



2018 IN REVIEW

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AUSTRALIA
AUSTRIA
BRAZIL
CANADA
CHINA
FRANCE
GERMANY
INDIA
IRELAND
JAPAN
NETHERLANDS
NORWAY
UNITED KINGDOM
URUGUAY
USA

OUR MEMBERS



PIPELINE MEMBERS

- ATCO Pipelines
- Boardwalk Pipeline
- Buckeye Partners, L.P.
- Cadent Gas Ltd.
- Chevron Pipe Line Company
- Colonial Pipeline Company
- ConocoPhillips
- Dominion Energy Transmission, Inc.
- Enbridge Pipelines Inc. and Enbridge Energy Partners LP
- Energy Transfer
- Enterprise Products
- ExxonMobil Pipeline Company
- Flint Hills Resources
- Gassco A.S.
- GRTgaz
- Kinder Morgan
- Marathon Pipe Line LLC
- N.V. Nederlandse Gasunie
- National Fuel Gas Supply Corporation
- National Grid
- Pacific Gas and Electric Company
- Petrobras
- PetroChina Pipeline Company
- Phillips 66 Pipeline LLC
- Plains All American Pipeline, LP
- Shell Global
- Southern California Gas Company
- Total S.A.
- TransCanada PipeLines Limited
- TransGas Limited
- Williams Companies, Inc.



PIPELINE INDUSTRY ORGANIZATIONS

- American Petroleum Institute
- Association of Oil Pipe Lines
- Canadian Energy Pipeline Association
- Operations Technology Development



ASSOCIATE MEMBERS

- Applus RTD
- Baker Hughes, a GE company
- China Petroleum Pipeline Engineering Co., Ltd.



TECHNICAL PROGRAM ASSOCIATE MEMBERS

- Aegion Corporation
- ArcelorMittal
- Australian Pipelines & Gas Association Research & Standards Committee
- Baoshan Iron & Steel Co., Ltd.
- CNPC Tubular Goods Research Institute
- Diakont
- Dresser-Rand Corporation
- Emerson Process Management
- Enduro Pipeline Services, Inc.
- Evraz North America
- HOERBIGER Wien GmbH
- Innospection Ltd
- JFE Steel Corporation
- KROHNE, Inc.
- Lincoln Electric Company
- NDT Global
- Nippon Steel & Sumitomo Metal Corporation
- Quanta Services
- Quest Integrity
- ShawCor Ltd.
- SICK
- Solar Turbines, Inc.
- Subsea Integrity Group
- T.D. Williamson
- Tenaris Global Services S.A.
- The ROSEN Group
- Welspun Tubular LLC
- WorleyParsons Group Inc.



LETTER FROM THE CHAIRMAN

*I*t was a transformative year for PRCI. We made significant strides towards our objective to improve our value to our members by more effectively delivering projects and improving the knowledge transfer of research results. The operational improvements that were made during 2018 will ensure a sustainable and relevant project inventory going forward.

The expansion of PRCI's content delivery program and the creation of six PRCI compendia on key industry focus areas were also counted as successes in 2018. The compendia will help members solve technical challenges by providing better access to PRCI's comprehensive resources. Both the webinar program and the compendia development supported our goals of increasing knowledge transfer and facilitating the application of research results.

PRCI also expanded its scope in 2018 by establishing a Subsea Technical Committee to provide a more collaborative platform for offshore operators. The Subsea Technical Committee will focus on the design, construction and integrity management of subsea pipelines, risers and flowlines.

Digitalization is a focus area for PRCI. In 2018, work was initiated on the Pipeline Data Hub (PDH) that will provide a step change in the way we collaborate as an industry. The PDH will improve the way we manage research output and consolidate datasets on an international scale. The PDH effort will allow the industry to analyze and leverage data in an unprecedented manner.

PRCI's Technology Development Center (TDC) was selected as the site for development and testing focused on improving in-line crack detection technology and associated in-the-ditch non-destructive examination techniques. The TDC offers unrivaled testing capabilities, which will prove to be a keystone in facilitating the next generation of tools and process improvements for pipeline safety.

Although PRCI continues to positively impact the pipeline industry, our collaboration to improve the industry is always ongoing. To remain a global leader in pipeline research in 2019 and beyond, PRCI will maintain its focus to continually improve the way research is executed.

- JEFF WHITWORTH, CHAIRMAN, PRCI

"THE TDC OFFERS UNRIVALED TESTING CAPABILITIES, WHICH WILL PROVE TO BE A KEYSTONE IN FACILITATING THE NEXT GENERATION OF TOOLS AND PROCESS IMPROVEMENTS FOR PIPELINE SAFETY."

Jeff Whitworth





Many years ago, I was in a meeting with a number of industry leaders discussing the challenges and opportunities facing the pipeline industry. A comment during that meeting has always stuck with me, "If one operator fails, we all fail." In the current political and social environment surrounding pipeline operations this statement has never been truer: the time is now to work together and share knowledge to ensure joint success.

In 2012, PRCI embarked on a project that had the potential to reshape our industry and provide a pivotal shift in our corporate and industry culture. Today, looking back, the importance of this project is less about the actual results, NDE-4E (ILI Crack Detection Tools Reliability and Performance Evaluation), and more about the vision it created to develop a process on how to leverage large amounts of industry data, developed in conjunction within PRCI research, and through industry testing and validating. The executive sponsor of this endeavor is Walter Kresic, VP of Pipeline Integrity, Enbridge Pipelines.

The fundamental aim of NDE-4E was to assess the capabilities of current In-line Inspection (ILI) tools ability to find and identify cracks in pipelines and to provide a means to aid operators in tool selection based on operational threats. During the course of this project, PRCI compared over 75,000 data points from ILI tool runs to determine their accuracy. Although the project was successful, it's not the actual project that is the focus today, but the process and procedure for retrieving ILI tool data from the many operators who participated in the project, reviewing the data (even if not in similar formats), reporting on the current state of the tools, and enabling the ongoing addition of data to the database to continually build upon our knowledge of tool capabilities. This was a first for the industry and is now a cornerstone for establishing a culture of "sharing" within PRCI and across our entire industry.

It may sound strange, given that PRCI was established in 1952 for the purpose of working collaboratively to solve industry challenges; however, now we must make a step change towards a continuous learning and sharing environment that builds on our research with additional data provided by our members and other industry stakeholders.

