



2007
year in review

 PIPELINE RESEARCH COUNCIL INTERNATIONAL

Leading Pipeline Research

PRCI By the Numbers



“The Pipeline Research Council International is the preeminent global collaborative technology development organization of, by, and for the energy pipeline industry.”

—George W. Tenley, Jr. • *President*

2007
year in review



PRCI is a not-for-profit, tax-exempt membership organization

of energy pipeline companies directing research to enhance the safety, reliability and productivity of the energy pipeline industry. Unique among all pipeline research organizations, PRCI brings together leading pipeline companies from around the world to engage in a collaborative process that is truly “of, by, and for” the industry. With the commitment and technical expertise of its members, PRCI develops dynamic research programs devoted to identifying, prioritizing, and implementing the industry’s core research objectives.





Our Members

Working to assure the safe, reliable, environmentally-sound, and cost-effective pipeline transportation of energy to consumers worldwide.

PRCI Pipeline Members

Alliance Pipeline Ltd (Canada)
 Boardwalk Pipelines
 BP
 Buckeye Partners, LP
 CenterPoint Energy Gas Transmission
 Chevron Pipe Line Company
 Colonial Pipeline Company
 Colorado Interstate Gas
 Columbia Gas Transmission Corp.
 ConocoPhillips Pipe Line Company
 Dominion Transmission Corp.
 El Paso Natural Gas
 Enbridge Pipelines Inc. (Canada) & Enbridge Energy Partners, LP
 EPCO, Inc.

Explorer Pipeline Company
 ExxonMobil Pipeline Company
 Gassco A.S. (Norway)
 Gasum Oy (Finland)
 Gaz de France (France)
 Marathon Pipe Line LLC
 N.V. Nederlandse Gasunie (Netherlands)
 National Fuel Gas Supply Corporation
 National Grid (U.K.)
 ONEOK Partners
 Pacific Gas & Electric Co.
 Panhandle Energy Company
 Petrobras (Brazil)
 Saudi Aramco (Saudi Arabia)
 Shell Pipeline Company LP
 Southern California Gas Co.

Southern Natural Gas
 Spectra Energy Transmission, LLC
 Tennessee Gas Pipeline
 Total S.A. (France)
 TransCanada PipeLines, Ltd. (Canada)
 TransGas Ltd. (Canada)
 Transwestern Pipeline Co.
 Williams Companies, Inc.

PRCI Associate Members

Applus RTD
 Berg Steel Pipe Corp.
 GE Oil & Gas
 Lincoln Electric Company



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PRCI Technical Program

Associate Members

BJ Pipeline Inspection Services (Canada)
IPSCO (Canada)
Nippon Steel (Japan)
Rosen
Siemens Energy & Automation, Inc.
Solar Turbines
T.D. Williamson, Inc.
Tuberia Laguna (Mexico)
Tubos de Acero de Mexico (Mexico)
Tuboscope Pipeline Services

PRCI Pipeline Industry Organizations

Association of Oil Pipe Lines (AOPL)

MISSION

To conduct a collaboratively-funded technology development program that enables energy pipeline companies around the world to provide safe, reliable, environmentally compatible, and cost-efficient service to meet customer energy requirements.

PRCI'S VALUE PROPOSITION

PRCI uses the leverage generated by our members' resource contributions to create a research forum of ideas and results producing solutions providing our members a spectrum of quantified benefits. Formal cost/benefit studies of member participation show a consistently positive ratio of 4:1 to 7:1 from reduced costs of operations and maintenance, inspection, materials, design, construction, and testing.



Chairman's Statement

I am sure that you will find this "Year in Review" to be a useful and informative look back at PRCI's many accomplishments of 2007. As you know, communication with our members and stakeholders remains critical to our success. PRCI's President, George Tenley, and his staff have developed this publication with that goal in mind in order to keep you informed on our progress.

PRCI's members are well aware of our drive to meet the needs of our diverse and growing membership. Our members now span four continents and bring together many of the leading gas, oil and liquids pipeline companies across the United States, Europe, Canada, South America and the Middle East. Associate and technical members have further broadened our expertise and geography.

PRCI's annual research program has continued to attract a wide array of interest with project participation levels that cross both international borders and traditional business boundaries.

We made great strides in 2007 to advance pipeline research in areas that are vital to the safe and efficient design, construction and operation of pipeline systems worldwide. In addition, under the leadership of our Chief Operating Officer, Eric Thomas, we examined the organization's program execution capabilities relative to our growing portfolio of projects and membership. A research deployment optimization review was completed in 2007 and we are now implementing the results of that effort throughout our committee structures, processes and tools. These efforts will further strengthen PRCI as a leader in research for the pipeline industry.

