prior to utilizing it in your assessment. Practitioners often encounter data that necessitates intervention before it can be effectively used for assessment purposes. Noise within ILI caliper data is common and may arise from various sources, including tool misalignment, sensor position relative to the deformation, tool dynamics, irregularities or roughness on the internal pipe wall surface, and limitations inherent in data acquisition or collection software.

Addressing noise issues in raw caliper data is a critical preliminary step prior to conducting a dent assessment. Addressing noise is complex and serves as the foundation for the entire assessment process. While ILI vendors, pipeline operators, and consultants have developed methodologies and tools to manage such noise, the effectiveness of these solutions can differ depending on the specific type of noise present. In certain rare instances, data quality issues can preclude the possibility of performing a reliable dent assessment.

This paper aims to:

- Present practical examples illustrating different types of noise observed in raw caliper data,
- Categorize these noise types according to tool type, technology, pipe characteristics, and more, and
- Discuss proven approaches for addressing noise and related data quality concerns.

The authors' shared experiences aim to increase industry awareness of this issue and support the ongoing development of innovative techniques to enhance the handling of noise in ILI caliper data.

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Joe Bratton serves as Principal Engineer and Head of the Integrity Solutions and Compliance Department at DNV. With 20 years at DNV, he has developed and implemented pipeline integrity programs, specializing in mechanical damage analysis methods and tools used by the company. Mr. Bratton joined the Pipeline Integrity group at DNV in 2005 and is currently responsible for leading the Integrity Solutions and Compliance Department that consists of over 40 engineers located in the United States and Canada focused on all aspects of pipeline integrity. He is also serving as co-chair of the 2nd Edition of API RP 1183.

Shanshan Wu is a knowledgeable principal pipeline integrity engineer with over 14 years of industry experience. With her extensive pipeline integrity management background, she dedicates to performing ILI assessments, defect FFS assessments, ILI signal reviews, dent ECA, SCCDA, dent, and crack fatigue analyses, integrity impact reviews for pipeline modifications, support integrity management programs, and providing training to various operators. She also provides SME reviews for mitigation planning, in-ditch assessment, and repair. Ms. Wu is the technical expert in stress corrosion cracking (SCC) and mechanical damage. She is the lead engineer in developing services related to dent and SCC management programs. She is also the instructor giving the 1183 dent management course at Clarion.

Rick Wang see #231

281
Leveraging Causal Models and Data Fusion to Assess Pipeline Integrity in the Presence of Ground Movement

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Ground movement hazards present serious risks to buried pipelines and require timely interventions to avoid costly failures. These hazards are characterized by complex geological mechanisms and may deform the pipeline to various degrees depending on environmental conditions and pipeline parameters. As such, there is a wide variety of risk-influencing factors and uncertainties to consider when predicting future ground movement and its effects on pipeline integrity. This makes it crucial for pipeline operators to actively collect pipeline and ground monitoring data and assess pipeline integrity to identify at-risk pipelines before it is too late.

This paper presents a data fusion approach to assessing pipeline integrity using Bayesian networks and longitudinal strain-based design and assessment methods. Probability distributions of strain demand, the strain induced on the pipeline, are assessed using one or more sources of pipeline and ground monitoring data and multiple pipe-soil interaction models from prior research. Pipeline material data and dimensional defect data collected from in-line inspections are then used to calculate tensile and compressive strain capacity distributions. Strain demand and strain capacity distributions are compared to one another to assess the probability of leak/rupture and wrinkling/buckling as well as the additional strain necessary to trigger a failure. The model was applied to a case study concerning a landslide where model-based recommendations were compared to the decisions made by pipeline operators during the ground movement scenario. Case study results showcase the model's ability to leverage all available data and assess pipeline integrity with uncertainty preserved. In practice, this model could be used to identify at-risk pipeline segments that require additional data collection or detailed integrity assessments. Furthermore, this work lays the foundation for the development of advanced decision-making tools for managing pipeline integrity in the presence of ground movement hazards.

Colin A. Schell is an Engineer at GTI Energy where he develops pipeline risk models using Bayesian Networks and advanced material models. Prior to joining GTI Energy, Colin earned his Ph.D. in Reliability Engineering and B.S. in Mechanical Engineering from the University of Maryland.

Ernest Lever has thirty years of experience in the plastics piping field with specific expertise in failure mechanisms of vintage plastic gas distribution pipelines, lifetime prediction and risk assessment, with a major focus on probabilistic risk models as applied to decision support systems.

Katrina M. Groth is a Professor and Director of Reliability Engineering and Professor of Mechanical Engineering at the University of Maryland. Groth specializes in safety, risk, and reliability analysis of energy systems and has published over 175 papers and archival technical reports, created multiple software packages, and holds 2 patents

284
Advancing Seam Integrity on Difficult to Inspect Pipelines: Robotic Inspection of Vintage ERW Pipeline for SSWC, Lack of Fusion, and other Longitudinal Weld Anomalies

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Difficult-to-inspect pipelines, particularly those constructed with vintage electric resistance welded (ERW) seams, continue to present significant challenges for pipeline integrity management. These longitudinal welds are prone to seam-related threats such as selective seam weld corrosion (SSWC), lack of fusion, and other manufacturing-related anomalies that are often undetectable using conventional inline inspection (ILI) tools.