As we moved through 2018, we began to set-up the framework for the Pipeline Data Hub (PDH), again, building on the success of NDE-4E. This will be the central repository of past, current, and future data-based projects. A few of the outputs of the PDH will be: 1) a library of the projects that have been completed by PRCI that leveraged data (either provided by members for projects or developed within the project) to understand and validate tool capabilities; 2) create an environment that enables continuous learning for tools, processes, and procedures that are needed to ensure pipeline system safety and integrity via data sharing and advanced learnings (Artificial Intelligence) based on that knowledge; and 3) defining the state-of-the-art for pipeline system integrity and safety tools, processes, and procedures. We are working to have the first evolution of the PDH live in late 2019.

Another quote that has stuck with me, "Safety is not a competitive issue." There is a vast, untapped information pool within the pipeline industry awaiting a broad industry coordination to extract and use. It is critical that we continue to develop the essential solutions needed by our members and the industry in order to build upon the high level of success that we have already achieved in transporting vital energy products. Stay tuned.

- CLIFF JOHNSON, PRESIDENT, PRCI

**"WE MUST MAKE A STEP CHANGE
TOWARDS A CONTINUOUS LEARNING AND
SHARING ENVIRONMENT THAT BUILDS ON
OUR RESEARCH WITH ADDITIONAL DATA
PROVIDED BY OUR MEMBERS AND OTHER
INDUSTRY STAKEHOLDERS."**



LETTER FROM
THE PRESIDENT

PRCI

RESEARCH OBJECTIVES

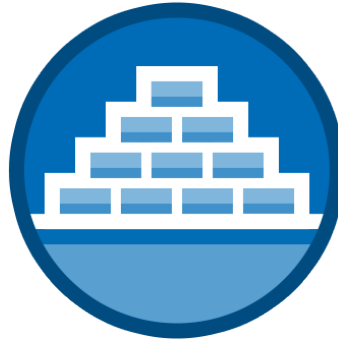
1

Develop and enhance ILI technology to reliably detect, size and also characterize indications that may be harmful to the integrity of the pipeline.



4

Confirm the fundamental integrity and safe operation of vintage pipelines by expanding the applicability and reducing the uncertainty of Fitness for Service methodologies, including defining critical feature dimensions, associated models & response criteria.



5

Develop, demonstrate and validate intrusion monitoring and surveillance technologies to enhance detection of third-party activities, ground movement and interferences potentially affecting pipeline infrastructure.



7

Develop, demonstrate and validate repair systems, including those that can be deployed on in-service facilities. Determine the useful life and safe operating envelopes of such repair systems.



2

Develop, evaluate and enhance NDE technologies and operator & data analyst performance to define the condition and assess the integrity of pipeline facilities and associated infrastructure from outside or above the pipeline or facility.



3

Develop and/or validate technology and analytical processes that are capable of characterizing pipeline material properties with sufficient accuracy for application in pipeline integrity assessments.



6

Define, understand and improve the key practices, including models, involved in the design, construction and integrity management of pipelines and related facilities.



8

Reduce all releases, i.e., leaks and emissions, from all parts of hydrocarbon production, storage and transport infrastructure by developing, demonstrating and validating processes + technologies to detect, locate, measure, quantify and mitigate such releases.



9

Enhance operational efficiency, flexibility, and availability including measurement functionality, accuracy, characterization of flows and custody transfer at all points in production and delivery infrastructure including liquid pumping and gas compressor stations and all storage systems.

A CORNERSTONE IN FACILITATING PIPELINE SAFETY

The efforts of PRCI and its members to bring awareness to the unique capabilities of the Technology Development Center (TDC) became especially apparent in 2018, as it was the TDC's busiest year yet.

The TDC experienced a 300% increase in year-over-year third-party projects, as well as assisting the Integrity & Inspection Technical Committee deliver over \$3 million worth of PRCI project work. An achievement that is a testament to why there was such a need for a research facility to be funded and built by PRCI membership.

PRCI related work included projects that utilized the flow loop, both dry and wet pull string tests and a large amount of NDE related work. The TDC was heavily leveraged for private consortium work to assess fundamental technologies for various difficult-to-inspect pipe configurations.

The TDC is being utilized by both members and non-members in a variety of ways that often combine classroom learning with hands-on training. The TDC provides not only a place to execute research, but to also demonstrate how to put the research into practice. PRCI is working to enhance the tools, processes, and personnel involved in pipeline safety and integrity.





300% INCREASE

In year-over-year
third-party projects

\$3 MILLION

Worth of PRCI
related work
in 2018

3 YEARS

Since opening in
Summer 2015



TECHNOLOGY DEVELOPMENT CENTER

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A PRCI project directed at understanding the human factors impact of in-service non-destructive examination results used the TDC to create real-world scenarios to better understand the influencing factors. "The TDC was developed for exactly this sort of pipeline industry research," said Hans Deeb, who is a long-time PRCI staff member and manages the day-to-day activities at the TDC, "the TDC has a large inventory of pipe with a wide range of real-world defect types that are ideal for training and evaluating NDE technicians."

PRCI leveraged the TDC to partner with other pipeline industry associations to bring more learning opportunities to its members and looks to continue this trend in the coming year. In 2018, the TDC hosted the American Society of Mechanical Engineers inaugural Robotics Forum and a joint PRCI and American Petroleum Institute workshop on dent assessment and management.

The TDC will also be at the center of the high profile pipeline data hub (PDH) as it is utilized for ILI tool testing.



“THE TDC HAS A LARGE INVENTORY OF PIPE WITH A WIDE-RANGE OF REAL-WORLD DEFECT TYPES THAT ARE IDEAL FOR TRAINING AND EVALUATING NDE TECHNICIANS.”

HANS DEEB, PRCI

KNOWLEDGE TRANSFER

AT A GLANCE

In 2018, PRCI hosted more than 20 webinars, many of which were open to both members and non-members.

“Utilization of PRCI research is key” said PRCI Director of Research Execution Gary Choquette, “without implementation, we will not have achieved the improvements to pipeline process and safety performance that are inherent to our mission at PRCI.”

The webinar series feature the project team lead and the principal researcher for the project. Together they provide attendees with an operator perspective on why the research was performed and how the results can be applied at an operating company, followed by a technical overview of the research conducted.