As you read this Year in Review, our members and stakeholders should take pride in their contributions to PRCI's continued success. We have been fortunate to see strong member commitment in terms of funding and technical representation as well as effective and capable executives and staff at PRCI. During my two year term as Chair, I look forward to hearing your ideas as we collectively shape this world class organization to meet pipeline research requirements both today and in the future.



Art Meyer
Chairman

President's Statement

From the perspective of a New Year with its promise of new opportunities and challenges, we can consider the meaning and impact of 2007. Speaking on behalf of the staff, we view 2007 as being marked by two significant factors, which taken together give a strong indication that 2008 will be a pivotal and successful year for PRCI. In 2007, the Board,



- Gave strong leadership support to the analysis of all PRCI structure, processes, and administrative tools and the development of necessary additions, modifications, and enhancements, and
- Provided direction for the organization as we consider our future by focusing on improving our program execution and productivity in the face of changes in our operating model and the interaction of the membership in program planning and execution.

These factors led us in 2007 to undertake the Research Deployment Optimization (RDO) initiative, the results of which will come to fruition in 2008. This initiative, coupled with actions devised and led by our new COO, Eric Thomas, to immediately address our project backlog put us in a much improved position as we prepare to implement the results of the RDO effort.

These results will involve principally,

- A fully-functional, user-friendly, project management tool that will be one of the critical components of our new website that went on line at the end of the first quarter 2008,
- A reconfiguration of the current five Technical Planning Committees into six Technical Committees, three under the Pipeline Program and the traditional three under the Facilities Program, with more responsibility to assure the overall management and success of the projects comprising the Committee,
- The development of program and corporate performance goals and metrics, and
- A set of systematically developed and applied supply chain management improvements covering all services and capabilities we engage in support of achieving our mission.

This inaugural Year in Review will report on and summarize the results PRCI delivered to the membership in 2007. As it is our first annual report since 2003 we are very interested in your feedback so that as we conduct our program in 2008 we can be capturing the information and results that you want to be reported and in the manner you will find most useful.

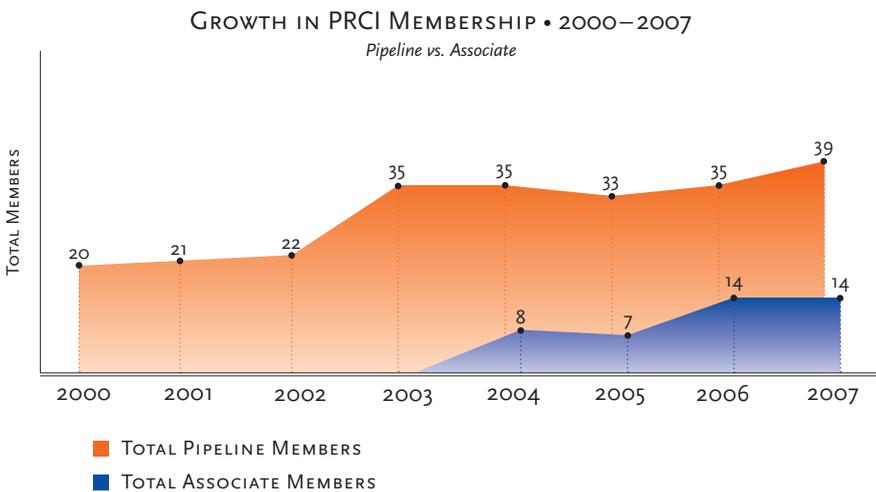
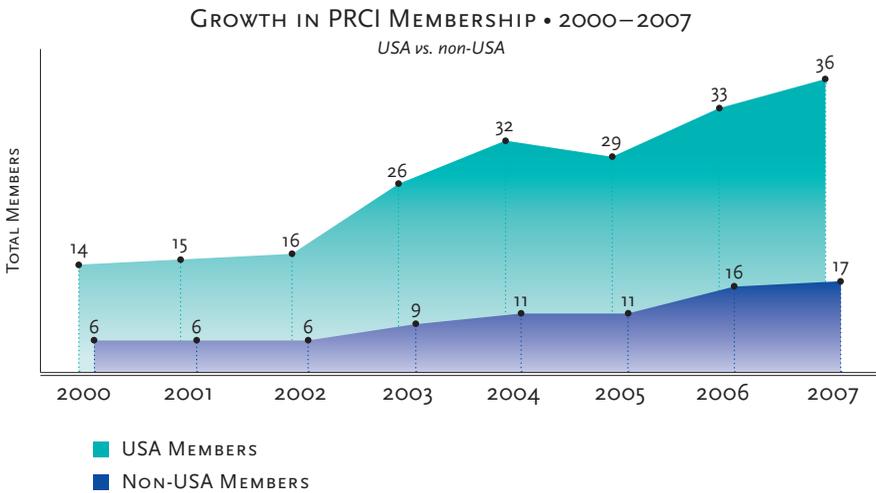
Thank you for your continuing commitment to PRCI. It is your commitment that is the core of what we do and our success in doing it.

