

YEAR IN REVIEW 2017

CELEBRATING
65
YEARS





Our Members

Pipeline Members

- Alliance Pipeline Limited
- ATCO Pipelines
- Boardwalk Pipelines
- Buckeye Partners, L.P.
- Cadent Gas Ltd.
- Chevron Pipe Line Company
- Colonial Pipeline Company
- ConocoPhillips
- Dominion Energy Transmission, Inc.
- Enbridge Pipelines Inc. & Enbridge Energy Partners LP
- Energy Transfer
- ENGIE
- Enterprise Products
- ExxonMobil Pipeline Company
- Gassco A.S.
- Kinder Morgan
- Koch Pipeline Company, L.P.
- Marathon Pipe Line LLC
- N.V. Nederlandse Gasunie
- National Fuel Gas Supply Corporation
- National Grid
- Pacific Gas & Electric Company
- Petrobras
- PetroChina Pipeline Company
- Phillips 66 Pipeline LLC
- Plains All American Pipeline, LP
- Shell Pipeline Company LP
- Southern California Gas Company
- Spectra Energy Transmission, LLC
- Total S.A.

- TransCanada PipeLines Limited
- TransGas Limited
- Williams Companies, Inc.

Pipeline Industry Organizations

- American Petroleum Institute
- Association of Oil Pipe Lines
- Electric Power Research Institute
- Operations Technology Development

Associate Members

- Applus RTD
- Baker Hughes, a GE company
- China Petroleum Pipeline Engineering Co., Ltd.
- RCP Inc.
- Shell Global Solutions (US) Inc.
- Sonomatic Limited

Technical Program Associate Members

- Aegion Corporation
- ArcelorMittal
- Australian Pipelines & Gas Association – Research & Standards Committee
- Baoshan Iron & Steel Co., Ltd.
- CNPC Tubular Good Research Institute
- Diakont
- Dresser-Rand Corporation
- Elster-Instromet N.V.

- Emerson Process Management
- Enduro Pipeline Services, Inc.
- Evraz Inc. NA
- Hoerbiger Kompressortechnik Holding Gmbh
- i2i Pipelines Ltd.
- Innospection Ltd
- JFE Steel Corporation
- KROHNE, Inc.
- The Lincoln Electric Company
- NDT Global
- Nippon Steel & Sumitomo Metal Corporation
- Quanta Services – Inline Devices, LLC
- Riccardelli Consulting Services
- The ROSEN Group
- ShawCor Ltd.
- SICK Process Automation
- Solar Turbines, Inc.
- Subsea Integrity Group
- T.D. Williamson, Inc.
- Team Inc.
- TWI Ltd.
- Welspun Tubular LLC
- WorleyParsons Group Inc.

**Pipeline Research Council International
is the preeminent global collaborative
research development organization of, by,
and for the energy pipeline industry.**

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Letter from the Chairman

JEFF WHITWORTH



It is a great honor and privilege to accept the role of PRCI Chairman for 2017-2019. I would like to begin by acknowledging the accomplishments of our outgoing Chairman, Mr. Phillip DePriest. Under Mr. DePriest's leadership, PRCI made significant improvements to the organization. Key accomplishments under his direction include the establishment of PRCI's **Research Objectives** – a formal process by which we integrate the key challenges of the oil and gas pipeline industry into the PRCI roadmap; the newly formed **Research Steering Committee**, which ensures the appropriate prioritization of PRCI's Research Portfolio, and finally, the **Research Bank** created during Mr. DePriest's tenure that allows members to set aside annual funds to invest in off ballot projects to address key issues facing PRCI members. In its inaugural year, members contributed more than \$1.5 million to the Research Bank.

Just as the pipeline industry focuses on continuous improvement, so does PRCI. Therefore, during my tenure as Chairman, I will work to continue Mr. DePriest's progress and further build upon the organization's substantial foundation.

Looking to the coming year, I plan to focus on **Project Inventory and Knowledge Transfer**. To remain a global leader in pipeline research, I believe it is mission critical for PRCI to deliver our project inventory and results more effectively and efficiently.

As we complete our current project inventory, we will also initiate exciting new opportunities that will provide



a step change in the way we collaborate as an industry. In September, the Executive Assembly approved work on establishing an interactive ILI tool performance repository to improve pipeline reliability and integrity. Another focus area will be to leverage the TDC to improve ILI and NDE performance. This work will employ the recently implemented Research Bank to fund a **Joint Industry Project** and complete the work on an accelerated schedule.

My challenge to the PRCI community over the next two years is to improve PRCI's value proposition by emphasizing delivery of relevant research that can be implemented in a practical manner. Through effective utilization of PRCI research, we will improve process safety performance in the pipeline community.

“Through effective utilization of PRCI research, we will improve process safety performance in the pipeline community.”



Jeff Whitworth

Letter from the President

CLIFF JOHNSON



This has been a great year for PRCI – and I am looking forward to a productive and impactful 2018. As we plan for the future, it is clear that our organization is at an important inflection point. The value of research has never been higher, as there continues to be negative public sentiment towards energy pipelines and facilities, which is why our driving goal is to produce research that focuses on safety and integrity. It is paramount to our mission at PRCI that we continue to provide the needed tools and processes that enable the oil & gas industry to safely maintain the global pipeline network. The following are a few examples of how PRCI research impacted the industry in 2017 and enhanced our membership.

A great compendium of ILI and NDE data exists in our industry and represents an abundance of opportunity. The Integrity & Inspection Technical Committee recently completed the second phase of the ILI Crack Tool Reliability and Performance Evaluation research. The project overcame the challenges associated with data gathering and now represents the first known exercise to establish an *industry-wide database* for modern crack ILI technologies. The database has set a new standard for data mining as a basis for establishing ILI performance metrics. Significant results of this analysis concern crack shape and its influence on detection, burst pressure, and differences between ILI indications and field measurements, and effective crack detection depth. The database provides the industry with the necessary framework to begin assessing the strength of various NDE and ILI tools and processes and to understand



which may perform best for which defects.

The Compressor and Pump Station Technical Committee recently completed the first phase (field campaign) of the Environmental Protection Agency (EPA) Regulatory Model (AERMOD) project, which evaluated its applicability in estimating ambient NO₂ concentrations used for permitting gas industry sources. The analysis identified multiple factors that contribute to the model's significant over prediction of NO₂ from pipeline engines, including:

- Light wind conditions
- Building downwash
- Plume chemistry

After recent meetings with the EPA and the Oklahoma Department of Environmental Quality, the agencies indicated an interest in considering our data for enhancing the model. This work enhances our members' environmental stewardship of these important facilities.

These are just two of the many projects that were completed in 2017. As we move into 2018, I encourage you and your company to get involved. The development and production of the research is a partnership between members, staff, and researchers. There are still many key issues that we must address to further raise the bar.

“It is paramount to our mission at PRCI that we continue to provide the needed tools and processes that enable the oil & gas industry to safely maintain the global pipeline network.”



PRCI'S
FIVE YEAR
STRATEGIC
PLAN
2018-2022



A major focus of PRCI's leadership over the past year has been the development of the 2018-2022 Strategic Plan for the organization. Centered around a refined Mission Statement, the strategic goals laid out below will continue to build on our success and serve as a guide to move PRCI to the next level and enable us to better address the needs of our members and the industry.

In order to fulfill our goals, it is important for every member, employee and stakeholder involved in PRCI to be aware of the Strategic Plan and consider how our actions within all aspects of the organization support the mission and the goals. The plan should be used to set priorities, focus energy and resources, strengthen operations, and ensure that we are working toward common goals.

Mission Statement

To collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems.

Strategic Goals

- 1 PRCI will enhance the tech transfer of the research portfolio with a focus on usability and relevance to the operator members.
- 2 PRCI will improve the execution of the research portfolio and achievement of the Research Objectives.
- 3 PRCI will create a community of collaborative research that enables/establishes a culture of participation for members at all levels: that enables networking, leadership development, and professional development.
- 4 Identify, and when appropriate, pursue innovative, step-change, pro-active solutions.
- 5 Ensure the sustainability of the Technology Development Center.

PRCI
TECHNOLOGY
DEVELOPMENT
CENTER

2

The Technology Development Center: A Tool to Ensure Pipeline Safety & Integrity

In 2017, as the Technology Development Center (TDC) was well into its second year of operations, it continued to mature and grow as a one-of-a-kind industry facility. The uniqueness of the TDC facility becomes more apparent as the pipeline industry continues to use its available resources for a variety of pipeline related projects.