Looking forward to 2019, the industry can expect an expansion of the webinar program, with more operator lead presentations.

[VIEW OUR WEBINARS ONLINE NOW AT PRCI.ORG](https://www.prci.org)

TOP 3 PRCI WEBINARS IN 2018:



**HYDROSTATIC TEST GUIDELINES
FOR INTEGRITY MANAGEMENT**



**FIELD MEASUREMENT FOR PIPE GRADE & QUALITY
VERIFICATION USING A PORTABLE HARDNESS,
STRENGTH & DUCTILITY (HSD) TESTER**



**FIELD VALIDATION OF SURFACE LOADING
STRESS CALCULATIONS FOR BURIED PIPELINES**



3,600+
REGISTRANTS



1K VIEWS
ONLINE



20
WEBINARS
TOTAL



2,000+
ATTENDEES



100%
WEBINARS AVAILABLE
ONLINE AT PRCI.ORG

A dramatic, low-key photograph of a welder working inside a large, circular industrial structure, possibly a tunnel or a large pipe. The welder is silhouetted against a bright blue light source, creating a strong contrast. Sparks are flying from the welding point, illuminating the scene. The text "ACCOMPLISHMENTS & IMPORTANT FINDINGS IN RESEARCH" is overlaid on the left side of the image.

ACCOMPLISHMENTS & IMPORTANT FINDINGS IN RESEARCH



COMPRESSOR AND PUMP STATION TECHNICAL COMMITTEE

The Compressor and Pump Station Technical Committee focuses research efforts on minimizing the operating costs and capital requirements of compression and pump service while meeting market demands and all applicable environmental regulations.

Technical Committee Leadership

Technical Committee Chair: Thomas Lumadue, TransCanada Pipelines Limited
Vice Chairs: Daniel Rem, Enbridge Pipelines Inc.; Howard Koop, Enbridge Pipelines Inc.
Program Manager: Gary Choquette, PRCI

Featured Reports

PR-309-17203-R01 STARTING DAMAGE ON LEGACY PIPELINES

This PRCI research project studied methods to detect and quantify damage during startup in two cycle gas engines. The application of modern automation and combustion control technologies has greatly increased the reliability of engine operation when operating under load. Detonation and preignition along with unanticipated shutdowns have been reduced if not eliminated on modernized legacy engines; however, starting and unloaded operation can result in substantial detonation and preignition resulting in pressure and temperatures, which significantly exceed loaded operation. In addition, these combustion aberrations can trip an engine off line before it achieves stable loaded operation, which will result in a failed start and may trigger the dispatch of a technician to investigate and resolve the problem. This report presents the finding of this research and how detection of various damaging cycles is achievable using pressure waveform characteristics.



PR-312-16202 GHG EMISSION FACTOR DEVELOPMENT FOR NATURAL GAS COMPRESSORS

The U.S. EPA Greenhouse Gas (GHG) Reporting Program (GHGRP) requires compressor stations and underground storage facilities to measure compressor vent, rod packing, and seal emissions for facilities subject to 40 CFR, Part 98, Subpart W. The objective of the project is to gather and evaluate 2011 – 2016 Subpart W compressor vent and seal methane emissions data from site measurements, and present results of an analysis to develop methane Emission Factors (EFs) based on this data.

The EFs and analysis of relative contribution from different sources can be used: (1) as alternatives to current emission factors for compressor methane emissions used for Transmission and Storage (T&S) operations in EPA's annual GHG inventory; (2) to provide an EF based emission estimate for Subpart W that replaces ongoing annual GHGRP vent measurements; and (3) to document the relative contribution of different compressor leak/seal sources and support alternative leak mitigation strategies.

Comparisons of the EPA Annual GHG Inventory EFs to Subpart W based EFs in this report show consistently lower compressor emissions than estimates based on historical data or reports. Large leaks, which stem from less than 3% of the compressor measurements, increase the EFs by 26% to 194%, thus greatly impacting the EF results. Additionally, alternative EFs are provided for transmission and storage compressor methane emissions.

CONTROL OF VENTED METHANE EMISSIONS FROM INTEGRAL COMPRESSOR ENGINES

At natural gas pipeline compressor stations, methane emissions from compressor and engine crankcases are often vented directly into the atmosphere. There may be advantages to capturing these emissions and using them to offset fuel usage and / or decrease the overall carbon footprint of such a typical compressor station. This study evaluates the feasibility of directing such captured emissions into the intake of the compressor engine and subsequently combusting the methane emissions into carbon dioxide and water.

The study relies on both extensive literature review and model-based engine simulations to determine the feasibility of rebreathing crankcase gases in pursuit of reducing compressor station methane emissions. The conclusions of the study are limited to the crankcase vent rebreathing into the air intake of large bore, natural gas, 2-stroke engines.

COMPRESSOR & PUMP STATION 2019 FUNDED PROJECTS

CPS-14-03 Engine Controller Design Solutions to Address Variable Fuel Composition of Lean-burn Engine: Field-based Evaluation (continuing project)

CPS-14B-08 CEPM for Turbochargers (continuing project)

CPS-5-10 Centrifugal Compressor Dry Gas Seal Reliability Enhancement III

CPS-11-6B Portable Analyzer Lab Tests to Support Simplified Test Method (new multi-year project)

CPS-14S Residual Gas Fraction Estimation Based on Measured In-cylinder Pressure (new multi-year project)

CPS-17-01A GHG Database to Support Emission Factor Improvement - Methane Data and "Super-emitters" (new multi-year project)

CPS-11-08 Stack Testing Methods for Accurate VOC Measurement (continuing project)

CPS-11-5A Ambient NO2 Modeling for 1 Hour Standard

CPS-15-01 End of Pump Seal Life Modeling



Additional Research

GRI-02-0201 Emissions Reduction Methods for 4SLB Industrial NG Engines 

GRI-03-0083 NO2 Emissions from 2SC Large Bore Natural Gas Engines 

GRI-04-0158 Precombustion Chamber Fuel Metering with an Electronic Fuel Valve 

L52360 NOx Reduction Through Improved Precombustion Chamber Design 

PR-283-16201-R01 Improved SoLoNOx Taurus 60 Control Algorithm to Reduce Part Load Emissions *an executed NDA is required from Solar Turbines to access this research document. 