A handwritten signature in black ink that reads "George W. Tenley, Jr." The signature is written in a cursive, flowing style.

George W. Tenley, Jr.
President

Membership Growth

PRCI was established in 1952 as the Pipeline Research Committee of the American Gas Association, comprised of 15 member companies. With the commitment and technical expertise of its members, today PRCI continues to develop dynamic research programs for its members, the wider industry, and key government agencies to assure the sustainability of the essential lifelines that deliver most of the world's energy, both gas and liquids. As a result, PRCI now has a global membership of 39 leading pipeline companies and 14 associate members and is a critical resource for all energy pipelines regardless of where they operate, how they operate, or the purpose of their operation.





Recent Accomplishments In Research

The projects members support with input, funding, time and resources result in intelligence and technology addressing the needs of the worldwide pipeline industry and, by extension, global energy consumers. PRCI focuses on projects that:

- Assure system safety and environmental performance
- Assure the productivity and reliability of pipeline assets
- Anticipate change and adapt existing systems
- Build new pipelines where and when they are needed
- Continue to reduce risks from and to pipelines
- Provide support for public policy positions

Research Reports

PIPELINE

- Damage Management for Operating Pipelines—Gap Analysis
- Decompression Response of High-Pressure Natural Gas Pipelines Under Rupture or Blowdown Conditions
- Detection of Small Leaks in Liquid Pipelines: Gap Study of Available Methods
- Evaluating the Need for Loading Specifications for Highway Transportation of Line Pipe
- Evaluation of Grouted Tee™ Connections for Thin-Walled Pipe
- Evaluation of Hydrogen Cracking in Weld Metal Deposited using Cellulosic SMAW Electrodes
- Evaluation of the Interaction of Mechanical Damage on Welds
- Failure Initiation Modes of Pipe with High Charpy Transition Temperature
- Fracture Arrest Assessment Program (FRAAP) Users Manual
- Gap Study and Recommendation for the Analysis and Testing of Pipe Response to Buried Explosive Detonations
- In-Situ Measurement of Pipeline Mechanical Properties Using Stress-Strain Microprobe - Validation of Data for Increased Confidence & Accuracy
- Internal Repair of Pipelines—Final Technical Report
- Pipeline Design for Mechanical Damage
- Strain-Based Design: Strain Concentration at Welds
- Survey and Interpretive Review of Operator Practices for Damage Prevention
- Ultrasonic Inspection of Hot Tap Branch Connections and Weld Sleeve-Fillet Weld using Phased Arrays

COMPRESSOR & PUMP STATION

- Engine Infrastructure Project (DOE)
- Gas Composition Testing
- Ion Sense—Rich Burn Engines
- Micropilot Field Test

- Turbocharger Booster System
- Turbocharger Component Matching

MEASUREMENT

- Clamp-on Ultrasonic Meter Evaluation (Year 1)
- Clamp-on Ultrasonic Meter Evaluation (Year 2)
- HCDP Prediction Method and Water Vapor Sampling
- Sampling and Monitoring of Water Vapor and HCDP Estimation
- USM Diagnostics (Smart Meter)

UNDERGROUND STORAGE

- Assessment of Alternative Casing Repairs
- Chemicals for Improved Deliverability
- Predicting and Mitigating Salt Precipitation

In 2007, PRCI produced and approved over 30 project reports, adding to the research library of over 1,700 technical reports.