The facility was used in 2017 for both PRCI and non-PRCI related work. Both operators and service providers used the facility individually and as collaborators. The TDC was used for NDE testing and qualification certification of field technicians, which proved to be ideal due to the proximity of the available meeting space to the warehouse stocked with real-world pipe samples. One non-member company, after seeing the benefits of the TDC, became PRCI members as a direct result. This is a fine example of how valuable the TDC is for the application of practical research.



The TDC has a fully-equipped conference center.

The pipe inventory grew to over 1,300 samples in 2017. It is these samples that create exceptional value and research opportunities for PRCI members and the pipeline community, so please keep those pipe samples coming! **We are currently looking for samples with cracks and interacting defects.**

Thank you to those who have already generously donated to the TDC inventory.

Part of the uniqueness of the TDC is the ability to create the needed assets for each of the projects. For example, this year we constructed both a 20-inch and 8-inch string in the state-of-the-art pull test facility. With the current inventory of pipes, we are able to build strings with diameters from 6- to 32-inches and this year we even pulled through a 42-inch diameter pipe string. The accessibility of the facility and the available liquid flow loops and pull test strings make it ideal for inline inspection tool development, validation and testing.



The pull test facility at the TDC can pull tools up to 11 miles per hour.

Not only are we working to enhance the tools, but also the processes and personnel that support the industry. One such project conducted in 2017 proved to champion the facility for that very purpose and emphasized how the industry can maximize the value of the money invested jointly in the TDC. The non-PRCI project evaluated current EMAT technology on several critical indications found during a real-world EMAT inline inspection. Williams, a long time PRCI pipeline member company, was able to leverage the TDC's pull test facility using their previously inspected pipe, which had been extracted from

their line earlier in the year, to conduct pull-through tests using the exact same EMAT tool as previously used, at both low and high speeds.

The pull tests, which collected and thoroughly measured and evaluated intact cracks, was instrumental in helping Williams make a required notification to the Pipeline and Hazardous Materials Safety Administration (PHMSA) of the U.S. Department of Transportation concerning the use of EMAT technology. Recently, PHMSA notified Williams they had no objections to William's use of EMAT technology as described in their submittal.

"Williams was able to leverage the TDC, at a very competitive cost, to conduct necessary research that was influential in our response to PHMSA regarding the use of EMAT technology. This research was not only beneficial to Williams, but to the entire industry," commented Williams' Asset Integrity Engineer, David Katz, P.E.



PRCI members receive discounted TDC facility rates.

PRCI funded project work continued to flourish in 2017. Notably, the addition of a 12-inch liquid test loop, which directly benefited the *Performance Capabilities Evaluation of ILI for Long Seam Features In ERW Pipe* (IM-3-1) project by incorporating ERW pipe samples into the loop design. The project intends to validate current ILI technologies and their performance capabilities in an effort to identify the best inspection methods for detecting critical flaws along the long seam. The intended benefit of this analysis is to improve the remediation decision process by enhanced identification of injurious cracks, or crack like features, vs stable manufacturing flaws.

Utilizing the extensive pipe inventory, the *Validation of In-ditch Material Characterization Equipment and Techniques* (NDE-4-8) project is using pipe samples to test accepted *in situ* non-destructive techniques that can identify the mechanical properties of the pipe, especially toughness. By validating an in-ditch method for establishing toughness, operators will be able to perform fitness-for-purpose analysis and establish operating pressures based on actual pipe properties, rather than using overly conservative values.

These are just a couple examples of the PRCI project work conducted in 2017, and there are additional PRCI project highlights in this Year in Review.

If you are interested in any of the available services at the TDC or would like to schedule a tour, please contact us at TDC@prci.org.

"To see the TDC be leveraged collaboratively by member companies, and non-member companies alike, for both PRCI and non-PRCI project work, gives me a great deal of satisfaction, as that was the intent when the Board approved its construction – a facility for the advancement of pipeline research for the entire pipeline community," said PRCI President Cliff Johnson.

**THE TECHNOLOGY
DEVELOPMENT CENTER BY
THE NUMBERS**

1,900+

Visitors in 2017

1,300+

Pipe sample inventory

\$1.7MM

of research projects

7

External projects using the pull test facility and liquid test loop

6" & 12"

liquid flow loops constructed

5

strings in our state-of-the-art pull test facility: 24", 20", 16", 12" and 8".

20,000+

square feet of indoor warehouse space

Up to 40,000 lbs

can be pulled via winch



WEBINARS:
KNOWLEDGE
SHARING &
INDUSTRY
COLLABORATION

3

Through careful content planning, creation and collaboration, PRCI continued using webinars as a powerful new communication tool in 2017 to transfer the results of our research. Webinars allow for easy, real-time access to research and industry experts that further establishes a culture of participation from members at all levels.

All PRCI webinars, many covering the results identified in this Year in Review, are recorded and available to view at any time. Please visit the Research section of our website to see a list of all past and upcoming webinars.

Here is a look at PRCI's webinar program by the numbers:

Average number of attendees:

89

Total number of webinars:

12

Total number of attendees:

1072

Total number of downloads:

475

Most attended webinar (Public):

**Improving the Dig
Selection Process for
SCCDA**

Most attended webinar (Members Only):

**Guidelines for the
Determination of Pipeline
Lowering-in Stresses
and Mitigative Strategies
for Construction – Joint
PRCI & IPLOCA Research
Initiative**

A low-angle, upward-looking shot of a worker in a white hard hat and a blue and yellow safety jacket, reaching up into a dense network of industrial pipes and metal structures. The entire image is overlaid with a semi-transparent orange filter. The pipes are arranged in a complex, crisscrossing pattern, creating a sense of depth and scale. The worker is positioned in the lower right foreground, looking towards the upper left where the pipes converge.

ACCOMPLISHMENTS & IMPORTANT FINDINGS IN RESEARCH

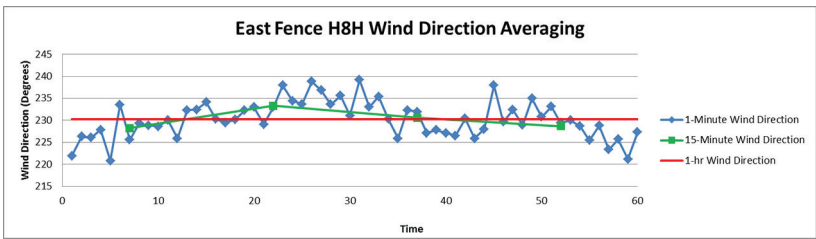
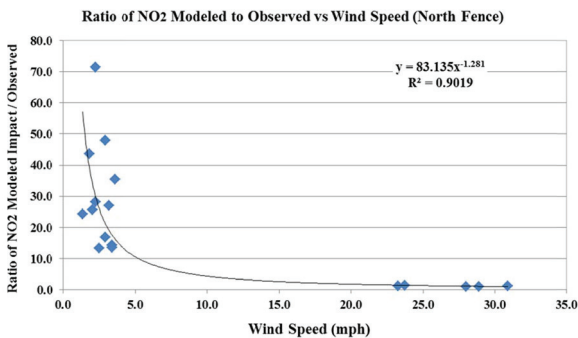
4

Compressor & Pump Station

Continued Focus on Controlling Emission of Hazardous Pollutants, Enhancing Engine Reliability and Emission Compliance

Since the change in ambient NO₂ standards by the USEPA in 2010, it has been increasingly challenging to verify compliance at some compressor station facilities by utilizing the AERMOD tool. PRCI coordinated with others to gather a comprehensive dataset that included ambient NO, NO₂, and ozone measurements at four locations around a compressor station, parametric emissions from the compressor units, and meteorological conditions. The 13-month data gathering period has been concluded and an initial analysis of the data has been published (along with the associated dataset). Significant conclusions include:

- AERMOD downwash models appear to significantly over predict ground concentrations of NO₂ for the types of exhaust stacks/buildings used by the industry.
- AERMOD significantly over predicts ground concentrations of NO₂ during low wind conditions.
- There is a wide variation in the performance of the various dispersion chemistry models available in AERMOD. In general, the default models significantly over predict when compared to some of the more complicated models. Typically, special approval is required to use the more complicated models.
- The dispersion chemistry models significantly over predict for ambient monitors that are relatively close to the emission source; i.e., the chemical reactions converting NO_x to NO₂ in the model appear to occur faster than they do in the environment.
- AERMOD appears to over predict due to the assumption that meteorological conditions are held constant throughout a one-hour evaluation period. Meteorological data shows that there is sufficient variability in both wind speed and direction that reduce the actual ground level concentrations.