PR-309-14209-R01 Field Demo of Integrated Expert Level Continuous Performance Monitoring 

PR-312-12206-R02 FTIR Formaldehyde Measurement at Turbine NESHAP and Ambient Levels 

PR-312-17204-R01 Portable Analyzer Method Update - Phase 2 

PR-312-17204-R02 Portable Analyzer Method Update - Phase 3 

PR-316-17200-R01 Effects of Liquid Contamination on Dry Gas Seal Performance 

PR-457-14201-R04 Variable NG Composition Effects on LB 2SC Integral Engines 

PR-457-17201-R01 Residual Gas Fraction Estimation Based on Measured In-Cylinder Pressure 

PR-471-14207-R02 Field Pump Performance Testing Procedure Phase II Proof of Concept Testing 



CORROSION TECHNICAL COMMITTEE

The Corrosion Technical Committee focuses on industry challenges related to internal and external corrosion prevention and mitigation, as well as stress corrosion susceptibility evaluation and repair.

Technical Committee Leadership

Chair: Dr. Didier JC Caron, GTRgaz

Vice Chairs: Trevor Place, Enbridge Pipelines; David McQuilling, Pacific Gas and Electric; Bi Wuxi, PetroChina; Benny Mumme, Flint Hills Resources; Ivan Mathew, Kinder Morgan; Thierry Cassagne, Total; Terry Huang, TransCanada
Program Manager: Laurie Perry, PRCI

Pictured above: Len Krissa, Enbridge, outgoing Chair of the Corrosion Technical Committee. Thank you for your leadership.

Featured Research

PR-015-153602-R01 VAPOR CORROSION INHIBITORS EFFECTIVENESS FOR TANK BOTTOM PLATE CORROSION CONTROL

The research project set out to evaluate three key questions: 1) are VCIs effective in mitigating corrosion to a level comparable to a working cathodic protection (CP) system for tank bottoms, 2) what is the best way to apply and monitor efficacy of VCIs, and, 3) are VCIs compatible with CP?

The results indicate that when applied at vendor-recommended dosage levels, VCI's can reduce pitting corrosion and have a positive effect on overall surface corrosion. The rigorous data analysis concluded VCI's are clearly compatible with current CP practice, and that additional field work can optimize the integration of VCI application and CP system design & operation.

Related research: Vapor Corrosion Inhibitors Effectiveness for Tank Bottom Plate Corrosion Control - Phase 2 (multi-year project) EC-6-5A

PR-244-153719-R01 QUANTIFICATION OF ILI SIZING UNCERTAINTIES AND IMPROVING CORRECTION FACTORS

The focus of this project was to use existing ILI and excavation data to develop better approaches for assessing ILI tool performance. This project expanded on previous work by increasing the number and type of feature morphologies available for analysis, and by estimating the sizing error of ILI measured external corrosion features. New geometric classification criteria, complementing the current criteria suggested by the Pipeline Operator Forum (POF 2009), were also investigated. Lastly, correction factors based on burst pressure prediction accuracy were developed to account for the effect of adopting various feature interaction rules.

Related research: PR-244-173605-R01 Improving Corrosion ILI Sizing Model for Long Complex Corrosion Anomalies

PR-185-173600-R01 REFERENCE STRESS FOR METAL-LOSS ASSESSMENT OF PIPELINES

This project focused on quantifying the reference stress to be used in predictive models for assessing the effects of metal loss on pipeline integrity. The results of this project work in concert with the outcomes of another project that examined



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sources of scatter in metal-loss predictions with respect to the metal-loss defect geometry. The methodology included empirical and finite element analyses along with comparison of full-scale experimental results that indicate the failure behavior of defect-free pipe has dependence on the strain hardening rate, n , of the pipe steel. Since the strain hardening rate is often unreported in qualification test records and mill certification reports, the development of a new reference stress will seek to include the utilization of the ratio of yield-to-tensile strength (Y/T) as a surrogate for n .

Related research: PR-185-163609-R01 Corrosion Model Error - Phase II Full-scale Experiments 

Additional Research

PR-185-163609-R01 Corrosion Model Error - Phase II - Full-scale Experiments  

PR-186-113600-R01 Grinding Limits for Repair of SCC on Operating Pipelines 

PR-186-163603-R01 Assessing the Feasibility of Polarization Based CP Criteria for Mitigating High-pH SCC 

PR-186-163606-R01 Establishing the Potential Severity of Various Cathodic Protection Shielding Parameters 

PR-306-163607-R01 Near Neutral pH Stress Corrosion Cracking, Influence of Environmental Parameters 

PR-388-143604-R01 Identifying Coating Faults & Their Severity through Electrolyte Resistivity Measurements 

PR-444-143603-R01 Monitoring Cathodic Protection Effectiveness at Horizontal Directional Drill Pipe Crossings 

PR-244-173605-R01 Improving Corrosion ILI Sizing Models for Long Complex Corrosion Anomalies  

CORROSION

2019 FUNDED PROJECTS

Applicability of Existing Metal-Loss Criteria for Low Hardening Steels (continuing project) EC-2-8

Peer Review of the Plausible Profile (Psqr) Corrosion Assessment Model EC-2-9

Vapor Corrosion Inhibitors Effectiveness for Tank Bottom Plate Corrosion Control - Phase 2 (multi-year project) EC-6-5A

Developing Guidelines on the Selection and Application of Cathodic Protection (CP) Coupons through Establishment of Technical Key Knowledge between Coupon Measurements and its Matching with Pipeline Real Cathodic Protection Conditions (continuing project) EC-8-8

Water Wetting Prediction Tool for Pipeline Integrity (continuing project) IC-1-7

Effect of Pressure Fluctuations on Growth Rate of Near-Neutral pH SCC - Phase 3 (continuing multi-year project) SCC-2-12A

Expert Review of Past PRCI and PHMSA SCC Studies, Gap Analysis and Road Mapping SCC-7-1

Deliver Comprehensive Metal-Loss Assessment Criterion (new multi-year project) EC-2-10

DESIGN, MATERIALS & CONSTRUCTION TECHNICAL COMMITTEE

The Design, Materials & Construction (DMC) Technical Committee focuses research efforts on the development of safe, environmentally responsible, cost-effective and reliable solutions for the design, construction and operation of energy pipelines. DMC research enhances the performance of new pipelines through development and implementation of new design methods, materials, and construction technologies.