Important Findings

PRCI research has yielded numerous important findings that members have been able to put into practice resulting in cost efficiencies, operational changes, and evaluation programs. Some of the most recent are as follows, the details of which can be found in the accompanying Appendix:

- A method to check the design of pipelines for mechanical damage such as that caused by excavation was developed and suggests that the risk of pipeline damage from a mechanical excavation is lowest for thick-walled pipelines and that moderate increases in wall thickness can help achieve adequate safety for thin-walled pipelines.
- Developed recommendations for a consistent analytical approach to assess interaction of a weld seam to mechanical damage related to initial construction, pipeline bedding material consolidation, or ground movement.
- Survey and interpretive review of PRCI member companies to determine how effective pipeline operator practices and technologies have been with respect to pipeline damage prevention, and identified ones that show high potential.
- Determined that where an extended analysis of a natural gas stream is not available or fails to accurately predict the observed HDP of the stream, the Gauss-gamma characterization and the Soave-Redlich-Kwong (SRK) equation of state are recommended for predicting dew points from a C6+ analysis of the stream.
- Suggestion that a recommended practice should be developed for line pipe loading on trucks for transports because the potential for fatigue-related damage is present.
- Evaluated the accuracy and repeatability of commercially available clamp-on ultrasonic meters (USMs) when installed in a meter run incorporating another metering technology so as to verify the accuracy of the meter under test.

Current Research

The majority of the funding for PRCI's research program comes from the voluntary annual subscriptions of its member companies, which are allocated by them to research projects with the greatest relevance to their business objectives. Funding is further augmented by member company supplemental contributions, and cofunding from non-member companies. A detailed explanation of PRCI's funding can be found on its website (www.prci.org). Following are some highlights of our current program focus, and related projects.

Operations & Integrity

- In 2007, PRCI completed its Virginia Pilot Project—Incorporating GPS Technology to Enhance One-Call Damage Prevention, which fully demonstrated the concept of using GPS coordinate locating devices in mapping planned excavation sites and submitting the location to the Virginia Utility Protection Service (VAUPS). A second phase will be started in Virginia and the PRCI cell phones and Trimble GPS units were donated to this effort being led by VAUPS and DOT.

Design, Materials & Construction

- \$4M jointly funded DOT welding program for High Strength Steels (X100+) was kicked off in fourth quarter of 2007 with an anticipated completion date in 2010.

Mechanical Damage

- Researching the effects of mechanical damage and developing design and construction standards to minimize further impacts.
- Technologies for prevention of damages, tools for detecting and characterizing damage that may have occurred to pipelines, and methods for evaluating the structural significance of identified defects and deformation to pipelines through either third-party mechanical impacts or other means (e.g., rocks).

Corrosion

- Re-inspection intervals for corroded pipelines—includes work on ECDA and RBDA methods, and corrosion growth rate analysis and validation using in-line inspection data.
- Evaluating the Structural Significance of Corrosion—research focus areas include leak/rupture boundary conditions and remaining strength of corroded pipe.
- Location and evaluation of pipeline coatings and coating disbondment—includes work with CP systems and development of new ILI tools for detecting coating disbondment.
- Accuracy of tools for corrosion mapping.
- Location and characterization of corrosion in difficult to inspect areas—some work on ECDA for cased crossings and above ground surveys for difficult areas, as well as evaluation of facility releases (gas and liquid).

Stress Corrosion Cracking

- Analysis of the various factors contributing to the formation (or lack) of SCC and the development of technologies and inspection tools to detect and differentiate SCC cracks from the remaining SCC colonies.

- Development and demonstration of diagnostic tools for improving the detection and characterization of SCC.
- Evaluating the effects of SCC in steel pipelines as it relates to the transportation of fuel-grade ethanol.

Compressor & Pump Station

- Work continues on a multi-year R&D program to develop cost-effective options for reciprocating engine operators to meet very aggressive expected NOx reduction requirements. EPA actions in 2007 to further tighten air quality standards confirm the underlying regulatory trend, and provide clarity that specific regulations will become widespread in 2012.
- A detailed CFD model of an existing liquid pump design was completed as a key step towards developing retrofit components for a large set of pump models for greater overall pump efficiency, throughput and reliability.
- Field testing has confirmed that widely-used gas turbine models with dry low-NOx combustion systems can be operated at lower turndown while still maintaining acceptable NOx performance. Gas turbine vendor engineering reviews are ongoing as a prelude to the release of new operating specifications by 2009.
- Compressor station operations are being examined to determine what opportunities exist for reducing fuel consumption and fugitive (methane) emissions.
- Engine testing is being initiated to determine if increased levels of DRA in gasoline has an adverse impact on automobile engines, with the objective of allowing greater use of DRA in product pipelines.

