

TRENCHLESS

FOR GAS INFRASTRUCTURE



2019

INAUGURAL EDITION



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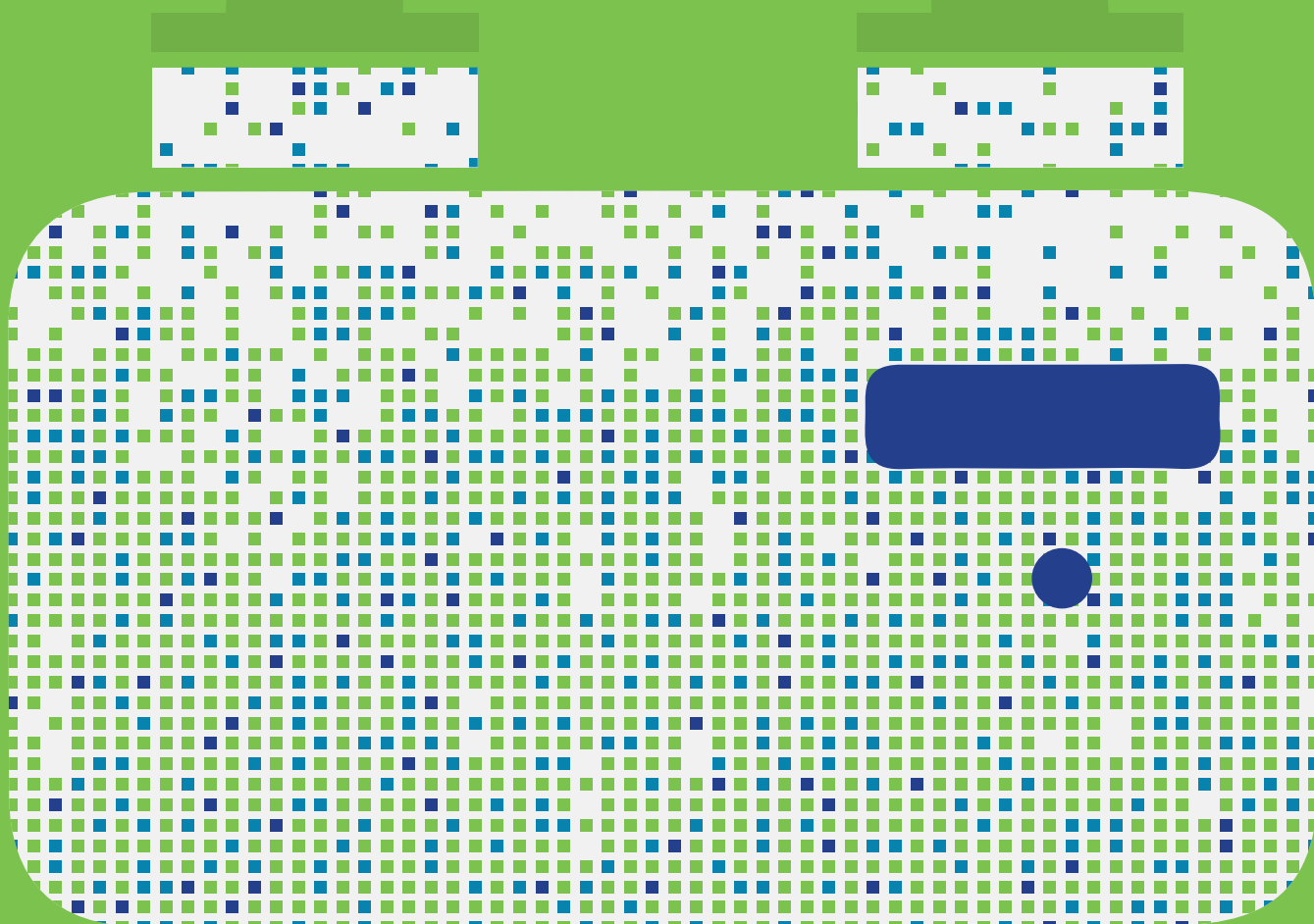


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WELCOME MESSAGE FROM NASTT-NE CHAIR

Ian W. Mead, PE, BCEE, NASTT-NE Chair

Welcome to the first issue of the NASTT Northeast Regional Chapter's *Trenchless for Gas Infrastructure Journal*. The issue you hold in your hands has been quite a while in the making. It is the result extensive deliberations, hard work and dedication from our chapter members (especially George Ragula) and the team at A to B Publishing, along with the support of the NASTT Board of Directors and Executive Director Mike Willmets. Thank you to all who played a part in creating what we hope will be a valuable resource for the gas industry, further advancing the case for trenchless technology.