Technical Committee Leadership

Chair: Stephen Rapp, Enbridge

Vice Chairs: Construction - Tim Huggins, Williams; Assessment and Repair - Russell Scoles, Enbridge; Welding - Jorge Penso, Shell; Fracture - Eduardo Hippert, Jr., Petrobras; Materials - Dr. Muhammad Rashid, EVRAZ; Design - John Gregory, ExxonMobil; Geohazard Mgt - Michael Cook, ExxonMobil; Program Manager: Thomas Marlow, PRCI

Pictured above: David Horsley, TransCanada, outgoing Chair of the Design, Materials & Construction Technical Committee. Thank you for your leadership.



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Featured Research

PR-201-164502 STUDY TO EVALUATE DELAMINATION AND DISBONDING OF COMPOSITE REPAIR



The purpose of this PRCI research project was to provide information regarding the current state of available composite inspection techniques, as well as the impact of delamination and disbondment defects on the performance of composite repairs. The results of this research provide operators with guidance on using inspection technologies to assess the integrity of installed composite repair systems.

PR-616-164506-R01 GUIDELINES FOR MANAGEMENT OF GEOHAZARDS AFFECTING THE ENGINEERING AND CONSTRUCTION OF NEW OIL AND NATURAL GAS PIPELINES



This research project includes guidelines on the management of geohazards for the construction of oil and gas pipelines. Pipelines are inextricably exposed to geohazards, given they are long structures that encounter variable terrain and geologic conditions. As such, reconnaissance, feasibility, and engineering design studies for new or existing pipelines need to include analyses that identify, characterize, and mitigate the potential effects of geohazards on pipeline integrity. These succinct, easily readable guidelines have been formulated to be accessible to non-specialist staff, such as project managers, project engineers and other decision makers associated with the construction of new pipelines.

PR-453-134505-R05 - INDUSTRY HIGH VALUE OBJECTIVES PIPELINE ON-BOTTOM STABILITY SOFTWARE UPGRADE



This project revised and updated the popular Pipeline On-bottom Stability computer program suite. This report includes reconsideration of the objectives and issues excluded from this program as well as the results of Objective 8 regarding flows at a very low angle of incidence to the alignment of the pipeline. Also included is an updated user guide and a report on possible objectives for further revisions to the analysis tools and user guidelines.

Additional Research

PR-164-164504-R01 Suitability of Line Pipe Materials for Sour Service 

PR-214-144500-R05 Weld Hydrogen Cracking Susceptibility Characterization 

PR-334-174504-R01 Suitability of Line Pipe Materials for Sour Service Literature Research Summary 

PR-164-114512-R03 - CRA Weld Overlay Pipes for Subsea Application 

PR-182-124505-R04 Developing Tools to Assure Safety Against Propagating Cracks in Modern Gas Pipelines 

PR-218-104509-R01 Field Validation of Surface Loading Stress Calculations for Buried Pipelines Mileston  

PR-472-174501-R01 Ultra-Deep Water Pipelines 

PR-472-174502-R01 Pipeline Construction Using Mechanical Connectors 

PR-472-144505-R04 Development of Guidance on Subsea Launchers and Receivers  

PR-201-154500-R01 Composite Repair Load Transfer Study  

PR-350-114511-R02 Refined Methodology for Assessment of Weld High-Low Misalignment Phase 2

DESIGN, MATERIALS & CONSTRUCTION

2019 FUNDED PROJECTS

Composite Repairs for Dent and Metal Loss Defects - State of the Art and Full-scale Instrumented Tests (continuing multi-year project) MATR-3-13

Assuring the Permanency of Composite Systems for the Repair of Corrosion and Mechanical Damage MATR-3-3/4

Guidelines to Calculate Erosional Velocity for Liquid Hydrocarbon Transmission Pipelines FLOW-1-2

Toughness Specification to Avoid Brittle Fracture in New Fitting/Pipe Materials with High Charpy Energy MAT-4-5

Modernize the Assessment of Pipeline Water Crossings (multi-year project) ENV-4-1A

Enhancing Strain Capacity of Pipelines Subjected to Geohazards (continuing project) SBD-1-6

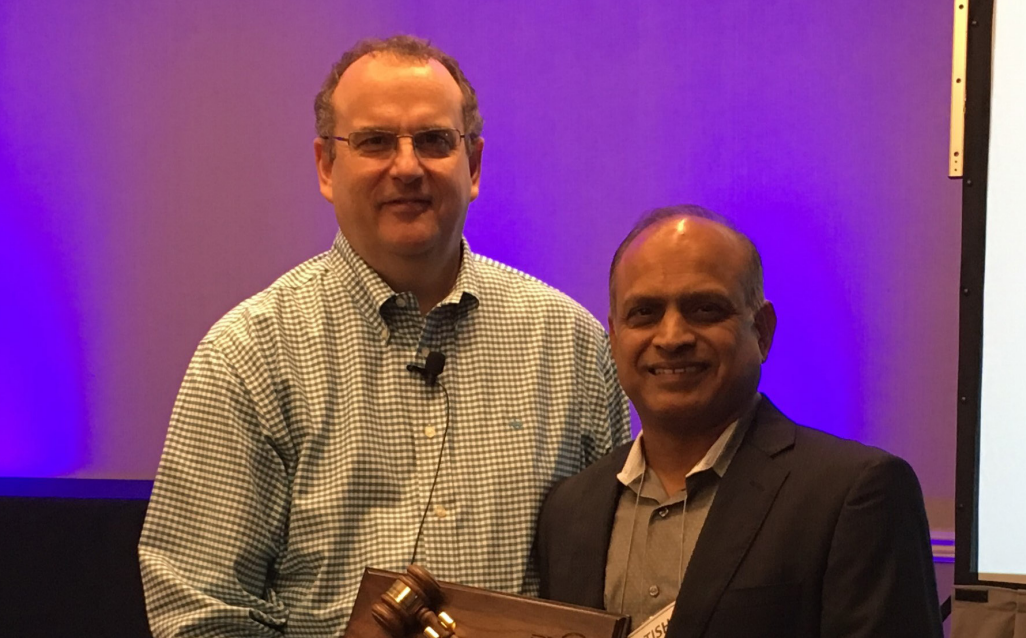
Guidance on the Use, Specification, and Anomaly Assessment of Modern Linepipes (continuing multi-year project) MATH-5-3B

Full Thickness Weld Tensile Round Robin (continuing multi-year project) API-2-1A

Reliable Service Performance of Dissimilar Metal Welds and Corrosion Resistant Weld Overlays for Clad Pipelines (continuing project) MAT-1-5

Post-Heating as an Alternative to Delayed NDE (multi-year project) MAT-1-6

Evaluate Higher Strength Consumables for Manual Root Beads in X70 Girth Welds (multi-year project) MATH-5-4



INTEGRITY & INSPECTION TECHNICAL COMMITTEE

Products resulting from research activities conducted under the Integrity & Inspection (I&I) Technical Committee improve the reliability of the pipeline infrastructure and ensure the continuity of public service through the development and successful deployment of technologies associated with mechanical damage, pipeline integrity management, and associated inspection technologies.