Statistical Data on the Ration of NO₂ to total NO_x by Engine Type

Related to the AERMOD work, PRCI has produced statistical data on the ratio of NO₂ to total NO_x by engine type. This may be used by users of AERMOD to provide more realistic assumptions on the NO₂ emissions from engines used by the industry.

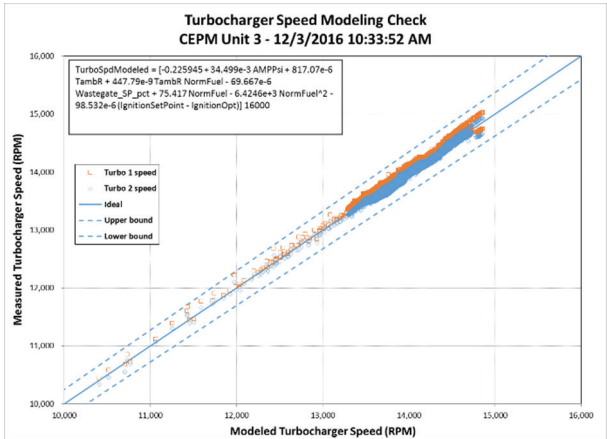
Engine or Turbine Category	No. of Tests	Controlled NO2/ NOx Ratio	Uncontrolled NO2/ NOx Ratio
2SLB RICE	1,227	0.285	0.112
4SLB RICE	462	0.336	0.257
4SRB RICE	115	0.054	0.013
Turbine (All Units)	491	0.249	0.131

Guideline Development for the Selection, Design, Operation, Troubleshooting and Maintenance of Vertical Pumps

These pumps are often improperly designed or selected and further are misapplied or inappropriately used. The industry standards for vertical can booster pumps are generic and do not consider all the specific requirements and service needs in pipeline applications. The work examines best practices considering the unique design issues for pipelines and how the pumps should be specified, operated and maintained to ensure long term service.



Continuous Equipment Performance Monitoring

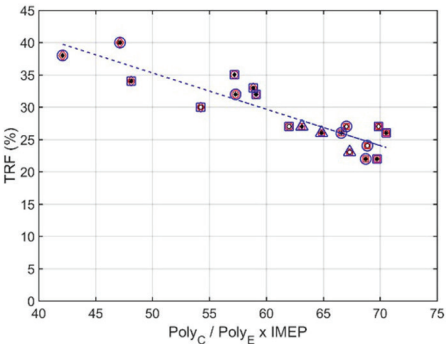


Additional work was completed further enhancing continuous equipment performance monitoring (CEPM). This work focused on conventionally instrumented reciprocating engine/ compressor units. This effort extends diagnostic techniques to main bearings, power cylinder exhaust temperatures, and ancillary equipment (e. g., turbocharger, aftercooler, pumps). Additionally, combustion monitoring techniques are described that can be implemented on most existing mainline compressor units used in the industry. Work was also

completed for highly instrumented engines including ignition diagnostics and combustion performance monitoring.

Development of a Model to Investigate Trapped Residual Fraction (TRF) at Various Operating Conditions

A GT-Power based model was developed to simulate the AJAX E-565 single cylinder, large bore, natural gas fueled two-stroke engine. This model was used to investigate the trapped residual fraction (TRF) at various operating conditions. This is an ongoing exercise. As of now, the engine has been simulated at 19 different operating points that include different speeds, loads and spark timings. Effects of various engine parameters, if any, on the TRF (or conversely) were studied. Preliminary findings have shown

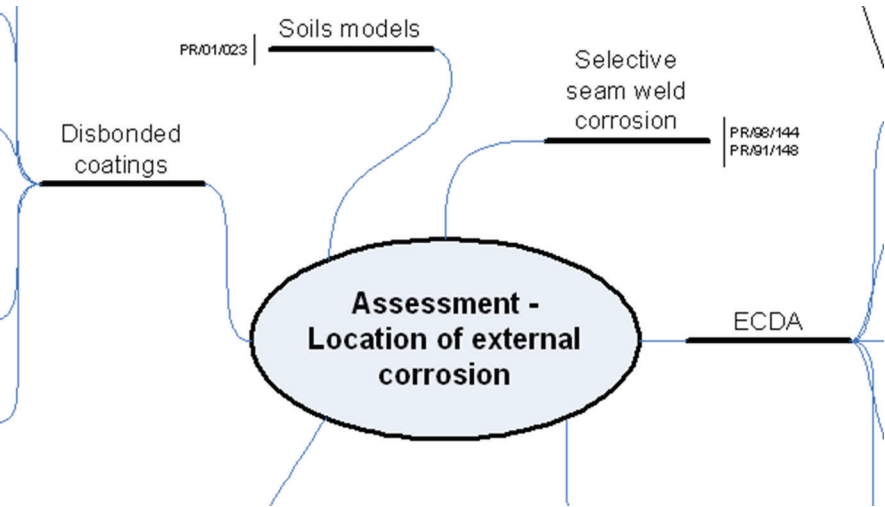


some promising relationships between indicated mean effective pressure and temperature at exhaust port closure with trapped residual fraction. To develop an operating point independent correlation between trapped residual fraction and indicated mean effective pressure, a ratio of the compression and expansion polytrophic coefficients is being tested to tune the indicated mean effective pressure. This approach has shown some promising results (illustrated in the plot above). In the next stages of the project, this approach will be vetted by simulating more operating points and experimental trapped residual fraction measurements.

Corrosion

Summarize Findings from Past PRCI Reports in an Expert Review

This summary report of past PRCI and PHMSA-funded projects on external corrosion is intended to make it easier for member companies to identify and locate past projects to avoid unnecessary replication and to aid in implementation of the results. In purely monetary terms and conservatively assigning a budget of \$100,000 per project, the current report summarizes a combined investment by PRCI to the order of \$20 million. If this report results in the avoidance of only two to three future projects, then the savings alone would be of the order of \$1 million. The summary report will also provide operators with a collective corporate knowledge in the area of external corrosion for use by engineering staff.



Design, Materials & Construction

Development of Guidelines for the Determination of Pipeline Lowering-in Stresses and Mitigative Strategies for Construction: A Joint PRCI & IPLOCA Research Initiative

This project was a multi-year joint effort among PRCI, the International Pipe Line and Offshore Contractors Association (IPLOCA), and the Interstate Natural Gas Association of America (INGAA) aimed at developing a common framework for generating lifting and lowering-in procedures. The key outputs of this effort included a software tool and a set of written guidelines for the management of lifting and lowering-in stresses. The tool and the guidelines can be used to generate specifications

of operational parameters, such as the number of sidebooms, spacing between adjacent sidebooms, maximum lifting heights of the sidebooms, necessary lift load, et al., to ensure that the maximum stress stays below a predetermined safe level. A webinar was held in May 2017 to review the proposed final software product. It is expected that the feedback from the webinar participants will help the project team revise the tools and guidelines to better serve the needs of the industry.

Composite Repair Load Transfer Study

Composite repair systems are typically installed with internal pressure in the pipeline, and this reduces load transferred from the flawed pipe to the composite layer. Much of the previous work has utilized composites applied to pipes at low or zero pressure; therefore, the pipeline industry needs guidance in quantifying the effects of internal pressure on the level of reinforcement provided composite repair systems. By identifying critical factors such as the composite systems material properties and the filler material, this program will quantify the performance levels that account for internal pressure in the pipeline. A webinar was held in September 2017 to review the results of the project and provided a demonstration of the primary deliverable, a calculator that utilizes critical factors identified during testing including pipeline geometry and grade, anomaly type, and composite repair properties including geometry and material properties.

Pipeline Construction Using Mechanical Connectors

The results of this study show that while many connector concepts have been proposed, prototyped and, in some cases tested, industry experience through application on actual offshore projects remains limited. Nevertheless, advances over the past two decades in connector technology bring their application on offshore pipeline projects closer to reality from the technical perspective.

Three basically different connector types were identified:

- 1 interference fit between bell or box and pin
- 2 interference fit with non-helically threaded box and pin
- 3 helically threaded (with or without separate coupling element)

Interference fit connectors with bell and pin for shallow water or connectors with non-helically threaded box and pin for shallow and deep water are the most viable alternatives for welding. Of these connectors the interference fit bell and pin connectors for shallow water already have a limited offshore track record from the commercial perspective, the viability of using mechanical connectors in place of welded joints remains to be evaluated on a case-by-case basis. Cases where the mechanical connectors are most likely to be competitive include small diameter pipelines in water depths shallower than 200m and pipelines with short to medium length in any diameter size or water depth.