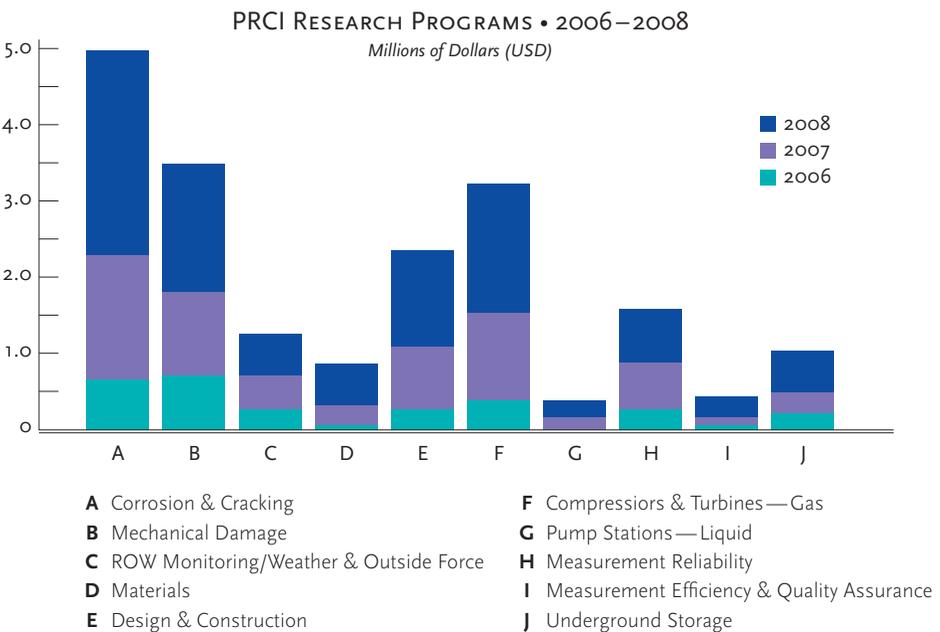
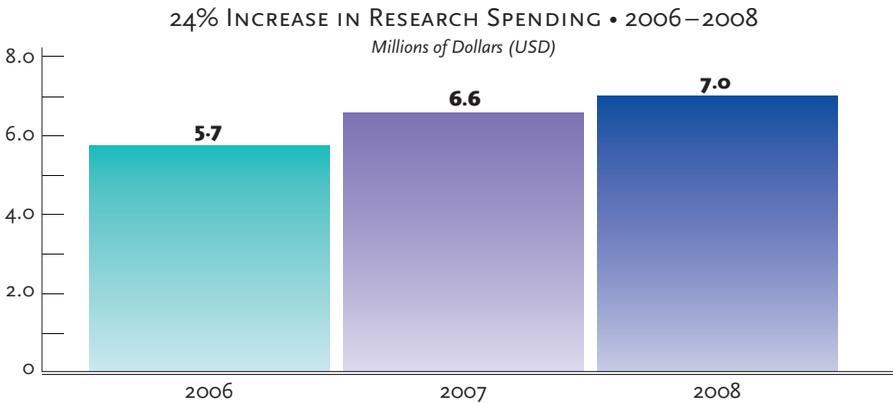
Measurement

- Meter performance variability and recalibration is an ongoing theme of PRCI projects due to the increased economic consequence of lost and unaccounted for gas due to high gas prices. Projects are underway to assess the impact of dirty meters and orifice plate geometry variations, and which develop improved diagnostics and recalibration interval criteria for ultrasonic meters. Portable clamp-on ultrasonic meters to field check installed meters promises to locate anomalies more quickly, and clamp-on behavior is being characterized.
- Determining precise gas composition and energy content is an important function of the measurement system, due to changing gas supply sources, increased LNG volumes and the need to ensure that gas receipts meet pipeline tariff gas specifications. Projects to evaluate the performance of hydrocarbon dew point analyzers, the effects of upstream methanol injection on transmission gas measurement, and gas sampling procedures at dewpoint conditions will address this need.

Underground Storage

- Increased operational flexibility of storage assets is targeted by R&D projects that improve the deliverability of existing reservoirs and developing new downhole damage remediation diagnostics and tools.
- Storage field integrity is an increasingly important consideration, and methods to characterize the condition of downhole tubulars and cement integrity are moving towards commercial application. Supporting analytic tools include reservoir inventory monitoring software, and analytic tools that prioritize O&M work and identify specific maintenance methods. Brine string integrity for cavern storage is included under this project umbrella.