This paper presents the results of a collaborative technology development initiative between Pacific Gas and Electric Company (PG&E) and Intero Integrity Services (Intero) aimed at overcoming these challenges. A segment of 10-inch vintage ERW pipeline, previously difficult to inspect with traditional Circumferential MFL tools, was successfully inspected using Pipe Explorer, an advanced robotic crawler equipped with high-resolution axial magnetic flux leakage (MFL). A follow-up inspection was conducted using the Pipe Explorer circumferential MFL technology specifically designed to assess ERW seam. The combined inspections successfully detected and characterized seam-related anomalies, enabling PG&E to incorporate the findings into their integrity management and risk assessment programs.

This paper demonstrates the viability of Pipe Explorer robotic inspections as a powerful tool for advancing seam integrity in aging pipeline infrastructure and offers a novel approach for managing risk in difficult-to-inspect ERW pipelines.

Ryan Trapp is a Principal ILI Engineer at PG&E with over a decade of ILI experience. Ryan holds a bachelor’s degree in Mechanical Engineering from California State University, Long Beach and is a licensed professional engineer in California. Throughout his in-line-inspection career, Ryan has gained extensive experience in challenging ILI project planning and execution, program management, regulatory requirements, and procedural and process development, contributing to a robust transmission pipeline integrity management program.

Michael Kobelak is a Sr. Sales Account Manager at Intero with over a decade of industry experience. Michael holds a bachelor’s degree in Electrical Engineering from Toronto Metropolitan University and is a licensed professional engineer in Ontario, Canada. Throughout his career with in-line-inspection, Michael has gained extensive experience in data analysis, field operations, and project management, equipping him with a well-rounded skill set to drive success in his role.

285

Automated Landslide Impact Detection Through Machine Learning Analysis of Pipeline IMU Bending-Strain Data

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Inertial Measurement Unit (IMU) bending-strain data play a critical role in detecting and assessing landslide impacts on pipelines. In line inspection (ILI) vendors often flag numerous pipeline bending-strain features based on IMU data; however, most identified features (>90–95%) are not associated with geohazards such as landslides. Manually reviewing these strain indications is labour-intensive and relies heavily on the experience and expertise of the analyst. This study describes a machine learning (ML) method developed to automatically screen and prioritize IMU bending-strain anomalies linked to landslide-related deformation.

A Convolutional Neural Network (CNN) deep-learning classifier model was trained using IMU data from North American transmission pipelines, primarily in the Appalachian region of the USA. The dataset included over 30,000 strain feature training examples segmented into 200-meter windows, with 478 labelled as landslide impacted by pipeline geohazard experts. Model performance was evaluated using a hold-out test dataset consisting of 25% of the available dataset, including 112 landslide impacted strains. The model achieved 90% recall, 95% specificity, 95% accuracy, and an ROC-AUC of 0.96. In other words, it filtered out approximately 95% of benign features while capturing over 90% of landslide-related deformations.

This research demonstrates the potential of ML models applied to IMU data which already has the potential to reduce analysis time per ILI run and improve consistency in identifying high-risk features. By rapidly identifying landslide related pipeline deformation, it helps operators allocate resources more effectively, respond faster to emerging threats, and maximize the value gained from their IMU data. The future integration of additional contextual data such as lidar and landslide mapping, along with increases in the training dataset size and diversity, are expected to yield substantial future improvements to model performance.

Sarah Newton is a Geological Engineer and the VP of Product and Customer Success at Cambio Earth. She has over 15 years of pipeline geohazard experience as an engineering consultant as a product manager and has co-authored multiple publications on geohazard probability assessment and risk management for pipeline operators.

Aron Zahradka is a data scientist and Geological Engineer with over 10 years of pipeline industry experience. He graduated from the University of British Columbia and now leads data science at Cambio Earth, specializing in geohazard assessment through statistical and machine learning analysis of earth science and remote sensing datasets.

Owen Bunce is a Geological Engineer and graduate from Queens University. He is a member of the BGC pipeline team specializing in geohazard management programs and the use of inertial measurement unit data to manage pipeline impact from landslides.

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292
Measuring Fracture Toughness of Line Pipe Using Miniature Test Coupons

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An increasing number of pipeline segments are in-line inspected every year for the presence of cracking and seam weld anomalies. While not all planar indications reported by in-line inspection systems pose a safety concern to the integrity of a pipeline, an engineering assessment can assist in identifying and prioritizing which indications to investigate and remediate. One key input in the engineering assessment is the determination of the pipeline's fracture toughness, a material property that can be measured and quantifies the resistance of the pipeline to crack extension and fracture. To accurately measure this parameter, specialized sub-scale specimen geometries and standardized testing procedures have been published in the industry.

In this study, the fracture toughness of steel line pipe using miniature compact tension (CT) specimens with a ratio width-to-thickness, W/B = 2, unflattened, and side grooved was measured. These test specimen conditions led to a limited test ligament area, magnifying the influence of inherent weld material inclusions, crack tip constraint, and test set up fidelity on the measured toughness. Testing focused on characterizing the lower-bound J-R resistance curve of the seam weld using both displacement-controlled and crack opening displacement (COD)-controlled methods. While displacement control is commonly used, it poses a significant challenge for miniature test specimens due to the sudden release of elastic energy at peak load, which can trigger uncontrolled tearing and compromise data validity. In contrast, COD control offers a more stable crack propagation regime by dynamically compensating for stored energy changes at the onset of unstable crack advance. However, it requires precise tuning and robust error detection.