Each year at No-Dig the program is packed full of excellent technical presentations on the advances made in trenchless technology? If you work in my area of expertise, you might be thinking of how those technologies can help complete projects focused on water and sewer infrastructure. Those are the types of projects that I've been involved with for my entire career. For better or worse, I have been less exposed to the challenges associate with our energy and gas networks. Unfortunately, and very much like the water and transportation industries, it's the catastrophic failures that get reported in the media and catch everyone's attention. Such a failure occurred across several communities north of Boston in the Merrimack Valley in

September 2018, which called attention to the condition of our gas infrastructure and the need for investment.

In this inaugural edition we showcase a range of trenchless applications presently used to replace or rehabilitate gas distribution pipe, large and small diameter. We also explore several condition assessment inspection technologies which provide the basis to prioritize needs, in order to fund and design remediation projects. It is important to focus attention on the need to implement replacement and renewal programs which use the cost effective, low impact and environmentally friendly construction approaches offered by trenchless technology.

The NASTT-NE Chapter is dedicated to the future development of trenchless technology and innovation in underground construction techniques. We are very proud of our active NASTT student chapter at UMass Lowell. Presently the Chapter is actively investigating the establishment of a trenchless center of excellence at UMass Lowell, to facilitate additional industry events and aid in the education of the next generation of trenchless professionals.

Save the date! You are invited to attend the 4th annual NASTT-NE Trenchless Technology Conference in Syracuse, NY on Tuesday, November 12th,

“Please join us!”

at the Embassy Suites by Hilton Syracuse Destiny. Please visit our website at www.nastt-ne.org for the latest information, registration and hotel details. The technical program and outdoor demonstrations are currently being developed.

Finally, conducting the business of the NASTT-NE Chapter would not be possible without the generous support of our sponsors and vendors. Please reach out to those who have advertised and contributed to this journal, and visit with our vendors if you are able to join us at the annual conference in November. Thanks to our Past Chair, Executive Committee, and Board of Directors for your time and dedication to the chapter.

Ian W. Mead

Ian W. Mead, PE, BCEE
Chair, NASTT-NE



NASTT-NE SITE



MESSAGE FROM THE NASTT EXECUTIVE DIRECTOR

Michael J. Willmets, Executive Director, North American Society for Trenchless Technology (NASTT)

TRENCHLESS TRENDS – A GROWING RESOURCE FOR THE GAS INDUSTRY

Trenchless Technology and Infrastructure Management

The complex needs of North America's underground municipal services continue to expand as existing infrastructure reaches the end of its lifecycle. This is a major challenge for today's public works and utility professionals.

According to a 2017 US Department of Energy report on Gas Infrastructure Modernization, local gas distribution companies operate over 2.4 million miles of gas mains and service lines, and spend over \$7 billion annually maintaining and repairing pipeline networks. A significant proportion of these networks consist of very aged cast iron and unprotected steel pipe, especially in the US Northeast and Mid-Atlantic regions. The American Water Works Association (AWWA) State of the Water Industry Report, underlines this fact that the single most important issue faced by North American municipalities and public utilities is the renewal and replacement of aging infrastructure. As the AWWA report states, "Even systems that have acted as good stewards by planning for the renewal or replacement of their assets can sometimes find it difficult to secure reasonable funding for capital projects and/or to win public support for these necessary efforts." This issue is equally as critical to the Gas Industry.

The question on everyone's mind should be is there a way we can rehabilitate existing systems and install new systems that is economically feasible as well as environmentally sensitive and socially responsible? The answer is yes, and trenchless technology is the technique

that gas utilities should be considering. By definition, trenchless technology is a progressive civil engineering process for the installation, replacement or renewal of underground utilities with no or minimal excavation and surface disruption. These innovative methods have been used successfully for all underground utilities including water mains, storm and sanitary sewers and gas mains, along with electrical and fiber optics conduits.

The social and environmental benefits of trenchless technology are especially notable when employed in urban areas. These substantial benefits include dramatically reduced disruption to vehicle and pedestrian traffic, business activities, residential areas and environmentally sensitive areas. Recent advancements in robotics have allowed trenchless technologies to provide pipe condition diagnostics never before available permitting utility owners to more accurately identify infrastructure priorities. In most cases, trenchless techniques will also demonstrate significant cost saving benefits for municipalities and utilities over traditional open trench methods. These are all benefits that any gas distribution utility should be able to promote successfully within their areas of service.