Technical Committee Leadership:

Chair: Vacant

Vice Chairs: Dave Katz, Williams; Richard Kania, TransCanada;

Travis Sera, Southern California Gas Company; Mures Zarea, GRTgaz;

Sean Keane, Enbridge

Program Managers: John Lynk and Zoe Shall, PRCI

Pictured above: Satish Kulkarni, Chevron, outgoing Chair of the Integrity & Inspection Technical Committee. Thank you for your leadership.

Featured Research

PR-244-153719-R01 IN-LINE INSPECTION CRACK TOOL PERFORMANCE EVALUATION PHASE II

This project created a database of crack ILI and excavation information collected from operators and characterizes the performance of available ILI technologies. The database was created and populated in Phase I of the NDE 4-E project, completed in July of 2015. The purpose of Phase II was to collect additional data and update the database and statistical analysis with an emphasis on collecting crack features measured by Electromagnetic Acoustic Transducer (EMAT) ILI tools and interacting crack in corrosion features measured by ultrasonic (UT) ILI tools.

PR-214-073510-R01 FULL-SCALE FATIGUE TESTING OF DENTS (PLAIN DENTS & DENTS INTERACTING WITH WELDS AND METAL LOSS)

This project generated full-scale dent fatigue test data necessary to develop, validate and/or evaluate dent models capable of predicting cyclic internal pressure related failure of a pipe segment. The data generated includes: detailed material characterization of the pipe involved in full-scale test program, dent profile measurement, dent strains during dent formation and cyclic loading and recording of the details of fatigue crack location and orientation within a dent.

The test program developed detailed experimental data for: Unrestrained plain dents, Restrained plain dents, Dents interacting with welds and Dents interacting with metal loss.

PR-201-153718-R03 INTEGRITY ASSESSMENT OF DIFFICULT TO INSPECT PIPELINES USING HIGH RESOLUTION NDE IN SELECT AREAS

This report documents the current state-of-the-art for corrosion location NDE, selection models, and Extreme Value Analysis (EVA) Methodologies for deployment in a structured process as an Alternative to In-Line Inspection of difficult-to-inspect pipelines. The research on NDE screening technologies addressed in this report reviews technologies identified in the Year 1 work that can be used to screen the condition of pipe wall along its full length as well as existing location selection models such as employed by Direct Assessment Methodologies. This report leverages extensive research that has been conducted on existing Extreme Value Analysis Methodologies from multiple sources and applications including metal corrosion (HOIS, HSE), pipeline corrosion, metocean criteria, wind loading, and multiple textbooks.

The report also identifies gaps that currently exist and the work that must be completed to develop a complete validated structured process required to deploy the technologies for integrity assessment of difficult-to-inspect pipelines. The research also aims to compare predictions of remaining life using statistical approaches applied to the partial inspection data with remaining life obtained from conventional integrity assessment using ILI or hydrostatic test.



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Additional Research

PR-306-143732-R01 Advanced Material Characterization of Dent and Gouge Samples for Improved Strain Evaluation 

PR-392-113701-R01 Improved Crack Depth Measurement Techniques Final Report 

PR-328-173802 Hard Spot NDE Evaluation 

PR-218-173859 Integrating NDE-4E ILI CrackReliability Performance Evaluation, and Integrity Management 

PR-214-114500-R01 Fatigue Screening and Life Assessment of Plain Dents and Dents Interacting with Welds and Metal Loss 

PR-218-063505-R03 Safe Inspection Procedure for Dent and Gouge Damage 

PR-335-143705-R01 Study on Reliability of In-ditch NDE for SCC Anomalies 

PR-306-083509-R01 Realistic Mechanical Defects for Evaluation of Inspection Tools and Repair Techniques 

PR-335-173816 MV - Validation of in-situ Methods for Material Property Determination 

PR-589-163726 Assessment of Non-Destructive Evaluation Tools for Difficult-to-Inspect Pipe in Liquid Applications 

PR-306-123732-R01 Realistic Dent and Cracked Gouge Defects for Characterizing Inspection Tool Performance 

PR-306-123733-R01 Realistic Dent and Gouge Defects Without and With Fatigue Cracks 

PR-398-133725-R02 Evaluation of Large Standoff Magnetometry Techniques for Above the Pipe Integrity Assessment 

PR-003-063509 Improved Models for Predicting Delayed Fatigue Failure of Pipelines at Mechanical Damage 

PR-469-143708-R02 In-line Inspection and Assessment for Pipeline Girth Weld Defects 

PR-185-163731-R01 Time-delayed Failure in X65 Moderate-toughness Line-pipes 

PR-185-133739 Quantifying Re-Rounding in Pipeline Damage Severity Models 

INTEGRITY & INSPECTION

2019 FUNDED PROJECTS

Integrity Assessment of Crack Colonies with the Aid of Advances in NDE including EMAT and Ultrasonic Imaging NDE-4-10

Phase 2: Evaluation of low field MFL for branch connections NDE-4-3

Performance Evaluation of ILI Systems for Detecting and Discriminating Metal Loss, Cracks and Gouges in Geometric Anomalies MD-1-13

Quantification of ILI Sizing Performance for Severe Corrosion Anomalies EC-4-6A

Remaining Life Model and Assessment Tool for Dents and Gouges MD-4-16

Extended Evaluation of Large Stand Off Magnetometry NDE-3-4

Fracture Toughness via In-Ditch Nondestructive Testing - Validation NDE-2-9

Development of Heavy Wall ILI Test Samples SPIM-1-6

NDE Crack Depth Sizing Performance Validation for Multiple UT Techniques used to Establish Actual Crack Depths for PRCI Reference Standards and ILI Performance Verification NDE-4-6A

Qualification and Guideline of Inspection Technologies for Flexible Pipe Integrity Management SPIM-2-1

Small Diameter Acoustic Resonance (ART) ILI Tool Feasibility Study & Concept Design NDE-4-15



MEASUREMENT TECHNICAL COMMITTEE

The Measurement Technical Committee focuses research efforts on providing measurement technologies that result in increased customer satisfaction and achieve cost savings through more accurate metering, better management of data, improved operation efficiency, and reduced capital expenditures.