The material under investigation was an electric resistance welded (ERW) API 5L X60, with a 12-inch nominal outside diameter and a 0.312-inch wall thickness. Results suggest that while ASTM E1820-compliant subsize CT testing is feasible, it requires careful control and interpretation. Post-test SEM examination was conducted to distinguish between fracture mechanisms such as cleavage, material inclusion-driven fracture, crack tip over-constraint, and stable ductile tearing.

Sergio Limon has 23 years of experience in the oil and gas pipeline industry, developing, implementing, and executing strategic integrity management programs for gas and liquid pipelines. He is experienced in developing project scope of work and communicating effectively via written reports and oral presentations, and can interact with cross-functional organizations. Sergio is recognized as an industry leader in performing engineering structural analysis and fatigue and fracture assessments of pipelines, a proven leader with fourteen years of experience leading and developing supervisors, engineers, and field technical specialists.

Ryan Milligan has 10 years of experience in the Oil & Gas industry, including repairing and modifying offshore platforms, designing large equipment tie-downs/arrangements for air transportation, designing barge stingers for laying offshore pipelines, conducting midstream and upstream failure analyses, and performing research related to pipeline integrity. More recently, Ryan has focused on failure analysis and research related to pipeline integrity, including testing and validating current and new pipeline technologies.

292 Cont'd

Ken George has 30 years of experience in fracture mechanics, mechanical engineering, and materials science in oil and gas and aerospace applications. He has held positions as a mechanical engineer and materials scientist in industry, academia, and government. He has supported and led numerous investigations into gas and liquid line failures and military aircraft incidents. His focus is on mechanistic aspects of failure, including environmentally assisted cracking, microstructural effects, effects of welding variables, and load analysis. He holds a BSME from Lehigh U., an MSc in materials science from UVA, and is completing a Ph.D.

Daniel Gutierrez is a mechanical engineer with 15 years of experience working as a Pipeline Integrity Engineer. Since being hired in 2019 by Phillips 66, Daniel has focused on developing and implementing processes and tools to monitor and control pressure cycle fatigue, and he has also improved processes to perform Pressure Cycle Fatigue assessments (PCFA). Daniel's accomplishments while working for Phillips 66 include training young engineers on performing PCFAs, leading the development of an automated computer program to monitor pressure cycling, working with multidisciplinary teams to successfully reduce pressure cycling on pipelines, and establishing processes to test and choose toughness values for PCFAs.

293

Updated Correlations of IMU Bending Strain Features with Geohazards Based on Pipe-Slope Orientation

Caroline Scheevel[1], Jim Hart[2], Bailey Theriault[3], **Casey Dowling[4]**

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Operators who integrate inertial measurement unit (IMU) survey data into their geohazard management programs often find themselves holding large quantities of data and facing uncertainty about what to do next. Previous attempts to establish triage criteria for vendor-reported strain features have examined the correlation between the presence of mapped landslides and the magnitudes of reported horizontal and vertical bending strains (Theriault et al, 2020; McKenzie-Johnson et al., 2024). However, the relative magnitude of each bending strain component is strongly related to the pipeline's three-dimensional geometry and orientation relative to the landslide movement vector—landslides acting transverse to the pipeline centerline axis will generate notable horizontal strain signatures, whereas pipe-parallel landslides will tend to generate vertically dominant bending strain signatures.

This paper leverages a database of more than 14k bending strain interpretations across North America to build on the previous efforts. Bending strain features have been classified both by orientation to anticipated ground movement (slope-parallel, slope-oblique, and slope-transverse) and by interpretation (ground-movement impact, uncertain signature, or not ground-movement related). The strains have been evaluated for metadata trends that correlate with ground movement impact, providing an updated triage framework. The framework accounts for the peak bending stain magnitudes and their of the horizontal and vertical strain components and whether their relative magnitudes agrees with the anticipated direction of relative ground movement. This work also evaluated whether strain features with similar metadata are more likely to indicate ground movement impact if they are reported in different geographic regions—for example, is a horizontal strain in the Midwest more likely to be landslide-induced than a horizontal strain in Appalachia? These results, leveraging anonymized data from 50 operators, will help operators prioritize strain features for further assessment regarding geohazard impact, including at sites that may have been deformed by not-yet-identified landslides.

Caroline Scheevel is an engineering geologist specializing in landslide hazard management for pipelines. Caroline develops robust hazard inventories, screens pipelines for landslide impact in IMU, and wrangles complex data to repeatably produce hazard rankings. She collaborated on the development of a geospatial platform for analyzing IMU data with geologic context.

Casey Dowling is a Senior Geological Engineer at BGC Engineering. Casey has 13 years' experience characterizing, monitoring, and mitigating landslides. He has worked across North America, helping pipeline operators characterize and manage landslide hazards by incorporating IMU data into traditional geohazard assessment and has authored/coauthored multiple papers on the subject.

Bailey Theriault is a senior principal geologist at Geosyntec Consultants with more than 17 years of experience specializing in geohazard management. Bailey is a key author on several industry papers, including the 2023 INGAA documents on pipeline geohazard management and managing landslide hazards (i.e., the primary input for API RP1187).

