

**Proceedings of 2024 15th
International Pipeline Conference**

(IPC2024)

Volume 5

**September 23-27, 2024
Calgary, Alberta, Canada**

**Conference Sponsor
Pipeline Division**

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Two Park Avenue * New York, N.Y. 10016

© 2024, The American Society of Mechanical Engineers, 150 Clove Road, Little Falls, NJ 07424, USA
(www.asme.org)

All rights reserved. "ASME" and the above ASME symbols are registered trademarks of the American Society of Mechanical Engineers. No part of this document may be copied, modified, distributed, published, displayed, or otherwise reproduced in any form or by any means, electronic, digital, or mechanical, now known or hereafter invented, without the express written permission of ASME. No works derived from this document or any content therein may be created without the express written permission of ASME. Using this document or any content therein to train, create, or improve any artificial intelligence and/or machine learning platform, system, application, model, or algorithm is strictly prohibited.

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

ASME shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B7.1.3). Statement from the Bylaws.

For authorization to photocopy material for internal or personal use under those circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, tel:978-750-8400, www.copyright.com.

Requests for special permission or bulk reproduction should be addressed to the ASME Publishing Department, or submitted online at: <https://www.asme.org/publications-submissions/journals/information-for-authors/journalguidelines/rights-and-permissions>

ISBN: 978-0-7918-8858-2

TABLE OF CONTENTS

Risk Based Asset Management Model for Managing External Corrosion on Natural Gas Transmission Pipelines	1
<i>Martin Hommes, Eric Jager</i>	
Risk Modeling for Rupture Mitigation Valve	9
<i>Alex Woll, Guanlan Liu, Zhuoran Zhang</i>	
Modelling Consequence From Natural Gas Storage Wells	16
<i>Shawn Smith, Alex Fraser, Pedro Petraglia, Mari Shironishi, Dan Shapiro</i>	
EMAT Reinspection Interval Considering POD and Undetected Cracks	27
<i>Jason Yan, Billy Zhang, Shenwei Zhang, Jay Upadhyaya, Kyle Myden</i>	
Dealing With Epistemic Uncertainties in Reliability-Based Pipeline Integrity Management	40
<i>Dongliang Lu, Peng Gong, Aleksandar Tomic</i>	
Assessing Likelihood of Failure for Unpigged Pipelines Using Supervised Machine Learning.....	49
<i>Wei Xiang, Hassan Tayyab, Dongliang Lu, Colin Dooley, Sergiu Lucut</i>	
Accounting for Measurement Uncertainty in Alternative Sampling Plans for Verification of Pipeline Material Properties	58
<i>Jed Ludlow</i>	
Application of a Newly Standardized Risk-Based Pressure Design Approach - Implications From Pilot Studies.....	69
<i>Lowell McAllister, Aiden Svitich, Riski Adianto, Cory Wiechnik, Emeka Ezeiruaku, Dongliang Lu</i>	
Assessing Hit Rate Reduction Benefits of Mechanical Damage Prevention for Application in Risk-Based Pressure Design	76
<i>Lowell McAllister, Aiden Svitich, Riski Adianto, Emeka Ezeiruaku, Dongliang Lu</i>	
Reliability-Based Evaluation of Corrosion Assessment Safety Factors for Pipelines Designed to Risk-Based Safety Class System	86
<i>Riski Adianto, Smitha Koduru, Dongliang Lu</i>	
A Framework for Calculating Life Safety and Environmental Reliability Benchmarks for Highly Volatile Liquid (HVL) Pipelines.....	95
<i>Daryl Bandstra, Thomas Dessein, Jason Moritz, Aaron Schwing</i>	
A Spill Volume Calculation Approach and its Positive Impacts on Pipeline Risk Management	106
<i>Luis Fernando G. Pires, Claudio Barreto, Rodrigo S. N. Mesquita, Anderson Pacheco, Ana Paula Bahiense</i>	
A Data-Driven Process to Determine CVN Value Considering Comparable Pipe Attributes.....	112
<i>Shenwei Zhang, Wei Xiang, Clifford Maier, Kyle Myden, Elvis SanJuan Riverol</i>	
Multiscale Multidisciplinary Machine Learning Modeling for Pipeline Risk Assessment	121
<i>Guanlan Liu, Francois Ayello, Oleg Shabarchin, Gabriel Langlois-Rahme, Dongliang Lu</i>	
Refinement of Reliability-Based Safety Factors for Corrosion Assessment	128
<i>Riski Adianto, Maher Nessim, Dongliang Lu</i>	