Integrity & Inspection

Evaluated and Quantified the Performance of Large Standoff Magnetometry Techniques

These inspection techniques are of value due to their ability to assess the integrity of both difficult to inspect and conventional buried pipelines. The research examined results from field trials of available technologies to determine the reliability, correct calls, misses and false calls of these tools. While these

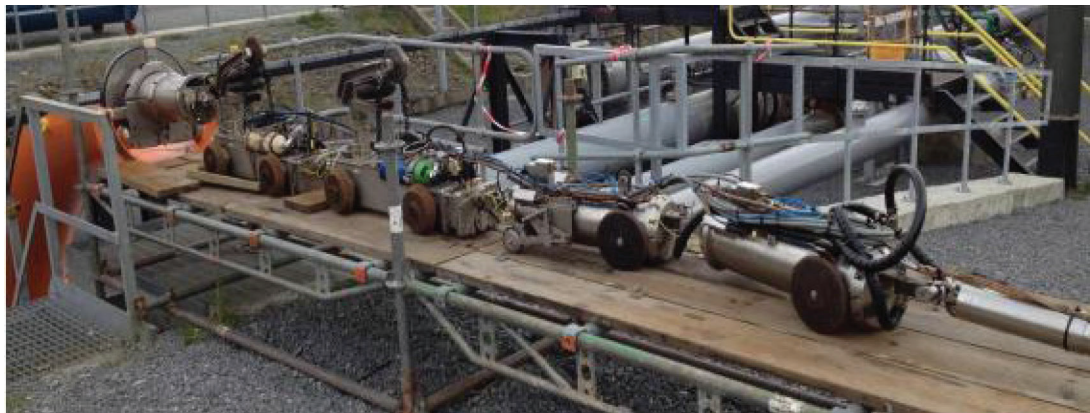


techniques are in initial stages of development, the potential to operators is substantial if they can be proven to be accurate with a high probability of detection. Understanding the base physics remains a key aspect of determining what is measured by this technology and how the results are interpreted.

Alternate Inspection Assessment Approach Using Low Resolution NDE

PRCI advanced the integrity assessment of difficult-to-inspect pipelines by proposing guidance for application of alternate inspection approaches other than hydrostatic test, in-line inspection and ECDA/ICDA, which are currently prescribed by Code and Regulations. The results propose a new structured process that evaluates low resolution NDE data of the pipe wall for the full

length of the pipeline followed by statistically significant numbers of high resolution wall thickness measurements to predict the condition of the pipeline relative to the fitness for service criterion of corroded pipe such as prescribed in ASME B31G.



Evaluation of Dents with Cracks for the Enhancement of ILI Technologies

Pipe samples were created with fatigue cracks in dents for the evaluation and enhancement of ILI technologies. The dent samples are now part of the mechanical damage inventory at PRCI TDC facility and will be used in the pull string for ILI performance evaluation and identify capability gaps, if any, where further development and/or enhancement of new technology is required. Additional pipe samples with dents were created to capture the life cycle of a dent, i.e.; elastic re-rounding; elastic re-rounding and pressure re-rounding; low number of pressure cycling and pressure cycling to beginning of crack initiation. The purpose of creating these four dent samples is to investigate whether there are measurable differences in magnetic, or other signatures, that can be detected by ILI or NDE technologies, can be used to establish the current condition of a dent.



Completed Construction of a 12-inch Liquid Flow Loop at the Technology Development Center

This is in addition to the already existing 6-inch liquid flow loop. The design of the loops provides the ability for continuous test cycles, and has the physical space and access to include a variety of pipeline configurations that can be encountered in pipelines ranging from piggable to “difficult to inspect.” The availability of the flow loop facility to the industry enables independent research on ILI tools using liquid-coupled sensor technology. Other applications include leak detection and flow reversals.



Developed Method for Determining Pipe Properties

PRCI developed a method and guidance for application of In-Line Inspection (ILI) technologies and/or in ditch non-destructive examination approaches for determining pipe properties, which will allow operators to use ILI to meet traceable, verifiable, and complete requirements that provide value to the pipeline industry.

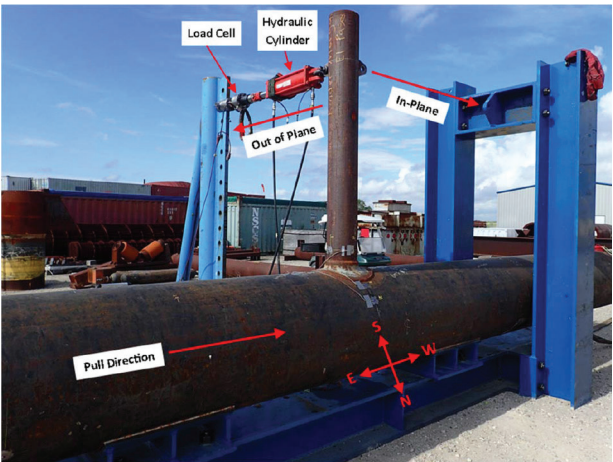
Detection of Close Metal Objects

The research tested MFL technology to determine whether a Close Metal Object (CMO) is near the carrier pipeline. There have been failures associated with CMOs both in contact and near the pipeline, specifically water lines. With the knowledge gained on the sensitivity of MFL technology to detect such objects, operators can now identify those CMOs that may be a hazard to the pipeline and prioritize them for evaluation. In October 2017, PRCI held a webinar to present the results of the research.



Evaluation of Low Field Magnetic Flux Leakage

This project evaluated the ability of Low Field Magnetic Flux Leakage (LF-MFL) in-line inspection technology to characterize loading conditions around branch connections and to validate the use of LF-MFL ILI to identify stressed branch connections. The results of this work provide operators with guidance for using LF-MFL ILI tools to identify integrity threats. A webinar was held in November 2017 to present the results.



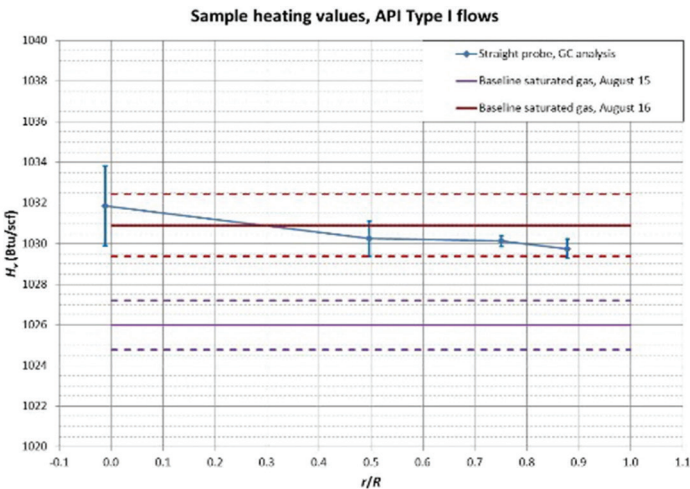
Evaluation Method for Determining Steel Grade and Calculate MAOP

This research evaluated technology using a Hardness, Strength, and Ductility (HSD) tester intended for use in the ditch for yield strength and variability in toughness. This project tested the ability to determine the steel grade of pipes through measurement of the American Petroleum Institute (API) 5L yield strength from testing the outside diameter surface of pipe joints without significant material removal. This data is intended to be used by pipeline operators to determine steel grade and calculate the maximum allowable operating pressure (MAOP) if allowed through engineering critical assessment or for determining acceptable anomaly criteria in pipeline integrity management.

Measurement

Minimum Necessary Insertion Length for Gas Sample Probes

This study assessed the minimum necessary insertion length for gas sample probes. The research concluded that current standards generally require longer sample probes than desirable.



Development of a Standardized Test Protocol

PRCI developed a standardized test protocol for the calibration of ultrasonic meters with a corresponding database to capture the calibration data and associated meter diagnostics information.

Surveillance, Operations & Monitoring

Open Path Laser Spectrometer (OPLS) Technology Development

The initial Open Path Laser Spectrometer (OPLS) methane sniffing technology developed as part of the ROW-3H project with NASA Jet Propulsion Lab (JPL) has been licensed by two commercialization partners, RKI Instruments and SeekOps. They plan to provide commercial products for parts-per-billion methane sensing from small unmanned aerial systems (sUASs) and hand-held instruments. The OPLS technology development was initiated with the goal of applying miniature gas sensors for fugitive emissions detection and geolocation. It should be noted that the commercially available versions are validated within the research project for methane only. PRCI is still working with JPL on validation for a combined methane and ethane version for the sensor system that would help to eliminate false indications of biogenic natural gas sources.