Technical Committee Leadership

Chair: Chris Levy, Chevron Pipeline Company
Vice Chairs: Johnathan Mustafa, Energy Transfer; Lori Curtis, Kinder Morgan
Program Manager: Gary Choquette, PRCI

Pictured on right: Kerry Checkwitsch, Enbridge, outgoing Chair of the Measurement Technical Committee. Thank you for your leadership.

Featured Research

PR-015-17605-R01 OPERATION OF SICK FS500 ULTRASONIC METERS IN CLOSED COUPLED INSTALLATIONS

SICK Flowsic500 ultrasonic flow meters were tested over a range of pressures and flow rates in piping configurations that are similar to those commonly used for rotary meters.

PR-306-16602-R02 - EFFECTS CALIBRATION BLENDS ON CHROMATOGRAPH ACCURACY – UNBLINDED

This report describes the tests results carried out on five natural gas gross calorific value analyzers depending on the calibration model. Three analyzers were conventional gas chromatographs. Two analyzers were new generation gas chromatographs. Twenty-three gas blend were used for this study including three calibration gas blends. Therefore, the report enables the most suitable linear calibration model to be chosen, in order to minimize gross calorific value measurement errors with respect to methods. This is an un-blinded report for members only. A blinded public version of the report is also available -PR-306-16602-R01.



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Additional Research

PR-015-17606-Z02 Elbow Meter Test Results

PR-306-16602-R01 - Effects Calibration Blends on Chromatograph Accuracy  

PR-306-17600-Z02 Gas Quality Benchmark Manufacturers Survey PII 

PR-461-14602-R02 Sample Mixing Methodology and Centrifugal Forces on Density Determination and S&W 

PR-363-17602-R03 Gap Analysis in Liquid Volume Proving Methods  

PR-363-17602-R02 Gap Analysis in Liquid Volume Proving Methods - Member Version  

PR-306-17600-R01 Gas Quality Benchmark Survey 

MEASUREMENT TECHNICAL COMMITTEE

2019 FUNDED PROJECTS

Develop Guidance for Calculation of HCDP in Natural Gas Pipelines
MEAS-15-01

Auto Diagnostic Method Development for Ultrasonic Flow Meter
MEAS-6-20C

Effect of Upstream Piping on Ultrasonic Meter Bias - End Treatment
Effects MEAS-6-5C

In-situ Ultrasonic Gas Meter Flow Verification MEAS-6-17A

Practical Effects of Rough Walled Pipe in Gas Metering Applications
MEAS-6-5D

Water in Oil Meter Technology Testing MEAS-16-02

SURVEILLANCE, OPERATIONS & MONITORING COMMITTEE

Products resulting from research activities conducted under the Surveillance, Operations, & Monitoring (SOM) Technical Committee improve the integrity of the pipeline infrastructure and the continuity of public service through the development and successful deployment of technologies identify Right-of-Way threats, leak detection, and damage prevention.

Technical Committee Leadership

Chair: Leanne Meyer, Marathon Pipe Line

Vice Chairs: Mike McCutcheon, TransCanada; Mohamed Elaoudiy, Phillips 66 Pipeline; Nikos Salmatanis, Chevron Pipe Line Company

Program Manager: Carrie Greaney, PRCI

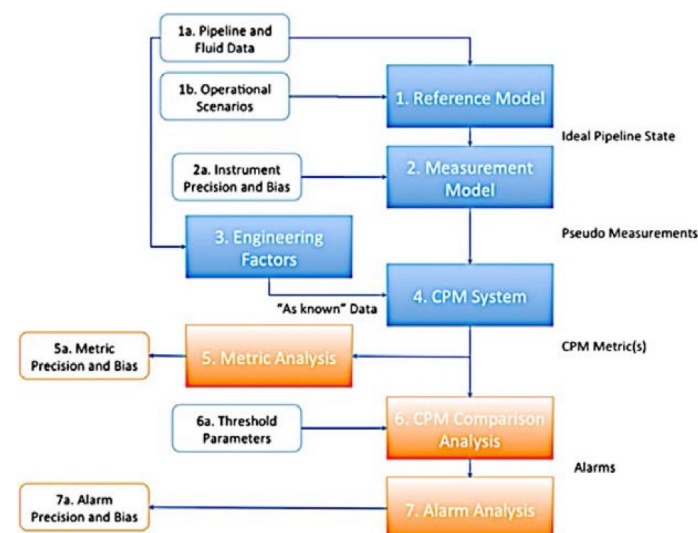
Featured Research

PR-426-123723-R01 PIPELINE VARIABLE UNCERTAINTIES AND THEIR EFFECTS ON LEAK DETECTION SENSITIVITY (API 1149 REVISION)



PRCI developed a revision of the API 1149 procedure for the assessment of uncertainty in CPM techniques, in light of a number of recent technological developments and operational requirements. It is also directed at engineering uncertainty factors that prove, in practice, to have a significant effect on LDS uncertainty but that were not thoroughly addressed in the 1993 version.

The associated software package and users guide is a product of a multi-year research project, which also served as the basis for the updated 2015 API 1149 publication.



PR-015-163766-R01 FIELD TESTING OF DISTRIBUTED ACOUSTIC SENSING SYSTEMS

This report documents a ten-week-long test of four commercially available Distributed Acoustic Sensing (DAS) leak detection technologies on an operational pipeline. The pipeline segment was 25-kilometers in length, and the systems were configured to autonomously alarm to leaks and mechanical digging. This research demonstrates the real-world performance of such systems and provides qualitative information in regards to the operational requirements for sustained deployment of DAS technology.