The 2008 program builds upon the strong foundation laid by PRCI's past research projects; in particular, its 2006 and 2007 research programs with their emphasis on the integrity and reliability of energy pipelines and related facilities. The 2006 and 2007 programs continued, in turn, a five-year trend of increasing research spending by PRCI's member companies. The 2007 program was itself more than 20% higher than 2005. The 2008 program continues the trend of increasing research spending by PRCI's member companies, and is more than 24% higher than the 2006 program.





PRCI's New Research Program

The 2008 research program broadens its integrity and reliability program to include an examination of the technical and operational issues associated with the transportation of ethanol. Core funding for the 2008 research program will be provided by PRCI's 39 pipeline member and 14 associate member companies through more than \$7.0 million in funding.

As in the past, PRCI will leverage its members' funding with co-funding from several sources, in particular with its leading co-funding partner, the Pipeline and Hazardous Materials Administration in the U.S. Department of Transportation, bringing the total amount of research in which PRCI currently is engaged to more than \$20 million allocated to more than 200 projects.

In addition to its work on ethanol, PRCI's 2008 program will include:

- **Mechanical damage** – detection, characterization, and management to address third party damage and geo-technical events.
- **Design and construction** – specialized programs in recognition of the dramatic build out of the pipeline system in both developed and developing regions.
- **Integrity management** – continued research in corrosion and environmental cracking so as to enhance safety and reduce the potential for incident.
- **Compressor and pump stations** – work to reduce air emissions and reduce fuel requirements.
- **Measurement** – continuing improvements to metering accuracy, reliability and cost-effectiveness.
- **Underground storage** – to improve storage facility integrity and operational flexibility.

Emerging Trends And Technologies

From its unique perspective as the global pipeline industry's premier research forum, PRCI identifies emerging trends and technologies that will have a significant impact on the transmission of energy worldwide. It is also the arena in which the transfer of information, technology and solutions for day-to-day pipeline challenges take place.

RESEARCH FOCUS

Since 2006, when members began voting for projects most relevant to their organizations, the trend has remained constant. The categories of greatest interest to PRCI members continue to be Corrosion & Cracking, Compression & Turbines (Gas), and Mechanical Damage. Funding levels—as shown on the accompanying graph—have been allocated accordingly.

Emerging trends facing the industry are also identified during the research process and through participation by members and PRCI staff in conferences, seminars and other professional gatherings around the world. Each year, through PRCI's balloting process, members vote to fund projects reflecting current and emerging technological, environmental, economic, and security matters they view as having the greatest impact on their organizations and the pipeline industry worldwide.

KEY DRIVERS

- Life extension and optimizing life cycle and operating costs
- Providing technical support and enhancements for the near-to-mid-term system buildout
- Enabling effective risk-based integrity management

- Providing flexible, cost-effective options for air emissions compliance and reduced fuel consumption
- Enabling flexibility for new and alternative fuels transportation by pipeline

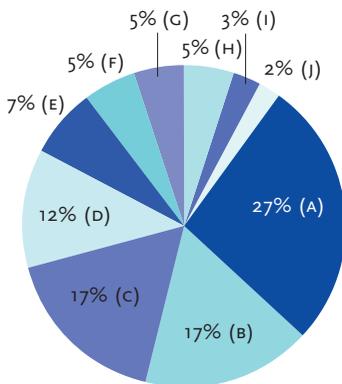
Collaboration: PRCI's Defining Difference

The need and opportunity for industry collaboration is brought into sharp focus by the convergence of two intertwined realities: a consolidation of the industry through mergers/acquisitions, and the introduction of new, non-traditional owners and operators (e.g., investment funds, insurance companies); and the current period of enormous global build-out and expansion of pipeline systems valued in the hundreds of billions of dollars.

Environmental issues, such as the development of alternative fuels like ethanol and the impact of greenhouse gases are future challenges, and meeting them will require a strong, well-funded, intensely-focused research program.

The results of future PRCI research projects will guide PRCI's members in making appropriate organizational and operational adjustments; accommodate public policy changes; participate in framing the global energy agenda; support their national interests; and enhance ROI.

A strong and sustainable research capability for the energy pipeline industry is essential to the security, environmental integrity, performance and productivity of an infrastructure that is the most efficient and safest means of energy transportation. Over the years, PRCI's research has produced value for those funding the work. It is this history of success that is the foundation of PRCI and the value proposition we offer our members, and through them the energy pipeline industry at large: "Using the leverage generated by our members' resource contributions we create a research forum of ideas and results producing solutions that assure the safe, reliable, environmentally sound, and cost-effective pipeline transportation of energy to consumers worldwide."