Fault Diagnosis of a Crude Oil Pre-Treatment Systems Based on DOOBNs.....	140
<i>Daqian Liu, Shangfei Song, Siheng Shen, Qi Kang, Xiaoping Li, Jing Gong</i>	
Incorporating Risk-Informed Methodologies to Complement Deterministic Integrity Decision-Making in the Gas Industry	150
<i>Mohamed R. Chebaro, Kai Ji, Miaad Safari, Danielle Turney, Mike R. Hildebrand</i>	
Proper Probabilistic Characterization of Uncertainties and its Impact to Reliability-Based Pipeline Integrity and Risk Management	162
<i>Dongliang Lu, Thomas Dessein, Daryl Bandstra, Francois Ayello</i>	
Interpretation of the Safety Risk Tolerance Criteria for Integrated Asset Management of Pipelines	170
<i>Smitha D. Koduru</i>	
Use of High Density Polyethylene (HDPE) Slabs As an Effective Risk Mitigation Method for Mechanical Damage Hazard.....	180
<i>Mohammad Al-Amin, Jonathan Law, Usman Choudhary, Carla Bolanos</i>	
Off-Property Release Likelihood Assessment of Liquid Pipeline Stations Through Barrier Analysis	188
<i>Jeffrey Wideman, Millan Sen, John Dombroski, Doug McKechnie</i>	
Understanding the Impact of Correlated Corrosion Inline Inspection Uncertainties on Reliability	195
<i>Gabriel Langlois-Rahme, Miaad Safari, Oleg Shabarchin, Martin Di Blasi</i>	
Implementation and Optimization of a Multiphase, Transient Release Rate Model for Consequence Estimation.....	206
<i>Steven Middleton, Aiden Svitich</i>	
Risk Assessment of the Transmission Pipeline Appurtenance Threat	217
<i>Samir Fazli, Millan Sen, Saheed Akonko</i>	
Quantitative Assessment of Incorrect Operations Threat	224
<i>Pushpendra Tomar, Dawinder Kaur, Lorna Harron, Millan Sen, Samir Fazli</i>	
Hard Spot Management Framework for Gas Transmission Pipelines Using Risk-Based Approach.....	237
<i>Oleg Shabarchin, Austin Janousek, Brady Bolf, Sean Moran, Kelly Thompson, Owen Malinowski</i>	
Effective Integration of Commercial and Operational Risks.....	251
<i>Chuong Ngo, Charlene B. Wright</i>	
Next Generation Hit Rate Fault Tree for Third-Party Activities.....	263
<i>Daniel Fujinaga, Howard Yue, Riski Adianto, Mark Stephens</i>	
A Risk-Based Approach to Managing Exposed Pipelines	273
<i>Chike Okoloekwe, Millan Sen</i>	
Application of Gaussian Process Classification to the Integrity Management of Energy Pipelines.....	282
<i>Haotian Sun</i>	
Probabilistic Erosion Assessment of Natural Gas Storage Wells.....	294
<i>Sydney Veldhuis, Alex Fraser, Brent Ayton, Mari Shironishi, Daniel Shapiro</i>	
Effect of Polyethylene Pipe on Wall Sticking of Waxy Oil in Low-Temperature Transportation	304
<i>Yu Zhang, Qiyu Huang, Hanpeng Zhen, Xun Zhang, Yijie Wang, Zhenkang Xu</i>	