Jim Hart, President of SSD, Inc. has over 37 years of experience with pipelines subjected to extreme loadings and subject matter expertise on monitoring of pipeline deformations using IMU technology. He is a registered civil engineer in the States of Nevada, California and has published more than 50 technical papers.

296
Even Faster Effective Area Method: Further Optimization of the Effective Area Method for Plausible Profile Corrosion Assessments

Tristan MacLeod

Kiefner and Associates, Ames, USA

Developed in 1989, the Effective Area Method (EAM) has long been the standard pipeline integrity methodology for estimating the remaining strength of corroded pipelines using actual corrosion depth (river bottom) profiles. The EAM algorithm exhaustively evaluates all possible contiguous subsections of each corrosion anomaly. This is not a significant issue for a single anomaly. However, recent advancements in corrosion modeling, such as plausible profile-based corrosion assessments defined in ASME B31G-2023 Section 2.3(b) and "Plausible Profiles (Psqr)," leverage hundreds to thousands of EAM calculations to create plausible burst profiles. Thus, EAM runs hundreds to thousands of times per corrosion anomaly, amplifying the need to improve its computation speed. While recent algorithmic improvements have increased the speed of EAM, further speed improvements are essential for the widespread adoption of plausible profile assessments.

This paper introduces the "Even Faster Effective Area Method," a novel set of optimizations to improve EAM's speed. It builds upon the numerical techniques and improvements introduced in "A More Efficient Effective Area Method…" (Yan et al., 2022). By employing optimization techniques such as cumulative profile area pre-computation, strategic pruning of non-critical subsections, and parallelized operations, the methodology achieves up to a 5 to 10x speed-up over previous EAM implementations. Importantly, the "Even Faster Effective Area Method" maintains strict failure pressure equivalence with the EAM.

Even Faster Effective Area Method's improved performance should accelerate the adoption of plausible profile-based assessments. Integrity and field engineers may now perform plausible profile-type assessments more quickly, improving the accuracy of corrosion assessments and reducing integrity costs.

Tristan MacLeod is a Pipeline Integrity Engineer at Kiefner with six years of consulting experience. He holds a B.S. in Aerospace Engineering from Iowa State University and spent seven years at Aegeus Inspection Services as a field NDE and integrity engineer, earning Level 2 certifications in MT, UT, and PAUT. At Kiefner, Tristan focuses on developing automated tools for fitness-for-service analysis of corrosion, cracks, and dents using Excel and Python. He also applies machine learning to pipeline integrity challenges, such as identifying pipe steel grades for pipelines without TVC records, and performs cyclic fatigue analyses for gas and liquid pipelines.

304
Identification of Composition Measurement Errors and Their Effects on Calculated Pipe Grade

Janille Maragh[1], Pooya Delshad[2], Peter Martin[3], Peter Veloo[4]

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Per 49 CFR § 192.607, operators may use nondestructive testing (NDT) in the materials verification of pipe joints without traceable, verifiable, and complete (TVC) records, provided that the methods are validated by comparison to destructive tests, account for measurement uncertainty, and are conducted by subject matter experts (SMEs) using properly calibrated equipment. As part of its materials verification program, the Pacific Gas & Electric Company (PG&E) collects NDT data on pipe joints. This includes both strength measurements in the form of instrumented indentation testing (IIT) data and chemical composition measurements, collected using X-ray fluorescence (XRF), laser-induced breakdown spectroscopy (LIBS), and laboratory analysis of filings samples. Following careful SME review of this NDT data, downstream analysis includes the use of this NDT materials characterization data in the probabilistic calculation of pipe grade.

This paper presents a case study that highlights the critical role of SME-led validation and cross-checking of NDT results in identifying discrepancies and improving material verification. This case study highlights the potential for inaccuracies even in certified lab results, emphasizing the importance of operator-led validation processes to safeguard the integrity of material verification efforts. The first section of this paper details how PG&E's chemical composition SME review process was used to identify an irregular testing issue that occurred during the analysis of filings samples by a third-party laboratory. PG&E uses multiple NDT methods in tandem, when possible, to enable the cross-checking of data. Since XRF and LIBS were used in addition to filings analysis, the discrepancy was identified through comparison of the data from different sources. Through the SME review process, which involves a careful understanding of the relative performance of various NDT methods in quantifying different elements of interest, it was possible to distinguish real discrepancies from typical data scatter. The result of the error by the third-party testing lab was erroneously high manganese (Mn) measurements, which led to the pipe joint grades being incorrectly calculated as higher than their actual grades. This finding highlights the importance of validating third-party testing labs and carefully examining the data they report; recommended best practices are provided. The second section of this paper demonstrates the impact of NDT errors on the materials verification process by illustrating how errors in measurements of the three elements used for pipe grade calculation (i.e., carbon, sulfur, and manganese) propagate to errors in calculated pipe grade.

Janille Maragh, Ph.D., P.E. is a Materials Engineer specializing in asset integrity and reliability for pipeline infrastructure. She supports operators with engineering critical assessments, corrosion management, and data-driven characterization of pipeline steels to meet PHMSA compliance and extend asset life. Her work integrates laboratory testing, field measurements, and computational modeling to perform materials verification, diagnose degradation mechanisms, and prevent failure in complex systems. In addition to pipeline integrity, Dr. Maragh applies her failure analysis expertise to batteries, supporting quality assurance, root cause analysis, and safety evaluations through materials characterization and failure prevention strategies that strengthen quality control and improve safety in high-reliability applications.