PRCI RESEARCH PROGRAM • 2006–2008

- A** Corrosion & Cracking (27%)
- B** Compressors & Turbines—Gas (17%)
- C** Mechanical Damage (17%)
- D** Design & Construction (12%)
- E** Measurement Reliability (7%)
- F** Materials (5%)
- G** ROW Monitoring & Weather and Outside Force (5%)
- H** Underground Storage (5%)
- I** Measurement Efficiency & Quality Assurance (3%)
- J** Pump Stations—Liquid (2%)

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Appendix

Pipeline Design for Mechanical Damage

The leading cause of pipeline failures in North America and Europe is mechanical damage caused by third-party excavation. Current pipeline design standards have taken into account the pipeline's ability to resist internal pressure, but current standards do not address mechanical damage such as that caused by excavation. A design method that accounts for the likelihood and the consequences of mechanical damage does not currently exist.

KEY PROJECT RESULT

A method to check the design of pipelines for mechanical damage was developed using valid models from the U.S. Department of Transportation (DOT) and the European Gas Pipeline Incident Data Group (EGIG). The models suggest that the risk of pipeline damage from a mechanical excavation is lowest for thick-walled pipelines and that moderate increases in wall thickness (for Class 3 or 4 areas) can help achieve adequate safety for thin-walled pipelines.

Evaluation of the Interaction of Mechanical Damage on Welds

The United States Department of Transportation has indicated that 20 to 40 percent of the serious pipeline incidents in any given year are related to mechanical damage. This damage is due to third party activities, mishandling during construction, pipeline bedding material consolidation, or ground movement.

This project focused on three forms of mechanical damage and the potential for interaction with girth welds or long seam welds that may negatively impact the long-term integrity of a pipeline with a reduction in fatigue performance when subjected to

internal pressure fluctuations. The three forms of mechanical damage investigated were: restrained rock dents that occur during initial construction, pipe ovality, and wrinkles.

KEY PROJECT RESULT

The project provides recommendations for a consistent analytical approach to assess interaction of a weld seam to the three mechanical damage features investigated.

Development of Accurate Methods for Predicting Hydrocarbon Dew Points

Hydrocarbon dew points (HDPs) can indicate the quality of a natural gas stream. They can also be used to assess compliance with transportation tariffs. Accurate hydrocarbon dew points are crucial in accommodating the future introduction of liquefied natural gas (LNG) and marginal gas supplies into the natural gas transmission network.

The use of data from an on-site gas chromatograph (GC) is often faster and more convenient than using portable chilled mirror dew point testers. Unfortunately, the various methods used to calculate hydrocarbon dew points from GC analyses often produce inconsistent results across methods.

Previous research in 2001 identified the choice of characterization method as the largest source of potential error. Subsequent research sponsored by Gas Technology Institute (GTI), Pipeline Research Council International (PRCI) and the United States Department of Energy (DOE) in 2004 and early 2005 expanded the existing database to include experimental data on test gases.

This project completes the evaluation of analytical dew point determination methods begun earlier under the

sponsorship of GTI and PRCI through the Federal Energy Regulatory Commission (FERC) funding mechanism.

KEY PROJECT RESULT

Where an extended analysis of a natural gas stream is not available or fails to accurately predict the observed HDP of the stream, the Gauss-gamma characterization and the Soave-Redlich-Kwong (SRK) equation of state are recommended for predicting dew points from a C6+ analysis of the stream.

Evaluation of the Need for Loading Specifications for Highway Transport of Line Pipe

The ability to accurately predict static load stresses at the bearing strips on line pipe in transportation has been relied on through the application of the American Petroleum Institute (API) Recommended Practice (RP) 5L1 for rail and API RP 5LW for water borne transport. No practical application to predict the static load stresses on line pipe being transported by truck on highways has been developed because it was believed the highway transport distances were not sufficient to represent potential for a significant amount of pipe damage.

Occasionally, existing pipelines constructed at a time prior to the observance of the recommended loading practice still experience failures at defects that originated as shipping damage and subsequently enlarged in service. The National Transportation Safety Board (NTSB) Findings and Recommendations following their investigation of a liquid pipeline accident in 2002 included conducting a review of the API RP 5L1 and API RP 5LW for calculating the static load stresses at the bearing or separator strips for pipeline and revise the recommended practices based on that review. The NTSB also recommended that loading specifications applicable to the highway transport of line pipe be

developed. The objectives of this study were to establish whether a loading specification for highway transport of line pipe is actually necessary, and if so, to develop appropriate recommendations.