North American Society for Trenchless Technology (NASTT)

NASTT is a not-for-profit engineering society of individuals, public organizations and private companies with strong beliefs in the practical, social

and environmental benefits of trenchless technology. NASTT strives to advance trenchless technology and to promote its benefits for the public and the natural environment by increasing awareness and knowledge by providing technical information, research and development, education and training.

NASTT's Cured-in-Place-Liner (CIPL) Good Practices Course is especially beneficial for the Gas industry. The course provides an in-depth overview of CIPL and covers topic areas such as methods and applications, planning and preliminary design, construction considerations and troubleshooting. NASTT offers this course several times per year in conjunction with major utility organizations.

As the world's premier resource for knowledge and education in trenchless technology, NASTT engages instructors and panelists who are experts in their field to inform and assist public works professionals. These volunteer instructors ensure that all of NASTT's educational content is peer-reviewed and offered from a non-commercial perspective. Not only does NASTT provide valuable trenchless training, but it provides a community for trenchless professionals to network and share ideas.

For any questions contact NASTT at 888-993-9935 or email info@nastt.org.

Sincerely,

Michael J. Willmets

Michael J. Willmets
NASTT Executive Director



TRENCHLESS TECHNOLOGY PERSPECTIVE

George Ragula, Public Service Electric & Gas

With great anticipation and sense of accomplishment, I welcome you to the inaugural edition of the NASTT-NE Chapter *Trenchless for Gas Infrastructure 2019* specifically focusing on the benefits and applications of trenchless technologies for gas industry construction work. With a large proportion of North America's gas distribution pipe inventory well beyond the midpoint of its life-cycle, the time has come to look more closely at trenchless as offering the best toolbox of renewal and rehabilitation techniques.

Since the mid-60s the gas industry has used trenchless applications such as **sliplining**, which uses smaller diameter plastic pipe operating at high pressure to renew large diameter pipe operating at low pressure. That was followed by **pipebursting**, which offers the ability to upsize lines to larger diameters. The industry has also fostered and continued to expand the use of **Horizontal Directional Drilling (HDD)** on larger diameter crossings for new and replacement construction projects as well as expanding it to routine work that I refer to as bread and butter work, however there are many other trenchless options everyone needs to be aware of. With all the new and replacement gas work on the increase and continuing at high levels, it is critical

to be familiar with all the major trenchless installation/renewal options. Education and information, like this publication, are the foundation of this effort.

Utilizing trenchless applications on gas construction projects can reap huge cost savings, as well as significant social and environmental benefits. Vastly smaller surface footprints, minimal use of natural resources like asphalt, sand and stone, and greatly reduced energy and surface restoration costs all dramatically decrease the CO2 equivalent impact of trenchless renewal and replacement projects. In fact, the use of trenchless technology offers the gas industry an entire range of approaches which minimize gas construction project-related GHGs while minimizing roadway restorations. Impacts of necessary repairs and infrastructure upgrades on nearby residents, businesses and communities are also mitigated significantly by using trenchless techniques.

These economic, social and environmental benefits and progressive cutting-edge technologies first prompted me to join NASTT 27 years ago as its first member from the gas industry. Membership has made me a well-known nationally recognized expert in the use of trenchless technology and its applications in the gas industry. My involvement in NASTT has allowed me to maintain a current and state-of-the-art awareness of trenchless methods and potential areas of

“Education and information are the foundation.”

improvement, with access to a vast library of technical papers and industry expertise. Over the years, the common bond, passion and friendship I've shared with fellow NASTT colleagues is incredibly rewarding, both from a professional and personal perspective.

The common link of construction bonds the trenchless technology and gas distribution industries closely together. We share the same goal of ever greater quality and efficiency in construction techniques. Special thanks to the NASTT-NE Chapter for helping sponsor this magazine and their continued support for outreach efforts to the gas distribution industry. Hope you can join us at the NASTT No-Dig Show - the world's largest trenchless technology show in Chicago, March 17-21, and at the AGA Spring Operations Conference in Nashville TN April 29 - May 3.

George Ragula

George Ragula, PSE&G
NASTT Hall of Fame Member

2019 UPCOMING GAS INDUSTRY & TRENCHLESS EVENTS

March 17 - 21, 2019

NASTT 2019 No-Dig Show

Donald E. Stephens Convention Center
Rosemont, Illinois
Information: www.nodigshow.com

March 20, 2019

NASTT Gas Good Practices Course

2:30 PM - 5:30 PM
Donald E. Stephens Convention Center
Rosemont, Illinois
Information:
www.nastt.org/training/events

March 25, 2019

AGA Natural Gas Roundtable Luncheon

AGA Headquarters,
400 N. Capitol Street, NW
Washington, District of Columbia
Information:
www.aga.org/events-community