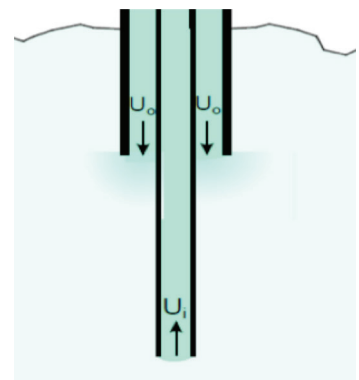
The Use of Unmanned Aircraft Systems (UAS) for Pipeline Monitoring and Surveillance

Initial research to develop technology solutions for pipeline monitoring and surveillance using Unmanned Aircraft Systems (UAS) was completed this year. This work focused on verifying the use of long-range UAS for pipeline patrol. The flight testing successfully demonstrated the interoperability of PRCI's Automated Threat Detection System (ATDS) payload, which is a significant outcome that will support the development of other sensing capabilities to be integrated into the ATDS payload. Results of the testing demonstrated that a UAS can be configured with technology systems that provide meaningful data and information on a range of pipeline operating and integrity parameters. Emphasis was concentrated on the safe operation of larger UAS platforms flying Beyond Visual Line of Sight (BVLOS) of the pilot operator, which is a necessary capability for covering thousands of miles along relatively narrow right-of-way (ROW) corridors. The work conducted to date has included a series of test flights to demonstrate that UAS can be applied to day-to-day functions of energy pipeline integrity management and that they can operate safely, effectively, and in full compliance with all federal and state laws or regulations.

Underground Storage

Vibration Study at McGill University

Through the ongoing study at McGill University we are extending the understanding of the flow-induced instabilities of brine and production strings used in salt-cavern applications. Learnings include how string movement/deformation and vibration are dependent on fluid velocity and geometric parameters of the string and casing. Bench scale testing and analytical modeling provides a quantitative framework for characterizing these factors. The findings from this work and future field testing will provide operators with added confidence in increasing the maximum allowable product flow velocity while maintaining brine string integrity, thus enhancing productivity.







2017 COMPLETED RESEARCH REPORTS

5

Compressor and Pump Station

- Balko Compressor Station 102 Data Summary and Initial AERMOD Performance Assessment
- Variable NG Composition Effects in LB 2S Compressor Engines – Prediction Enhancements
- Demonstration of Continuous Equipment Performance
- Pipeline Vertical Booster Pump Design Operation and Maintenance Best Practices
- Effect of Variability in Fuel on Operation and Reliability of Gas Turbine

Corrosion

- Expert Review of Past PRCI Corrosion Reports, Gas Analysis and Road Mapping
- Improved Site-Selection Modeling by Correlating ILI with Operational-Geotechnical Data
- Field Techniques for Determining Corrosion Status
- Review of Self-Healing Pipeline Coatings for the Prevention of External Corrosion
- The Effects of Test Voltage on FBE Coatings
- Evaluation of EMAT Tool Performance and Reliability by Monitoring Industry Experience
- Analyzing Active Corrosion in Inspection Data to Evaluate Cathodic Protection Criteria

Design, Materials & Construction

- Assessing Crack-Like Flaws in Longitudinal Seam Welds – A State of the Art Review

Integrity & Inspection

- NDE & Inspection Techniques Applied to the Assessment of Integrity of Composite Wrap Repairs
- Evaluation of Inspection Technologies for Challenging to Inspect Pipelines
- Development of an Industry Test Facility and Qualification Process for ILI Technology Evaluation and Enhancements
- Determining Pipe Properties Using ILI Technology
- Defining Close Metal Object Detection Capabilities of MFL ILI Tools
- Evaluating the Effectiveness of Low Field MFL Technology in Measuring Loading Conditions at Branch Connections
- Hardness Strength and Ductility (HSD) Testing of Line Pipes Initial Validation Testing (Phase 1)

- Evaluation of Large Stand-Off Magnetometry (LSM) Technologies
- Development of a PRCI ILI Performance Test Loop for Liquid Coupled Technologies (Phase 2)
- Full-Scale Demonstration of the Interaction of Dents with Localized Corrosion Defects
- Full-Scale Testing of Real Mechanical Damage Features Using Recovered Pipe

Measurement

- Effect of Upstream Piping Configurations on Ultrasonic Meter Bias
- Machine Learning Algorithms for Smart Meter Diagnostics – Part III
- Effect of Upstream Piping Configurations on Ultrasonic Meter Bias – Unblinded
- Sample Probe Insertion Depth Testing

Surveillance, Operations & Monitoring

- Numerical Modelling and Laboratory Simulation of Subsurface Fluid Migration from Small Pipeline Leaks
- PRCI Airborne Threat Detection System Prototype Development and Analysis

Underground Storage

- Methane Leak Detection and Quantification Systems for Underground Storage Facilities

Visit prci.org to download the 2017 completed research reports, as well as past reports. PRCI reports are available at no cost to members.



A blue-tinted photograph of industrial machinery, featuring large pipes and a prominent handwheel valve. A horizontal line of small white dots is positioned above the text.

CURRENT RESEARCH

6

Compressor & Pump Station

Dispersion Model Accuracy and Associated Opportunities for Improvement of Ambient NO₂

Model evaluation and performance improvements require a robust ambient monitoring and hourly emission data-set to use as the basis to define model bias and over prediction. Absent an adequate monitored data-set, state and regional planning will rely on model over predicted results to develop compliance strategies.

Reducing Part Load Emissions on a Solar Taurus Gas Turbine

A field proven improved control algorithm that will reduce idle and low load emissions. This improved control algorithm will be available for new Taurus 60S shipments as soon as 2018. In addition, this algorithm can be retrofitted onto existing units of the latest SoLoNOx configuration. This information can be used for getting new permits approved and reduce emissions at idle and low loads that will allow greater operational flexibility.

Assessing Residual Gas Fraction Estimation Based on Measured In-Cylinder Pressure

The benefit of the proposed research is improved control of engines by having better knowledge of the trapped residual fraction, which will enable better estimate of TER and thus refined control for NOx over various perturbations (e.g., AMP, IMT, fuel composition, etc.).

Analysis of the Effectiveness of NSCR Control System

By producing a comprehensive model of NSCR, this work will also serve as a building block for developing logic-based control systems.

Further Development of Emission Factors for Greenhouse Gas Emissions Reporting

The work includes data gathered through public (EPA) sources as well as member supplied data with a focus on the largest sources.

Field Evaluation of Field Pump Performance Testing Procedures

This research will benefit the liquids pipeline industry by providing practical guidelines for conducting field performance tests of pipeline pumps in viscous service and by providing a comparison between the corrected water performance curves and actual pump performance at high flow conditions with high viscosity fluids. This study also has the potential to improve the operation of pump stations by having a better understanding of pump performance in the field and how that differs from factory acceptance tests. This can lead to efficiency and operational improvements.

Simplified Test Methods Using Portable Emissions Analyzers for Emissions Verifications

An alternative Portable Analyzer Test Method that simplifies the method, including technically justified and simplified calibration (and other QA/QC) methods, will result in lower testing costs for reciprocating engines and turbines - including compliance test costs for state regulations and permits, U.S. EPA NSPS and NESHAP rules, and Environment Canada engine test requirements.

Enhancing the Reliability of Centrifugal Compressor Dry Gas Seals

The objective is to improve the reliability of dry gas seals on centrifugal compressors. The specifics of why some seals perform adequately and others do not is not known. When a seal does fail, it releases greenhouse gases and requires an extended, unscheduled outage.

Reciprocating Engine Starting Reliability

Evaluating alternatives to improve reciprocating engine starting reliability and reduce the engine wear associated with startup combustion instabilities.

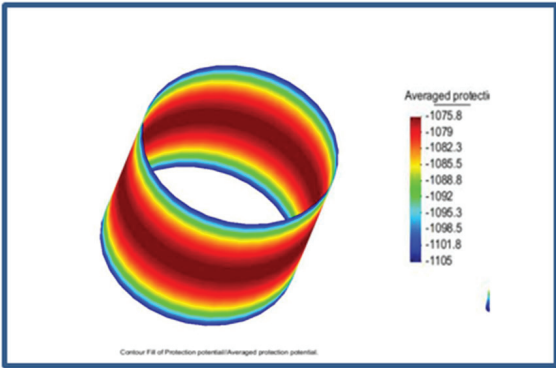
Develop Standardized Control Routines for Trapped Air/Fuel Control

The proposed research uses a combination of field-based empirical data and GT-Power simulation tool to provide controlled changes to fuel composition and observe computationally predicted engine response in terms of engine power, efficiency, and emissions. The research will allow operators to accurately capture fuel variability as part of a modified control method.