304 Cont'd

Cameron Morley, Ph.D. is a Mechanical Engineer specializing in soft materials and mechanobiology, with over a decade of experience from cellular to musculoskeletal systems. He develops advanced 3D cell culture and biomanufacturing platforms that have led to patented industry technologies. At Exponent, he applies experimental and theoretical expertise to complex engineering problems. His prior work includes developing granular and tunable hydrogels for bioprinting and cell therapy applications, leading collaborations on rheology, and innovating 3D printing and microscopy-enabled tools. His broad technical background spans microscopy, image analysis, manufacturing, polymer characterization, and microfabrication, emphasizing design innovation and biosafety integration.

Dr. Peter Martin see #139

Dr. Pooya Delshad see #139

Dr. Peter Veloo see #139

305

Coding, Context, and Convergence: Let's Write the Next Chapter in Pipeline Risk Management

Kelly Thompson

Williams, Tulsa, USA

In an evolving regulatory and operational landscape, pipeline operators face increasing pressure to demonstrate that their risk models are both technically sound and operationally useful. While regulatory frameworks such as 49 CFR Parts 192 and 195 mandate risk-informed decision-making, there remains no widely adopted industry standard for modeling risk in a consistent, transparent, and auditable manner.

While this presentation will outline current industry efforts to develop guidance and structure around this critical topic, it will focus on sharing Williams insights from developing an in-house integration, modeling, and management solution for pipeline risk—sharing learnings about the importance of asset knowledge, understanding your data, and developing a model that fits. In addition, we will discuss our experiences leveraging AI assistance and applying industry research—insights that have informed improvements in safety, integrity, and operational planning.

By highlighting areas of ongoing work, opportunities for collaboration, and a real-world case study, we aim to foster dialogue, promote alignment, and advance the development of a scalable, purpose-fit integrity risk management practice that supports both safety outcomes and program performance.

Kelly Thompson is a risk-modeling engineer with the Williams Companies, focusing on transparent, reproducible approaches to pipeline risk management. His work includes probabilistic methods, dynamic segmentation, and data-integration frameworks that support defensible, engineering-driven decisions. He contributes to industry collaboration through participation in INGAA and PRCI risk-related workstreams and is committed to improving the clarity, consistency, and practical value of risk insights across integrity-management programs.

307

Enhancing Pipeline Geohazard Management Through the Use of a Novel In-Line Inspection Micro-Magnetic Hysteresis Technology (MHT) for Direct Axial Stress Measurement of Pipelines

James Bainbridge, Rebecca Senior

ROSEN, Calgary, Canada

Geohazards represent a serious integrity threat to pipelines worldwide. Increasingly intense precipitation events and heightened regulatory scrutiny have underscored the need for more robust and proactive geohazard management programs. While most geohazard risks are addressed during the design and construction phases, unforeseen conditions and environmental changes may develop during the service life of the pipeline. Therefore, early identification, evaluation, and management of geohazard-induced loading is essential to reduce the risk of failure. There is a range of methods and tools available to support the management of pipeline loading from external forces, including hydrotechnical / geotechnical instrumentation, remote sensing technologies, and in-line inspection (ILI).

One deficiency in the range of available methods is the measurement of axial stress / strain in pipelines. Axial stress / strain can be severely detrimental to pipeline integrity and can be introduced as a result of manufacturing, construction (e.g. formed bends / trenching and backfilling), and external loading (e.g. landsliding, subsidence, hydrodynamic loads). Accurate quantification of axial stress / strain is essential for engineering assessments, especially when evaluating interacting anomalies that could reduce the tensile strain capacity of girth welds, or be susceptible to global buckling under compressive loads.

Currently, the most established method for predicting total longitudinal stress / strain within pipelines is numerical modelling. This method typically uses Inertial Measurement Unit (IMU) data to define pipeline trajectories and bending strains, and is coupled with ground movement / hydrodynamic models to understand the external load conditions. However, it is acknowledged within the industry that there are some uncertainties associated with this method due to the unknowns and complexities associated with hydro/geohazard loading.

Directly measuring axial stress / strain with ILI rather than numerical modelling is still in its relative infancy with regards to industry-wide adoption; however, it offers a promising alternative method for the quantification of total longitudinal pipeline stress / strain. This presents the potential for direct, rather than calculated, fitness-for-service determinations for operational pipelines subjected to external loading. ROSEN's novel Micro-magnetic Hysteresis Technology (MHT) is an innovative sensor that can accurately measure uniform longitudinal pipeline stresses with calibration, and supplement IMU to calculate total longitudinal pipeline strains.

This paper presents the theoretical principles of the MHT tool and highlights potential significant benefits of non-harmonic micromagnetic sensors versus other axial stress / strain technologies. Case studies illustrate a practical approach for the effective management of geohazards, demonstrating how MHT can complement conventional ILI, remote sensing technologies, and site instrumentation to support the continued development and enhancement of operator's geohazard management programs.

James Bainbridge, Senior Integrity Engineer at ROSEN Canada, has 11+ years' experience in pipeline geohazard management. After earning a BSc in Environmental Sciences in Liverpool, he joined ROSEN Newcastle in 2014 and moved to Calgary in 2022. His expertise includes site investigation, pipe stress analysis, and large-scale field operations for the implementation of geohazard mitigation measures.