The Study on Low-Temperature Transportation of Waxy Crude Oil in Chemical Flooding Pipeline	311
Wenchen Liu, Qiyu Huang, Xiaolong Zhou, Yang Lyu, Haoran Yang, Zixin Zhang, Jingru Tian	
Evaluation of the Use of 6Al-4V ELI TSJ (Grade F23) in Gas Export Risers in the SEAP Field.....	317
Fabio Magalhaes Ferreira, Kleberson Gomes de Carvalho	
Collapse Testing and Analysis of High Frequency Welded (HFW) Steel Pipes	325
Ilias Gavriilidis, Aris G. Stamou, Christos Palagas, Eftimios Dourdounis, Nikos Voudouris, Athanasios Tzedakis, Spyros A. Karamanos	
Enhancing Multiphase Flow Computational Performance: A Robust Approach Incorporating Phase Transition Modeling and Dynamic Simulation.....	333
Yunchao Li, Shangfei Song, Qi Kang, Guoyun Shi, Bohui Shi, Haihao Wu, Jing Gong	
Integrated Design and Operational Optimization of Gathering Pipeline Networks Using Neural Network Surrogate Models.....	344
Guangtao Fu, Shiyuan Pan, Ning Xu, Junzhuo Chen, Huanyu Zhao, Yongtu Liang	
Prediction of Gas Field Gathering Pipeline Liquid Accumulation and Analysis of Influencing Factors	353
Xinru Zhang, Lei Hou, Jiaquan Liu, Zuoliang Zhu	
Assessment of Pipeline Damages Caused by Ship Anchor-Chain Drag Incidents	361
Udayasankar Arumugam, Shree Krishna, Ryan Milligan, Ravi Krishnamurthy	
In-Situ Concentration Measurement of Blended Hydrogen Gas Using Sensor Fusion Enhanced by Machine Learning Model	376
Marcos Costa, Hansaem Lee, Seonghwan Kim, Ron Hugo, Simon S. Park	
An Oversized Pipeline: a Potential Solution for Seamlessly Integrating Intermittent Green Hydrogen Production and Low Carbon Fuel Synthesis.....	385
Randy Dinata, Guohua Li, Thomas Joseph Prewitt, Tatiana Flechas, Shane Finneran	
Investigation of Fracture Toughness Behavior for Carbon Steel Line Pipes Under Hydrogen and CO ₂ Environment.....	395
Chih-Hsiang Kuo, Brian Newbury, David Baker, Chong Li, Nathan Nissley, Fredrick Noecker II, Douglas Hoyt, Hyun Jo Jun, Neeraj Thirumalai	
HyTap-In-Service Welding: Tapping and Stoppling of a 66 Bar (950 Psi) Hydrogen Line.....	402
Otto Jan Huisng, David Stordeur, Chris Vrolyk	
Development of Probabilistic Reliability Models for Pure and Blended Hydrogen Pipelines	408
Lowell McAllister, Chance Wright, Mathew Bussiere	
Hydrogen Impurities and Their Potential Impact on Retrofitting Plans When Transitioning to Hydrogen - Natural Gas Blends.....	416
Saba N. Esmaeely, Johannes Sonke, Martin J. Brown, Shane Finneran	
Opportunities and Challenges in Repurposing Canadian Natural Gas Transmission Pipelines for Hydrogen Service - A Regulatory, Standards, and Technical Exploration.....	423
Randy Dinata, Shane Finneran	
Fracture Toughness Evaluation of JCOE Pipe Under High Pressure H ₂ Gaseous	431
Kota Nakashima, Nobuyuki Ishikawa, Hikaru Imayama	

New Aspects on Modeling Ductile Fracture Arrest Performance of Large-Diameter Pipes in Dense-Phase Carbon Dioxide	438
<i>Andreas Mondry, Christoph Bosch</i>	
Evaluation of Fracture Toughness of Welded Line Pipe Steels for Hydrogen Gas Transportation Based on ASME B31.12 and Alternative Test Method Development	450
<i>Eun Jung Seo, Amrita Bag, Michael J. Gaudet, Shaojie Chen, Greg Lehnhoff, Muhammad Rashid, Muhammad Arafin</i>	
Development of Pipeline Standards for the Delivery of Hydrogen and Hydrogen Blends	457
<i>Chris Blackwell, Howard Wallace, Mervah Khan, Brett Weinkauf</i>	
Comparative Fracture and Fatigue Testing of Selected Pipeline Microstructures in Gaseous Hydrogen Environment	463
<i>Sarah Hopkin, Bostjan Bezenek, Tom Martin, Wim Gijt</i>	
High-Frequency-Induction Welded Steel Pipes for the Future Hydrogen Gas Grid.....	471
<i>Holger Brauer, Georg Golisch, Georg Wackenbut</i>	
Pipeline Operators Forum (POF) White Paper on In-Line Inspection Tool Readiness for Hydrogen Pipelines	481
<i>Peter van de Camp, Charles Fernandez, Sieger Koops, Stefan Klein, Paul Roovers, Chris Lewis, Wilson Santamaria</i>	
Impact of High Speed Hydrogen Flow on System Integrity and Noise.....	489
<i>Nestor Gonzalez Diez, Stefan Belfroid, Leonard van Lier, Irma Meijer</i>	
Quantitative Risk Assessment for Residential Hydrogen Supply Trailer With 100% Purity.....	497
<i>Gary P. Yoho, Jacqueline Fusco, Tyler Klashinsky, Eduardo Munoz, Seyed Hamed Fateminia, Jeremy Fontenault, Tara Franey</i>	
Two-Phase CO ₂ Flow Behavior in Horizontal Piping.....	503
<i>Kevin Supak, Fuqiao Bai, Eugene Hoffman, Yingda Lu, Heath Noonan, Kaitlyn Witt</i>	
Convert or Not to Convert? Practical Scoping Considerations for Converting Pipelines to Carbon Dioxide Service	510
<i>Nicki Robertson, Graeme King, Mark Brimacombe</i>	
Comparative Analysis of Running Ductile Fractures in Dense-Phase and Supercritical CO ₂ Pipelines Designed Per DNV-RP-F104 and ISO-27913.....	515
<i>Parnian Ghoraishi, Wenxing Zhou, Jidong Kang</i>	
CO ₂ Dispersion Analysis Factors and Their Impacts on Pipeline Routing	524
<i>Nicola Compton</i>	
Decompression Behaviour of Natural Gas-Hydrogen Mixtures: Shock Tube Test and Numerical Prediction	531
<i>Guillaume Michal, Xiong Liu, Cheng Lu, Kamal K. Botros</i>	
Fracture Toughness and Management of Cracking in Hydrogen Pipelines	542
<i>Neil Gallon, Dominic Wynne, Benjose Baby</i>	
Going Beyond ASME B31.12: A Technical Feasibility Case Study for the Conversion of a 16" X 20 km Onshore Gas Pipeline to Hydrogen Storage	550
<i>Daniel Sandana, Sarah Hopkin, Tom Martin, Neil Gallon, Jonathon Doyle, Wim Gijt, Robert Timmerman, Benjose Baby</i>	