Additional Research

PR-271-143716-R02 Bayesian Belief Network (BBN) Decision Support for Pipeline Third Party Interference 

PR-420-143719-R01 Commercial Remote Sensing and Spatial Information Technology Applications Program RITA RS-13-01 

PR244-173902-R01 On-water Leak Detection System Evaluation  

PR-420-153722-R01 Pipeline Right-of-Way Ground Movement Monitoring from InSAR for PRCI Satellite Consortium Project 

SURVEILLANCE, OPERATIONS & MONITORING 2019 FUNDED PROJECTS

InSAR Monitoring of Pipeline Geohazards in Vegetated and Very Large Non-Vegetated Areas GHZ-2-03

Case Study: Optimal Approach to Cost Effective, Multi-source, Satellite Surveillance of River Crossings, Slope Movements and Land Use Threats to Buried Pipelines (new multi-year project) GHZ-2-02

On-water Leak Detection Technology Evaluation - Phase 2 PL-1-4A

Airborne Automated Threat Detection System - Monitoring and Surveillance of Imminent Threats Through Remote Sensing ROW-3-1

Autonomous System for Monitoring Pipeline Integrity, ROW Geohazards, and Product Leaks at River Crossings (new multi-year project) GHZ-2-01



SUBSEA TECHNICAL COMMITTEE

The Subsea Technical Committee, established in the fall of 2018, is dedicated to solving the unique challenges faced by subsea pipeline operators related to the design, construction and integrity management of subsea pipelines, risers, and flowlines.

Technical Committee Leadership

Chair: Jamey Fenske, ExxonMobil Upstream Research Company
Vice Chairs: Farzan Parsinejad, Chevron Energy Technology Company;
Ludovic Assier, TOTAL E&P
Program Manager: John Lynk, PRCI

Ongoing Research

In addition to PRCI-wide ballot-funded projects, the Subsea Technical Committee is host to a number of presently active joint-industry-project style Consortium projects. Please contact PRCI if you are interested learning more about this rapidly growing Technical Committee.

Featured Research

DEVELOPMENT OF HEAVY WALL ILI TEST SAMPLES SPIM-1-6

QUALIFICATION AND GUIDELINE OF INSPECTION TECHNOLOGIES FOR FLEXIBLE PIPE INTEGRITY MANAGEMENT SPIM-2-1

SMALL DIAMETER ACOUSTIC RESONANCE (ART) ILI TOOL FEASIBILITY STUDY & CONCEPT DESIGN NDE-4-15



UNDERGROUND STORAGE TECHNICAL COMMITTEE

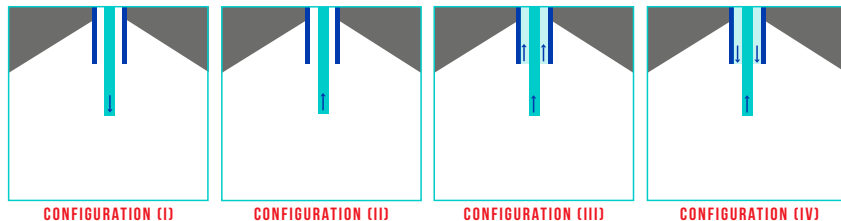
The Underground Storage Technical Committee is focused on developing and deploying technologies to ensure the safety, integrity, reliability and productivity of new and existing storage facilities, including both reservoir and cavern storage.

Technical Committee Leadership

Chair: John W Jackson, Enbridge

Vice Chairs: Stephanie Sexton, ExxonMobil Pipeline Company; Mark Thompson, Enterprise Products

Program Manager: Laurie Perry, PRCI



(I) Tube discharging; no flow in the annulus, (II) Tube aspirating; no flow in the annulus, (III) Tube discharging; annulus aspirating, and (IV) Tube aspirating; annulus discharging

Featured Research

PR-244-15700-R01 CHARACTERIZATION OF 4.5 INCH CASING CORROSION FEATURES

C-FER conducted a measurement and analysis project on characterization of 4.5" casing corrosion features. Casing samples removed from natural gas storage wells were provided for corrosion feature characterization and comparison. These casing samples had been previously logged by Baker Hughes using their High Resolution Vertilog (HRVRT) Magnetic Flux Leakage (MFL) tool in 2013. The log results formed the basis for comparing to laboratory-measured corrosion features to assess the HRVRT performance.

PR-593-16703-R01 LAB AND ANALYTICAL MODEL - FLOW INDUCED VIBRATION OF BRINE STRINGS

This is the report on the 3rd phase of "Brine String Stability Studies." Recent modifications on experimental setup, results of both theoretical and experimental investigations for a discharging tube with an aspirating annulus (configuration (iii)) and experimental achievements for an aspirating tube with a discharging annulus (configuration (iv)) are given. In addition to the results for the brine string problem with internal and external axial flow, a new idea for developing nonlinear dynamics of cantilevered plates in reverse axial flows is also presented.

PR-244-12700-R01 EFFECTS OF STRESS ON CASING MAGNETIC FLUX LEAKAGE (MFL) MEASUREMENTS

Research included a laboratory testing program to determine the effects of stress on casing magnetic flux leakage measurements. Tubing joints with localized defect features were subjected to increments in axial tension to maximum stress levels beyond yield. At various load steps, measurements were made using Baker Hughes' ("Baker") high resolution Vertilog Tool (HTVRT) to assess the variation in the defect measurements with load. This report describes the work performed, results, and considerations for future initiatives.

Ongoing Research

ILI Technology Comparative Testing US-3J

OF, BY, AND FOR THE ENERGY PIPELINE INDUSTRY.

OF worldwide pipeline industry organizations:

Since 1952, PRCI has been recognized around the world as a unique forum within the energy pipeline industry delivering great value to its members and the industry - both quantitative and qualitative - through the development and deployment of research solutions to the operational, maintenance, and regulatory challenges that face it.

BY members working together through PRCI:

The collaboration achieved through members' funding and resource/expertise contributions results in the development of pipeline industry research and technological advances that benefit member organizations and all energy users.

FOR the global pipeline industry and those who have an interest in it:

Members vote for research projects most relevant to their organizations, so projects truly reflect the industry's priorities. The results provide intelligence and allow the industry to continue reducing risks from and to pipelines.

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