Corrosion

Assessing High Voltage DC Interference Risks on Buried Pipelines

The project’s objective is to investigate the risk of DC stray current corrosion on pipelines and to understand the influence of HVDC system configuration & operational conditions. Currently, data analysis is in progress with result availability scheduled for the 4th quarter of 2018.

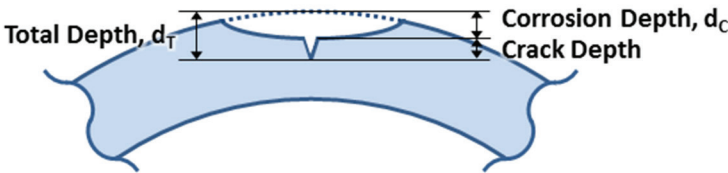


Guidelines on the Selection and Application of CP Coupons

CP coupons are used extensively in the industry to assess CP levels, yet there are no accepted guidelines for determining most appropriate coupon configuration. The project goals include the development of guidelines and recommendations describing how a coupon is representative of the CP level of a pipeline and to establish technical knowledge for CP coupon selection and application.

Assessment of Fitness-for-Service for Crack-within-Corrosion Anomalies

The purpose of this research project is to develop a tool to predict the failure pressure of crack-within-corrosion anomalies. The need for this research was initiated, in part, in response to NTSB recommendations post Marshall, Michigan.



Design, Materials & Construction

Guidelines for Using Composite Systems to Repair High Pressure Gas and Liquid Transmission Pipelines

The PRCI Composite Repair Research Roadmap prepared by a cross section of member operators identified the absence of a composite repair guidance document as being a key gap in the current body of knowledge. The objective of this project is to fill that gap by developing a prescriptive technical guidance document based on engineering principles, experience, and applicable codes and standards.

Integrity & Inspection

Testing of ILI Systems for the Detection, Sizing, and Discrimination of Known Features

Evaluating the current performance of a range of ILI systems for detecting, sizing, and discriminating coincident features associated with geometric anomalies, including cracks, metal loss corrosion, and dents with gouges. This program is utilizing the Technology Development Center in Houston to pull ILI tools through pipe samples with known features. The testing performed and data collected will also provide a basis for developing a standard set of ILI Performance Specifications for mechanical damage. The results will be fed directly to other work in the Mechanical Damage program that are addressing improved Mechanical Damage models.

Dents with Cracks – Remaining Life Modelling

The objective of this research is to develop a framework for life prediction of cracks in dents in liquid pipelines based on the existing corrosion initiation and corrosion fatigue crack growth models, and improve

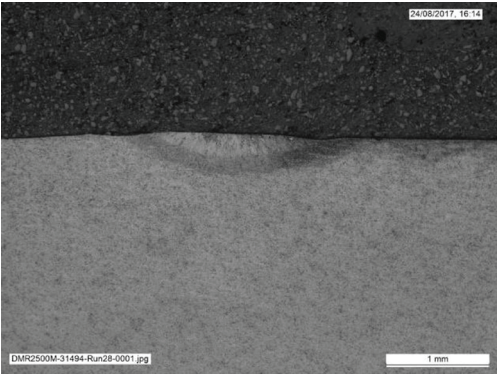


the understanding of the conditions of failure mode for dents associated with cracks. This project will distinguish between the failure mechanism and remaining life of dents with cracks produced by fatigue versus dents with stress corrosion cracking. This will ultimately lead to improved remaining life and leak vs. rupture prediction and modelling.



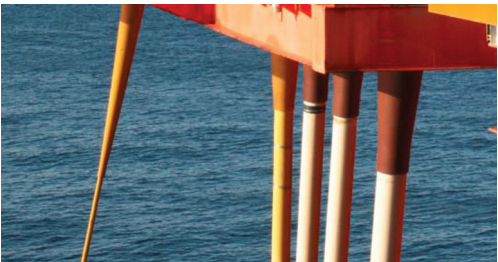
NDE Technology for the Detection of Near-Surface Hard Spots

This research will assess and develop NDE technology capabilities and qualification for near-surface hard spots, with potential deployment to steel mills, handheld devices, and ILI tools. This project will demonstrate the feasibility of NDE for industrial use and evaluate the ability for each technology to quantitatively estimate the hardness in a given area, and provide pass/fail criteria for a given hardness threshold. This project is part of the larger industry effort to understand the formation, characterization, and impact of hard spots on TMCP plate/pipe in the presence of sour service. An NDE methodology/tool will improve the procurement of TMCP plate for pipeline manufacturing by mitigating risk of hard spots prior to pipe formation. The technology could be applied at plate manufacturing or developed as an infield or ILI tool based on industry need.



Inspection Tools for Flexible Pipe Integrity Assessment

The objective of this study will be to conduct a quantitative performance evaluation of available flexible pipe inspection tools and develop a guideline for how the inspection results from such tools can



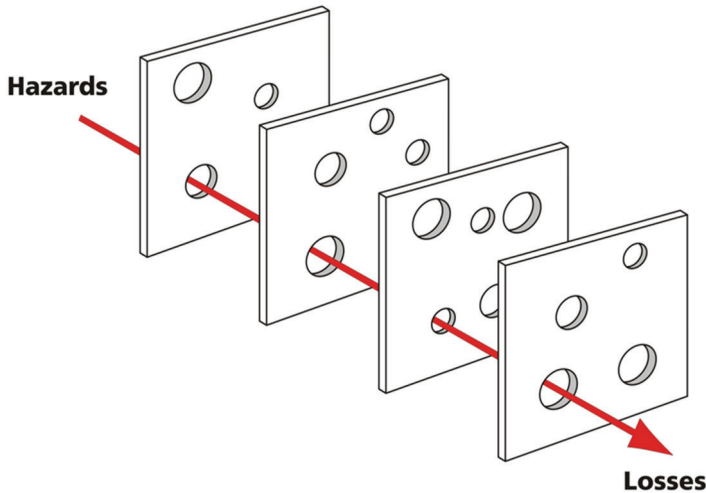
be used to improve the integrity assessment of flexible pipes in operation. The tool performance will be determined by performing blind tests on flexible pipe test samples pre-conditioned with flaws in a lab environment. The guideline will be based on the capability of the tools to detect critical flaws combined with available flexible pipe analysis tools and industry practice for integrity assessment.

Development of a Crack Management Standard and Industry Wide Database

The goal of this research will be to develop a Crack Management Standard and industry wide database for ILI performance that confirms the high-performance capability of crack detection tools and define limitations based on the analysis. Phase I was completed in 2016 and Phase II will be completed in Q1 of 2018 with a follow-on project to add other defects to the industry wide database.

Generating a Guidance Document for Conducting Engineering Critical Assessment (ECA) for Establishing MAOP/MOP

This project provides an opportunity for PRCI members to respond proactively to the PHMSA proposed process with a process embedded in future regulation that enhances pipeline safety and is practical for the industry. The purpose is to provide operators with a tool and an alternative to hydrostatic testing or removal and testing of multiple pipe samples for completing the pending PHMSA IVP.



Testing of Replicated/Machined Defect Samples vs Real World Defects

This research will analyze ILI technology performance specification for corrosion features of real vs. replicated/machined samples to determine how well replicated samples can represent real world defects, thus allowing the ability to generate many more samples without having to rely solely upon in service samples.



NDE Methods for ERW Pipe Weld Seam Anomalies

This study is testing NDE methods for in-ditch analysis of ERW Pipe weld seam anomalies, specifically long seam cracks. The same samples will also be used to test ILI technologies against the same samples used in the NDE testing.



Validating NDE Crack Depth Sizing Performance for Multiple UT Techniques

This research hopes to improve the reliability of in-line crack detection tools by providing a protocol for determining the actual depth of axial SCC or ERW cracks (within an expected accuracy specification) that will, in turn, be used to develop reference standards used for sensor development, training and calibration and a protocol for use in ILI response digs for the purposes of verifying ILI performance.

Validation of In-Ditch Material Characterization

For many early generation pipelines, insufficient data exist regarding their mechanical properties. Mechanical properties, especially toughness, must be known to perform in-service integrity assessments. Toughness estimations based upon an accepted *in situ* non-destructive technique will allow operators to carry out fitness-for-purpose analysis and establish operating pressures based on reliable estimates of actual material properties rather than overly conservative assumed values. This project is the final deliverable for providing an in-ditch pipe material characterization technique.