Toughness Evaluation and Integrity Assessment of Modern X80 Linepipe Welds for the Application of High Pressure Hydrogen Pipeline	563
<i>Nobuyuki Ishikawa, Hikaru Imayama, Takahiro Sakimoto, Dan Jia, Jiawei Wang, Yong-Yi Wang</i>	
An Operators Experience in Developing a Technical Strategy for Repurposing the UK National Transmission System (NTS) to Transport Hydrogen.....	571
<i>Gary Senior, Steven Johnstone, Jane Haswell, Corinna Jones</i>	
Engineering Assessment of Hydrogen Embrittlement Susceptibility at Defects in Hydrogen Pipelines by Numerical Modeling	586
<i>Luyao Xu, Shane Finneran</i>	
Consensus Engineering Requirements for Hydrogen Pipelines	598
<i>Simon Slater, Taylor Shie, Fredrick F. Noecker II, Neil Gallon, Daniel Sandana</i>	
The Blending of Hydrogen and Natural Gas by Direct Injection Into High-Pressure Large-Diameter Gas Transmission Pipelines	608
<i>Nigel Curson</i>	
Influence of Hardness on Hydrogen-Assisted Fracture in Pipeline Steels	614
<i>Joseph Ronevich, Milan Agnani, Michael Gagliano, Jonathan Parker, Chris San Marchi</i>	
Technical Challenges and Strategies for the Repurposing of Existing Gas Distribution Pipeline Networks for Hydrogen Transport.....	622
<i>Derek Landschoot, Johana Gomez, Ollie Burkinshaw, Benjose Baby, David Shanks</i>	
Rupture Proof CO ₂ Pipelines by Design - Not by Chance.....	632
<i>Gery Wilkowski, Elizabeth Twombly, Yunior Hioe</i>	
Sensitivity Studies on the Evaluations of Hydrogen Effects on Linepipe Integrity Challenges.....	645
<i>Lance Hill, Ken Bagnoli, Elizabeth Twombly, Ed Punch, Xiaosheng Gao, Gery Wilkowski</i>	
Applying Computational Fluid Dynamics to Reduce Greenhouse Gases Emissions in Natural Gas Compressor Stations.....	657
<i>Fernando Silva, Carlos Junior, Carlo Saggio, Fabio Fundo, Matheus Silva</i>	
Hydrogen Pressure Cycling of Subscale Pipes to Simulate Full-Scale Testing of Transmission Pipelines	663
<i>Chris San Marchi, Joseph A. Ronevich, Benjamin Schroeder, Brendan C. Davis</i>	
Anhydrous Ammonia Pipeline Safety Experience in the United States	669
<i>Kenneth Y. Lee, Sandeep Chawla</i>	

Author Index