March 28, 2019

NGA 2019 Sales and Marketing Conference

Renaissance Hotel, 5 Avenue of the Arts
Providence, Rhode Island
Information: www.northeastgas.org

April 8 - 9, 2019

AGA 2019 Crisis Leadership Summit

AGA Headquarters,
400 N. Capitol Street, NW
Washington, District of Columbia
Information:
www.aga.org/events-community

April 10, 2019

NGA 2019 Contractor Workshop

Saratoga Hilton, 534 Broadway
Saratoga Springs, New York
Information: www.northeastgas.org

April 11 - 12, 2019

NGA 2019 Spring Operations Conference

Saratoga Hilton, 534 Broadway
Saratoga Springs, New York
Information: www.northeastgas.org

April 11 - 12, 2019

SGA DOT 192 Compliance Workshop for Natural Gas Operators

Atmos Energy CKV Training Facility
Plano, Texas
Information:
www.southerngas.org/event-calendar

April 17 - 19, 2019

SGA Management Conference

Omni Fort Worth Hotel
Fort Worth, Texas
Information:
www.southerngas.org/event-calendar

April 25, 2019

NGA 2019 Regional Market Trends Forum

Marriott Downtown
Hartford, Connecticut
Information: www.northeastgas.org

April 29 - May 3, 2019

AGA Spring 2019 Operations Conference & Biennial Exhibition

Gaylord Opryland Resort &
Convention Center,
2800 Opryland Drive
Nashville, Tennessee
Information:
www.aga.org/events-community

May 7 - 9, 2019

Southwest Regional Gas Conference & Expo

Sheraton Georgetown Texas Hotel &
Conference Center
Georgetown, Texas
Information:
www.southerngas.org/event-calendar

June 4 - 7, 2019

NGA 2019 Gas Operations School

Bryant University, 1150 Douglas Pike
Smithfield, Rhode Island
Information: www.northeastgas.org

July 14 - 15, 2019

AGA 2019 Legal Forum

Resort at Squaw Creek
Lake Tahoe, California
Information:
www.aga.org/events-community

July 15 - 17, 2019

SGA NATURAL GAS CONNECT

J.W. Marriott Hill Country Resort & Spa
San Antonio, Texas
Information:
www.southerngas.org/event-calendar

September 23 - 27, 2019

AGA Fall 2019 Operations Section Meetings

Peppermill Reno
Reno, Nevada
Information:
www.aga.org/events-community

October 18 - 19, 2019

NGA 2019 Fall Operations Conference

Location TBD
Hartford, Connecticut
Information: www.northeastgas.org

October 28 - 30, 2019

NO-DIG NORTH

Telus Convention Centre
Calgary, Alberta
Information: www.nodignorth.ca

April 5 - 9, 2020

NASTT 2020 No-Dig Show

Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Leading Trenchless, Low-Dig, and Keyhole Technology Solutions

GTI, with funding support from Operations Technology Development (OTD), is working to develop and assist with the implementation of trenchless, low-dig, and keyhole technologies. Our experts are closely engaged with utilities and leading manufacturers to develop and commercialize minimally invasive technology that leads to faster repairs, less traffic delays, significant time and cost savings, and fewer impacts on the environment. Below are just a few samples of these exciting new tools and equipment.

GTI's Keyhole Consortium is expanding the adoption of keyhole technologies for utility system installations, repairs, and renovations. Comprised of members from manufacturers and utilities, it promotes cost-saving alternatives to common utility excavations that reduce public inconveniences and minimize environmental impact. It offers access to a community of industry experts and information sharing, supplies important data resources, and supports testing, development, and technology implementation. Learn more at www.gti.energy/keyhole-technology



PE Pipe-Splitting

Pipe splitting can offer significant cost savings in replacing vintage PE piping systems more efficiently, with less disruption to traffic and the general public. The GTI research team field tested existing PE pipe-splitting equipment to evaluate performance capability and effectiveness. The results were used to refine the hardware and develop standardized tooling packages and operating procedures for the commercially available equipment.

Intrinsically Locatable Polyethylene (PE) Pipe

A viable solution for intrinsically locatable polyethylene (PE) pipe materials, using 3M material resonators for path marking, has been developed and tested. The marker is applied directly to the plastic pipe, reducing installation time and offering greater accuracy, integrity, and ease of use. It offers precise location without tracer wires.



ORFEUS HDD Obstacle Avoidance

A real-time ground-penetrating radar obstacle detection system called ORFEUS (Optimized Radar to Find Every Utility in the Street) for horizontal directional drilling (HDD) developed in Europe was able to successfully detect plastic and steel gas lines, electric conduit, and a sewer main during live U.S. field evaluations. Ongoing technology development efforts and operator field tests are advancing the system to help bring it to the U.S. market.