Rebecca Senior, based in Calgary, Alberta, holds a Mechanical Engineering bachelor's and a Geotechnical Engineering master's from Newcastle University. With eight years in the pipeline industry, she specializes in geohazards, pipe stress analysis and integrity management, and is dedicated to advancing safe, reliable and sustainable infrastructure.

311

Advancements in Dent and Stress Raiser Measurement Accuracy Through Historical Dig Database and Industry Pull Testing

Anthony Tindall[1], **Jeff Sutherland[2],** David Classen[3]

[1]Baker Hughes, Cramlington, UK. [2]Baker Hughes, Calgary, Canada. [3]Baker Hughes, Houston, USA

Over the lifecycle of oil and gas pipelines, damage to pipelines can occur due to mechanical interference during operation or construction activities. The prevalence of such damage varies widely from isolated instances to pipelines with hundreds of indentations. While a single dent may not always pose an immediate threat to the integrity of a pipeline, dents associated with corrosion, welds or gouges significantly amplify the risk to pipeline integrity.

Drawing on decades of industry experience in dent and deformation detection and analysis by Inline Inspection (ILI), this paper explores both common and atypical causes of denting and damage observed in pipelines.

Recent industry testing programs (referred to as Test NDE 4-18 phase 1 & 2) have yielded critical insights, enabling further statistical validation and the means to establish performance accuracy and confidence criteria for evaluation that have traditionally been “best endeavours”. With definitions and confidence levels around critical parameters, operators can be more efficient with their dig programs. Performance data for the following will be discussed:

1. The Probability of Identification (POI) when distinguishing between a dent containing metal loss features and one involving a gouge.

2. The influence of the feature location within the dent geometry (e.g., at the apex versus the shoulders) on sizing accuracy for the associated metal loss or gouge.

The authors will discuss how extensive, collated, field-verified dent cases, both with and without accompanying stress raisers, have been used in the derivation and development of a robust, data-driven solution for pipeline operators.

David Classen is the US Analysis & Integrity Engineering Regional Manager at Baker Hughes, based in Houston. He joined PPS in 2008 as a Data Analyst, achieving (or obtaining) MFL-A, MFL-C and GEO Level 3 certifications. He holds a DS in Industrial Engineering from Universidad Tecnológica Nacional, Argentina.

Jeff Sutherland, NPI (New Product Introduction) Portfolio Manager, has over 20 years’ experience in the pipeline industry and has held roles in Engineering and Product Management. Jeff has a MSc and BSc degrees in Physics and Engineering Physics from Dalhousie and Queen’s University and is a licensed Professional Engineer (P.Eng).

Anthony Tindall is Product Line Manager – Magnetics, at Baker Hughes Process & Pipeline Services (PPS), based in Cramlington, UK. Anthony has over 25 years’ experience in the ILI industry, having held a variety of roles in Data Analysis and Quality.

312

Friend or Foe – Responsibly Applying Machine Learning and AI Techniques to In-Line Inspection for Pipeline Integrity Assessment

Jeff Sutherland, Stuart Clouston

Baker Hughes, Calgary, Canada

Advances in In-line Inspection (ILI) measurements and tool technologies have benefited the detection, characterization and sizing of critical features in pipelines globally. However, the nature of the output or formats of ILI reporting has not changed significantly in 25 years.

The unprecedented abilities of commercial computer graphics and visualization methods to represent physical and imagined objects in a "life-like" manner also apply to ILI features, flaws and the reference pipe. While at the same time, advances in computing, image processing and numerical algorithms have led to the application of Machine Learning (ML) techniques within ILI data processing, which are demonstrating flaw characterization at levels of granularity on the order of variations of the "clean" pipe itself.

ML also offers a unique opportunity to tackle the real-world challenges that existing analysis methods struggle with, such as complex, overlapping or densely packed defect morphologies, providing a means to consider and manage many more essential variables during the interpretation of the corresponding signal responses in these scenarios.

Application of these techniques still has the objective to maximize the predictive accuracy of the true severity of the most challenging defects, which in-turn are those more likely to be outliers and therefore present a greater uncertainty to the risk of failure. The conventions of errors and uncertainty have a distinct role in both perception and in practical evaluations.

Using examples from MFL and other ILI techniques, this paper will build from prior studies of traditional sizing approaches that looked at "How good is good enough?" to consider new dimensions of interest that must be considered by operators in applying ML and AI techniques to ILI:

- accuracies of flaw signal reconstruction vs accuracies of traditional flaw sizing, and
- when, why and how to apply these seemingly "black-box" techniques in safety-critical decision making?

The abilities to generate image-like flaw representations infer perfection but cannot be without an objective scrutiny and criteria for the actual level of accuracy of representation. Analogies can be made to AI generated images, videos as deepfakes that may be influencing subjective human bias as "truth" decisions vs having common objective criteria.

The authors will address these critical topics and expand on proposals as to how ML and AI, advanced flaw characterization and reconstruction can be progressively introduced to the processes of in-line inspection and engineering critical assessments, providing confidence both expected and needed for its adoption by the industry.

Jeff Sutherland *see #311*

Stuart Clouston, Global Product Line Manager, Pipeline Inspection, based in Calgary, has over 30 years' experience in the pipeline industry, having worked in Project Management, Sales, Marketing and Data Analysis. Stuart holds a BEng in Mechanical Engineering from Leeds University, UK.