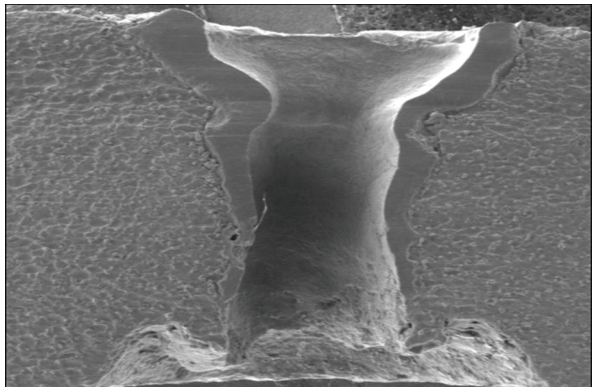


Developing Protocols and Procedures for the Use of UT Imaging for In-Ditch Measurements

UT imaging has demonstrated the capability of detecting, imaging, and sizing crack colonies in limited examples in the laboratory and in pipe yards. The results include a 3-dimensional map of the crack colony. This study is developing validated protocols and procedures for use of UT imaging for in-ditch measurement of cracks within an SCC colony.

Investigating the Applicability of Magnetic Flux Leakage to Inspect Pinhole Defects

This study will be used as a guide in managing pinholes in operators' systems and detection by in-line inspection. Finite element modeling, pull-through testing and field dig verification are being executed to improve the possibility of detection and identification of pinhole, and sizing model is being created.



Measurement

Effects of Upstream Piping Components on Ultrasonic Flow Meter Accuracy

Benefits of the proposed research would be guidance on the placement of piping components upstream from ultrasonic meter runs. Research on the effects of these upstream components on the velocity profile and meter accuracy would provide guidance on meter station design with upstream piping components.

Static Mixer Capability Assessment

S&W is the most challenging aspect of crude oil custody transfer with many variables contributing to uncertainty. This project could allow an end user to more accurately sample liquid petroleum in terms of sediment and water representativity at the point of sample extraction.

Gap Analysis in Liquid Volume Proving Methods

This project would evaluate changes in system (meter, prover, and flow computer) and/or calibration procedures that could significantly reduce the measurement uncertainty. The corresponding improvement in the meter calibration would have a direct correlation to reducing system measurement uncertainty (lost and unaccounted volumes) as improving the minimum detection thresholds of leak detection systems.

Assess and Identify Methods to Reduce Ultrasonic Noise Effects on Ultrasonic Gas Meters

This research has the potential to reduce the cost of each meter installed by approximately 20% if the current double tee configuration is shown to be unnecessary for noise attenuation. A second benefit will be the characterization of noise frequency and amplitude produced by different control valves that could lead to the preferable selection of particular control valve types when used with ultrasonic meters. A third benefit could be recognition of the effects of ultrasonic noise as indicated in meter diagnostic parameters, which may not be readily obvious to operators today.

Assessment of a Compact Ultrasonic Meter as a Potential Replacement for Rotary Meters

The FS500 has been identified as a replacement for low-pressure and high-pressure rotary meters. To minimize cost, it would be ideal if the meter could be installed in the existing meter run pipework that generally does not include 20D of upstream piping.

Assessing Sulfur Condensation in Pressure Reduction Equipment

The research will provide better guidance on what regulator styles are less prone to sulfur deposition, assist regulator/control valve manufacturers with design considerations for future models or for current model improvements, and provide operators a lower cost solution for sulfur mitigation when compared to gas heaters.

Assessing Critical Measurement Issues Associated with Emerging Gas Supplies

The proposed research would allow pipeline operators to adjust their business and operating practices to accommodate new gas supplies.

The Effect of Gas Chromatograph Calibration Methods and Compositions on Performance

Proper selection of calibration gasses will decrease the uncertainty of gas analysis, particularly as C9 units are brought into service. In addition, new gas chromatograph technologies will be evaluated against conventional technologies. This will allow operators to assess the performance of these units independently prior to purchase. The two projects are being performed in combination as there is significant synergies involved with executing these two efforts as one project.

Surveillance, Operations & Monitoring

Final Validation of the JPL Miniature Methane/Ethane Combination Sensor for Unmanned Air Vehicles

This research advances efforts to develop UAS technology for industry applications for safer and more accurate methane leak detection from aerial platforms. Flights were conducted in partnership with NASA's Jet Propulsion Laboratory (JPL) and SWIFT Engineering to validate their methane detection system on vertical-take-off-and-landing (VTOL) UAVs. Work will continue in 2018 to validate the combination sensor for a large, fixed-wing UAV that can fly many miles for pipeline ROW monitoring. This is the same UAV that was utilized for the Beyond Visual Line of Sight (BVLOS) demonstrations. The technology and commercialization plan from JPL has an estimated completion of the second quarter of 2018.

Field Evaluation of Distributed Acoustic Sensing (DAS)

Work started in 2017 on a project to address a key gap in widely-available field data for distributed acoustic sensing (DAS) technology's ability to serve its intended leak detection and Third-Party Interference (TPI) functions without generating false alarms at any other times. Field Evaluation of several DAS systems on an operational liquid transmission line for leak detection and TPI is planned to be completed in early 2018.

Evaluation of Leak Detection Technologies for Detecting Liquid Hydrocarbons on Bodies of Water

An off-ballot initiative to evaluate the ability to detect liquid hydrocarbons on water for several types of leak detection technologies was started in 2017. This research will help operators reduce the potential environmental implications of liquid pipelines traversing or approaching in-land water bodies by providing information that will facilitate the selection of appropriate technologies to detect the presence of hydrocarbon liquids on the water surface. The potential for the technology evaluation is also applicable for enhancement of early detection of liquid leaks within facilities, for remote and unmanned facilities, by installing sensors at locations such as sump pits and containment ponds. Completion of the research is scheduled for early 2018.

Polymer Absorption Sensor (PAS) Systems for the Detection of Liquid Hydrocarbons

Development of a large-scale testbed for validation specifically of the polymer absorption sensor (PAS) system for detection of liquid hydrocarbons was advanced in 2017. The final phase which aims at producing a commercially viable product for deployment for liquid hydrocarbon testing in a cable

configuration for outside of the hand-dig zone, will begin in 2018. This capability is essential for retrofit applications on established ROW assets. Currently the development thus far has shown great promise for a high-rate of detection with no false alarming.

Underground Storage

Storage Field Integrity – Technology Comparative Testing

This study is an assessment of a variety of inspection technologies that have found application in various aspects of pipeline integrity management, but which have not yet been widely used downhole. Comparative tests will provide operators with an enhanced understanding of the pros and cons of an array of in-line inspection options.



A full-page background image of an industrial worker in a blue jumpsuit, white gloves, and a white hard hat, working on a large industrial valve. The worker is positioned in the lower right, looking down at the valve. The valve is a large, horizontal, cylindrical component with a blue handwheel. The background shows a complex industrial structure with pipes, ladders, and scaffolding, set against a blue sky with white clouds. The entire image has a blue color overlay. A decorative horizontal line of white dots is located above the text.

INITIATIVES FOR THE 2018 RESEARCH PORTFOLIO

Compressor & Pump Station

Compressor Station NO₂ Modeling – Required Improvements and Station Impacts

Continued data modeling and analysis of the EPA's AERMOD NO₂ emission modeling program.

Greenhouse Emissions Reduction and Measurement

Additional analysis of operator-reported greenhouse emissions data.

Portable Analyzer Lab Tests to Support Simplified Test Method

Efforts to communicate and adopt the simplified test methods using portable emissions analyzers for emissions verifications, which will result in lower testing costs for reciprocating engines and turbines.

Effect of Suction and Discharge Piping Layout on the Performance, Reliability and Integrity of Pipeline Pumps

Additional assessment of station piping layout on liquid pump efficiency and performance and associated field pump performance testing.

Evaluating Stack Testing Methods to Measure VOC Emissions

EPA is proposing rule changes that would disallow the use of Methods 320 & 18. Both methods are widely used in the natural gas transmission industry. This research will evaluate the accuracy and effectiveness of these methods against other methods proposed by the EPA to determine if, in fact, Methods 320 & 18 are suitable or not.