KEY PROJECT RESULT

This project determined that a recommended practice should be developed for line pipe loading on trucks for transport because the potential for fatigue-related damage is present due to:

- The dynamic stresses from vibrations during truck transport are approximately 2 times greater than those during rail transport.
- A significant amount of line pipe is transported by trucks for distances up to 400 miles.
- The peak stress estimated using the equation in API 5L1 should be multiplied by a factor somewhere between 2.25 and 2.5.

Evaluation of Clamp-On Ultrasonic Meters as In-Situ Meter Verification Tools

A variety of meter types is used by the natural gas industry to measure the volume of gas transported through pipelines. To ensure accurate measurement and avoid costs associated with lost-and-unaccounted-for gas, these meters must be verified (or proved) periodically. Field proving of a meter, however, requires measurements with a highly precise reference device, as well as correct installation of the meter and related test instrumentation.

Ultrasonic flow meters were introduced to the natural gas industry for custody transfer measurements a decade ago. Attributes of ultrasonic flow meters include a relatively broad flow rate range compared to more traditional metering technologies, low pressure drop (when a flow conditioner

Appendix

is not used), and reasonably good measurement accuracy and repeatability. A more recent development in ultrasonic metering technology has been the clamp-on ultrasonic meter, which can be mounted on the outside of a pipe and sends and receives ultrasonic waveforms through the pipe wall. This device offers several advantages over the wetted sensor ultrasonic meters, including portability, the ability to be installed without shutdown and disassembly of the pipeline, and the use of electronic parameters to help determine the condition of the flowing gas and the accuracy and repeatability of measurements. Because of these features, clamp-on ultrasonic meters are being considered for their potential as diagnostic tools. The objectives of this project were to:

- Evaluate the reproducibility of measurements made with the clamp-on ultrasonic meter through repeated removals and re-installations of the meter.
- Evaluate the ability of a commercially-available clamp-on ultrasonic flow meter to accurately diagnose natural gas flow conditions that can produce measurement errors in traditional natural gas meters.
- Evaluate the ability of the clamp-on ultrasonic meter to quantify the errors in measurements made with traditional metering technologies under such adverse conditions.

KEY PROJECT RESULT

PRCI evaluated the accuracy and repeatability of commercially available clamp-on ultrasonic meters (USMs) when installed in a meter run incorporating another metering technology so as to verify the accuracy of the meter under test.

PRCI recommended that a performance baseline be established first in any

conventional meter run in which a clamp-on ultrasonic flow meter is to be used for diagnostic purposes. The test should account for flow conditions specific to the conventional meter and more accurately track changes from these conditions. The baseline flow test should be performed under optimal flow conditions in the conventional meter run. The configuration of the clamp-on meter should be recorded as part of the baseline process.

Survey and Interpretive Review of Operator Practices for Damage Prevention

Damage to pipelines from mechanical excavating equipment is the leading cause of pipeline release incidents and amounted to 22% of total reported incidents from 1995 to 2003. There is little or no evidence that incidents are on the decline as the result of various measures aiming to reduce them.

Both the pipeline industry and the U.S. DOT are making significant efforts to reduce the numbers of such incidents by instituting better excavation practices, and developing and implementing advance warning systems to prevent damage. A recent joint industry-U.S. DOT project has produced a number of practices and technologies for pipeline damage prevention.

Current practices and technologies employed by pipeline operators to prevent excavation damage include 'one-call' networks (excavators must call before digging so that buried utilities are notified), preventive practices (patrolling, marking, locating), and technological advance warning systems (aerial or satellite surveillance, physical warning systems, barriers).

The project objectives were to:

- Interview companies with representatives on the PRCI board in regard to their

experiences with the effectiveness of the various techniques used for pipeline damage prevention.

- Interpret their responses and evaluate the effectiveness of current techniques—or lack thereof.
- Identify techniques worthy of further investigation.

KEY PROJECT RESULT

PRCI has produced a follow-up project in the form of a survey and interpretive review of its member companies, that determined how effective these pipeline operator practices and technologies have been, and identified ones that show high potential with respect to pipeline damage prevention.



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, and support for influencing public policy affecting the industry.

2007

year in review

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