316

Keeping on the "Straight and Narrow" for Selective Seam Weld corrosion ILI inspections

Anthony Tindall[1], Cassidy Ryan[2], Jeff Sutherland[3]

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Selective Seam Weld Corrosion (SSWC) is a long-standing, known threat to pipeline integrity. With the comprehensive amendments to the Pipeline Safety Regulations (Code of Federal Regulations CFR, part 192) issued by the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA), there has been an increased focus on understanding this threat and other seam weld defects within operator pipelines.

According to the Pipeline Research Council International (PRCI), SSWC is defined as: "Accelerated corrosion of or near the bond line in autogenous welds, resulting in a groove-like feature that often coincides with shallower corrosion extending beyond the limits of the longitudinal seam."

Due to its distinctive morphology, SSWC poses a significant threat to the integrity of high-pressure pipelines, as its length-to-depth ratio significantly reduces its failure pressure over time. The interaction of SSWC with other pipeline defects, such as surrounding corrosion, dents, bends and strain, can increase integrity risk.

Given the very axially oriented narrowness and steep sided nature of SSWC, a Transverse Field inspection technology is best suited to detect SSWC, where the magnetic flux intersects the steep side of the defect perpendicularly. Transverse Inspection Vehicles, by design, are targeting the axially narrow defects and are not necessarily optimal for the "Shallower corrosion extending beyond the limits of the longitudinal seam".

The author has been inspecting pipelines using Transverse inspections since 1997. During this period, high-field Transverse inspection has detected cracks (with openings greater than 0.2 mm), SSWC, and preferential seam weld corrosion. Combining the results from Tri-axial Axial Magnetic inspection, high-resolution caliper, Inertial Mapping and Strain data, has allowed for comprehensive reporting of seam weld and spiral weld defects.

This paper presents a comprehensive evaluation of SSWC and other seam weld defects through the lens of Inline Inspection (ILI) technologies, including examples that leverage the multiple ILI data streams and technologies, and will share results from operational digs and quantitative industrial testing via pull-through testing.

Cassidy Ryan is Magnetic Product Support Manager. Cassidy previously worked at Dow Hydrocarbons as Pipeline Hydrocarbons Production Engineer, responsible for planning and executing DOT regulated pipeline outages, utilizing ILI technology for threat assessments and anomaly identification across three production sites. She holds a BSc Chemical Engineering from Purdue University, USA.

Jeff Sutherland see #311

Anthony Tindall see #311

318

Automating Level 3 Dent Assessment: A Consistent and Scalable Framework for Deterministic and Probabilistic Finite Element Analysis

Amandeep Virk[1], Muntaseer Kainat[1], Chike Okoloekwe[2], Michael Elkins[3], Nader Yoosef-Ghodsi[2], Saheed Akonko[2]

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Level 3 dent assessments are often required when screening tools cannot provide sufficient confidence for integrity decisions—particularly for complex, non-symmetric, or multi-peak dents, as well as dents interacting with secondary features. A key limitation of current methods is their reliance on 2D cross-sectional representations of dent geometry, which can overlook critical features and localized strain concentrations. In practice, these evaluations are typically carried out using partially automated workflows composed of discrete, task-specific scripts or macros. While technically robust, such approaches are time-consuming and costly, making them difficult to scale across large datasets or meet tight regulatory deadlines.

This paper presents a fully automated Level 3 dent assessment framework, developed as a direct extension of the strain- and fatigue-based screening methodology introduced at PPIM 2025 (Virk et al., 2025). The proposed system standardizes and automates the complete dent assessment workflow—transforming raw ILI, pipe asset, and SCADA data into validated, assessment-ready results with minimal manual intervention. Key automation innovations include:

Preprocessing Enhancements: The system generates indenter and secondary support geometry based on input dent profiles using 3D shape-matching iterations. It analyzes dent characteristics (e.g., curvature, profile dimensions, proximity to secondary features) and recommends mesh refinement strategies—particularly in high-strain zones. Users can review and adjust these recommendations before input file generation. Precise nodal placement and mesh definition are handled programmatically, eliminating reliance on GUI-based preprocessing.

FEA Post-Processing Automation: The framework automatically extracts peak stress and strain and compares simulated and ILI dent profiles in 3D. It computes key assessment metrics such as Strain Limit Damage (SLD) and the Ductile Failure Damage Indicator (DFDI). The initial implementation includes a semi-automated refinement loop, where users evaluate and approve shape-matching iterations. In future versions, this process may be further enhanced through intelligent automation using historical model data.

Advanced Damage Assessment: Post-processed FEA results are used to estimate fatigue life and assess the likelihood of indentation-induced cracking. These capabilities support reliability-informed evaluations aligned with recognized engineering methodologies and industry-leading best practices.

In addition to deterministic results, the framework supports probabilistic fatigue and strain assessments using a Monte Carlo simulation approach previously demonstrated by the authors. These outputs enable risk-based feature ranking and decision-making in scenarios with uncertainty in material properties, measurement accuracy, or pressure history. Outputs can support both severity-based triage and threshold-based prioritization depending on the operator’s workflow.

318 Cont'd

Designed for practical implementation, the framework offers consistency, scalability, and significantly reduced turnaround times for Level 3 dent evaluations while remaining technically sound. Its modular architecture integrates seamlessly with upstream data workflows and offers a viable path toward high-fidelity assessments without the typical resource burden of conventional FEA modeling.