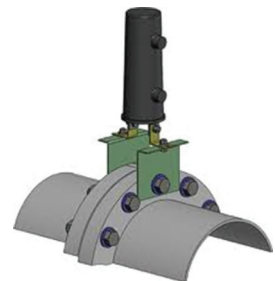
Corrosion

Applicability of Existing Metal-Loss Criteria for Low Hardening Steels

The objective of this study is to improve accuracy of DC interference criteria through the application of an advanced computational modeling tool like one used in the research programs on AC corrosion criteria. The project will assess the significance of low hardening materials on the existing and proposed metal-loss assessment criteria. Previous work has demonstrated the role of strain capacity on the failure pressure in metal loss defects, and shown evidence of reduced failure pressure due to strain localization within the metal loss for lower hardening steels. The final project deliverable will be a Level 1 equation (i.e. B31G & Modified B31G) that incorporates the effect of Y/T, D/t, d/t, and L/(Dt)^{0.5} on failure pressure for metal loss assessments.

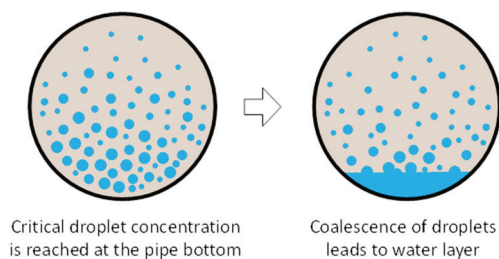
The Influence of Solid State DC Decouplers on Pipeline CP Surveys

This research project's objective is to uncover the cause of spiking phenomenon in instant-off potential survey and to study the influence of solid state decouplers (SSDs) on cathodic protection (CP) related surveys and establish field survey guidelines for pipelines with SSDs. The purpose of the study is to help PRCI member to improve field CP survey accuracy and better understand the negative effect of SSDs.



Water Wetting Prediction Tool for Pipeline Integrity

An essential part of Internal Corrosion Direct Assessment (ICDA) evaluations is to predict Water Wetting (WW). In general, the current WW prediction models used are lagging behind the current level of understanding; therefore, the purpose of this project is to transform the current understanding of WW into a practical tool that can be integrated with integrity management for oil and product lines. The results will include a flexible software tool that describes and predicts WW in oil and product pipelines for a broad range of flow rates and water cut.



Design, Materials & Construction

Field Validation of Surface Loading Stress Calculations for Buried Pipelines

The objective for this two-phase project is to validate surface loading criterion for pipelines with shallow burial. The first phase of the project focused on field measurements of the stress in shallow buried pipe while it is being crossed by heavy equipment. During the second phase, this data will be compared with the predictions of the most prevalent models currently used for surface load stress analysis for pipelines with shallow cover. The objective of the two-phase study is to have a validated model for surface loading of shallow buried pipe.

Integrity & Inspection

Integrity Assessment Guideline for Difficult to Inspect Pipelines

A white paper will be prepared that presents an overview of the current technology and/or state of the art technologies that are either deployed or under development. As a result of this project, pipeline operators will be provided with a mechanism to evaluate new integrity assessment solutions for difficult-to-inspect (DTI) pipelines and will be provided with concise documentation that can be relied upon to justify technology readiness.

Research on Oil & Gas Pipeline Pinhole In-line Inspection and Evaluation

Work will continue on the study to develop a guide to manage pinholes in operators' systems and detection by in-line inspection. Finite element modeling, pull-through testing and field dig verification are being executed to improve the possibility of detection and identification of pinhole, and sizing model is being created.

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

Research is ongoing to develop validated protocols and procedures for use of UT imaging for in-ditch measurement of cracks within an SCC colony.

Hard Spot NDE Evaluation

The final phases for the study of NDE Technology for the Detection of Near-Surface Hard Spots will take place. This project will demonstrate the feasibility of NDE for industrial use and evaluate the ability for

each technology to quantitatively estimate the hardness in a given area, and provide pass/fail criteria for a given hardness threshold. This project is part of the larger industry effort to understand the formation, characterization, and impact of hard spots on TMCP plate/pipe in the presence of sour service. An NDE methodology/tool will improve the procurement of TMCP plate for pipeline manufacturing by mitigating risk of hard spots prior to pipe formation. The technology could be applied at plate manufacturing or developed as an infield or ILI tool based on industry need.

Measurement

Develop Guidance for Applying Revised AGA Report #8 Based on Measurement Uncertainty

The project is to understand EOS-driven measurement uncertainty for unsteady process conditions over time. The hourly characteristics of on a single pipeline may change by discrete steps, sweeping modulation or some combination of each. The potential for bias is exacerbated by the short commercial time frames of modern pipeline operation. An operator's decision to implement AGA 8 Part 1 or Part 2 of AGA 8 may not be best served by using average conditions or worst-case scenarios.

OIML Test Data Summary for New Generation Ultrasonic Meters

This project will organize and compare data from the different OIML R137-1 testing programs from various meter manufacturers. The result will be a document that presents the data to operators in an unbiased fashion that also makes it simple to compare.

High Pressure Calibration of Turbine/USMs with an Inert Gas

If it can be proven that inert gas high pressure calibration results can be translated to natural gas metering applications without signification loss of uncertainly, then calibration costs can be reduced, and the high pressure inert gas calibrations can be adopted in international standards. Consolidating research information from the collective body of PRCI research associated with upstream piping configurations on ultrasonic meter bias.

Evaluating the Effects of Changing Gas Composition on Flow Measurement Error

This research will provide an independent evaluation of gas composition-related measurement errors that will be used to improve regulations and guidelines on gas sample analysis methods and intervals.

Evaluation of Commercially Available On-Line Analyzers for Measurement of Multiple Gas Contaminants

The operator will be able to use a single analyzer for multiple contaminants instead of several analyzers each measuring one contaminant. The use of a single analyzer at a biomethane site to "green" natural gas can save \$50,000 Capital cost and \$10,000 O&M expenses.

Biodegradable Solvents as a Replacement for the Solvents Used for Current Sediment and Water Content Determination Procedure

Solvents such as toluene, kerosene and xylene used in current S&W determination procedure are associated with significant health concerns. To mitigate these concerns all testing must be carried out in specially ventilated conditions to avoid exposing the operator to solvents. These conditions limit the locations where testing is possible and raise the complexity and cost of testing. Replacing some, or all of the solvents, with less toxic options could reduce the facility requirements for conducting the tests and reduce the risk for operators thereby opening up the number of locations where testing could be conducted and potentially reducing the costs.

Surveillance, Operations & Monitoring

Geohazard Focus Area

The Surveillance, Operations & Monitoring committee has recently dedicated a focus area within the committee to geohazards. While geohazards have long been an interest, most of the work has been specifically focused on monitoring by satellites. By concentrating on the asset risk rather than the technology, PRCI can greatly expand the evaluation and development of assessing and monitoring geohazard risks to pipeline infrastructure. For 2018, three projects have been approved on the ballot in the geohazard Focus Area. Specifically, two of the 2018 projects are concentrating on river crossings, which aligns with the industry identified need for better assessment in river crossings and flooding events along the pipeline right-of-way.

Human Factors

The Human Factors Focus Area has gained momentum in 2017 with an on-going project, “Benchmark of Human and Organizational Factors’ Approaches Used by Pipeline Transmission Operators,” two new projects for 2018 and a Joint Technical Meeting (JTM) sponsored project. “Competency in the Pipeline Industry: An Industry Survey,” which was developed as part of the 2017 JTM’s Human Factors Workshop. At the workshop, the participants from PRCI, the European Pipeline Research Group (EPRG) and the Australian Pipelines and Gas Association (APGA) identified a need to understand baseline competency requirements, for several areas, within the pipeline industry. To meet this objective, PRCI will design and implement a survey to operator members. The data collected from this survey will enable several initiatives, such as the identification of gaps in baseline industry competency. The data acquired could then be used to build a ‘roadmap’ as a guide for maturing industry-wide competency through various forms of knowledge transfer (e.g., training and development opportunities). The project is underway and currently looking to enhance the data collection by inviting additional participation from all PRCI pipeline members.

Underground Storage

Understanding Flow-Induced Vibrations & Instabilities of Brine Strings for Various Flow Configurations

The findings from this work and future field testing will provide operators with added confidence in increasing the maximum allowable product flow velocity while maintaining brine string integrity, thus enhancing productivity.

Accuracy of Temperature Logging for Calculating Gas Inventory

New regulations enacted by the Pipeline and Hazardous Materials Safety Administration (PHMSA) require gas cavern operators to calculate gas inventories to ensure continuance of cavern integrity. This research will evaluate the accuracy of conventional inventory calculation methods, which will help gas cavern operators comply with the new PHMSA regulations. In addition, appropriate shut-in durations will be recommended that may reduce the cost associated with out-of-service caverns and reduce the need to perform multiple wireline temperature logs to determine if the cavern has stabilized before the cavern integrity is evaluated.

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 allowing the industry to continue reducing risks from and to pipelines.



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