Looking ahead, this framework presents an opportunity for intelligent automation. Future iterations of the shape-matching and FEA processes could be optimized using machine learning models trained on validated dent cases. As more assessment data becomes available, such advancements may further reduce engineering effort and support scalable, operator-ready solutions.

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Muntaseer Kainat is the Principal Engineer and Co-Founder of IntegraFrame Ltd., where he specializes in pipeline integrity and reliability engineering. With over nine years of experience, he has developed expertise in finite element analysis (FEA), 3D metrology, fracture mechanics, and fatigue assessment. He is passionate about advancing pipeline safety through the integration of advanced modeling, automation, and cloud-based solutions. Muntaseer holds a PhD in Structural Engineering and is a licensed Professional Engineer in Canada.

Amandeep Virk is the Principal Engineer and Co-Founder of IntegraFrame Ltd., with extensive expertise in pipeline integrity management. He specializes in advanced numerical modeling, integrity data analysis, and risk management strategies. Amandeep has a proven track record of developing and implementing innovative, data-driven solutions that enhance the accuracy and efficiency of pipeline integrity assessments. His in-depth knowledge of in-line inspection data, fitness-for-service methodologies, and fatigue analysis has been instrumental in advancing industry practices. Amandeep holds a PhD in Mechanical Engineering, is a licensed Professional Engineer, and is a strong advocate for leveraging cutting-edge technologies to improve pipeline safety and operational reliability.

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319

Management and Validation of CSCC Using Multiple ILI Technologies

Rick Gonzales[1], Katrina Dwyer[1], Sergio Limon[2]

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Xcel Energy operates ~2,128 miles of natural gas transmission pipeline, ~80% of which is piggable, with significant legacy segments in challenging terrain. Since the initial discovery of circumferential stress corrosion cracking (CSCC) threats in 2015, Xcel's integrity program has evolved through investigative digs, ILI pull testing, and successive in-line inspections using AMFL/CMFL/DEF/XYZ tools—culminating in reliable detection and sizing, and field validation/repairs across >450 miles of susceptible lines in the 6"–12" diameter range.

This paper documents system conditions, baseline CSCC tool runs, CSCC signal characteristics, susceptibility drivers (coating condition, bending/strain, slope), and results from a case study on a 1960's vintage pipeline system. Results include reassessment, excavation, and repairs. Xcel will discuss tool performance, depth accuracy (±15–20%), operational constraints (seasonal access, pressure cuts), and mitigation methods. The findings highlight the success of using ILI based assessments to supplement susceptibility or risk-based models in order to more reliably identify and address CSCC threats. Last, the paper will provide recommendations for NDE sizing, repair practices, and reinspection logic for CSCC.

Rick Gonzales is a pipeline integrity manager and brings over 15 years of experience in the utility industry, spanning combined cycle generation, engineering consulting, gas operations, and Rick currently serves as the Manager of the Transmission Integrity Management Programs (TIMP) team, where he leads a group of high-performing engineers that perform integrity assessments and risk analysis on Xcel Energy's ~2,100 miles of transmission natural gas pipeline across the organization's service territories. He began his career as an intern with Xcel Energy while studying Mechanical Engineering at the Colorado School of Mines. Additionally, Rick supported Xcel Energy's combustion turbine assets as a Plant Engineer. In this role he was responsible for day-to-day operations in addition to planned and unplanned maintenance activities and overhauls. Since joining the Gas Engineering team in 2015, he has held progressive leadership roles in pipeline integrity management.

Katrina Dwyer is a Corrosion Engineer with 15 years of experience in Pipeline Integrity Management and a background in materials engineering. At Xcel Energy, she manages the in line inspection (ILI) program across the company's pipeline system, overseeing tool runs, engineering evaluations, and the repair dig program. Katrina has worked extensively across multiple integrity topics, including circumferential stress corrosion cracking (CSCC), regulatory compliance, ILI run to run comparisons, and root cause analysis.

Sergio Limon see #292

320
A Comparative Study of ICDA and ILI in Subsea Pipelines

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This study provides a comparative analysis of Internal Corrosion Direct Assessment (ICDA) and In-Line Inspection (ILI) methodologies for subsea pipelines. It reveals that while ICDA is effective in predicting corrosion depth during its Pre-assessment and Indirect Inspection stages, it struggles with accurately locating specific damage points. This difficulty arises because internal corrosion is often localized and influenced by factors like severe corrosion at joints, making it challenging to identify critical defects even when predictive models highlight vulnerable areas. Moreover, there is a notable difference in the effectiveness of inspection and defect detection when conducted onshore compared to offshore environments.

The study also explores the impact of corrosion inhibitors on inspection processes. These inhibitors are generally effective against widespread corrosion but are less effective at preventing localized pitting. This variability introduces randomness on predicting defect location, which challenges the standard inspection approach outlined by NACE SP-0116. This standard assumes a pattern of widespread corrosion for detailed examinations, but it is inadequate for pipelines with inhibitors where pitting is unpredictable.

To address these issues, the study recommends enhanced inspection strategies. For pipelines that cannot be inspected using traditional pigging methods, it suggests increasing inspection frequency beyond the ICDA guidelines. These adjustments aim to improve defect detection accuracy and better manage the complexities introduced by corrosion inhibitors, ultimately ensuring more reliable pipeline integrity.

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