For more information contact:

Dennis Jarnecke, GTI R&D Director, Energy Delivery | 847-768-0943 | djarnecke@gti.energy





SAFETY & OPERATIONAL EXCELLENCE – ACROSS THE GLOBE!

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THE AGA OPERATIONS CONFERENCE IS NORTH AMERICA'S PREMIER TECHNICAL FORUM FOR NATURAL GAS UTILITY AND PIPELINE OPERATIONS MANAGEMENT. MORE THAN 125 PRESENTATIONS BY INDUSTRY EXPERTS WILL ADDRESS RELEVANT AND TIMELY TOPICS, INCLUDING:

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- corrosion control
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- integrity management – distribution & transmission
- measurement – distribution & transmission
- operations planning & support
- pipeline safety
- piping materials
- quality management
- safety management systems
- supplemental gas
- underground gas storage
- workforce development
- ...and much more

**FIND THE CONFERENCE PROGRAM
AND REGISTRATION DETAILS AT
WWW.AGA.ORG/OPSCONF2019**

**(Operations Technical Committee Spring Meetings
April 29–30 in conjunction with the Operations
Conference & Biennial Exhibition).**

**ATTENDEES ARE ELIGIBLE FOR
PROFESSIONAL DEVELOPMENT HOURS.**

**ATTENTION, EQUIPMENT
& SERVICE PROVIDERS!**



The conference will again feature the renowned AGA biennial exhibition of products and services related to the operating functions of natural gas utility and transmission companies.

The exhibition attracts approximately 250 domestic/international vendors with exhibit space exceeding 90,000 sq. ft., including large islands. Don't miss your chance to reach the natural gas industry's leading operations management of local, national and international gas utility and transmission companies who routinely attend this event. The Exhibition happens once every two years; make 2019 count!



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New Jersey Natural Gas RISE Program Improves Infrastructure Resiliency

HDD Plays Pivotal Role in Four System Enhancement Projects After Superstorm Sandy

By: John Wyckoff, P.E., New Jersey Natural Gas



Sandy cut a new inlet between the ocean and the bay at the base of the Mantoloking Bridge



The aftermath of Sandy

When Superstorm Sandy made landfall on October 29, 2012, the impact was almost beyond comprehension.

It was a storm like no other. Spanning approximately 1,000 miles wide, Superstorm Sandy (Sandy) was the largest Atlantic hurricane on record and one of the most destructive ever. The New Jersey Natural Gas (NJNG) service territory, which includes Monmouth and Ocean counties, was the hardest hit. Communities were underwater. Major roads were buried under up to six feet of sand and debris. A new inlet was created. And icons of the Jersey Shore, like the historic Seaside Boardwalk, were washed out to sea [See photos above].

Access to the most severely impacted areas was virtually impossible in the

immediate aftermath of the storm. Once NJNG's crews were able to reach these areas to assess the damage, the unprecedented decision was made to curtail service to more than 31,000 customers in parts of 14 municipalities along the Jersey Shore, from Mantoloking to Seaside Park as well as Long Beach Island, Sea Bright and other impacted areas.

It was a difficult decision, but necessary to ensure the safety of our customers, employees and the public.

Within days, NJNG formulated a plan and immediately began working to repair the system. In the face of this unimaginable devastation, and in some cases with their own homes flooded and their families displaced by the storm, NJNG's employees demonstrated extraordinary resolve to

meet any challenge and restore service to customers.

Under extreme conditions, and with help of mutual aid from 14 other utilities, NJNG re-pressurized 270 miles of main, replaced one mile of 12-inch main, rebuilt or replaced 51,000 meters, completed 121,000 service assessments, and restored service to every customer that was safely able to accept it – all in less than eight weeks.

In the months following Sandy and the restoration of service to those damaged areas, NJNG began to look at how its systems responded to this event, along with several other previous storms, to see what lessons could be learned. On a high level, the distribution systems along the Jersey Shore's barrier islands that were curtailed each had just one natural gas main supplying the areas. These areas are



Figure 1: South Seaside HDD crossing route



Figure 2: Long Beach Island HDD crossing route

islands and peninsulas, created by nature over time to protect the mainland from storms such as Sandy. As they became more and more developed, utility infrastructure followed to support the now tens of thousands of local residents and businesses.

In an analysis of the damage that Sandy wrought, although widespread above ground, only certain areas were fully destroyed to the point where underground facilities, such as natural gas mains, were directly impacted. Curtailment and/or restoration of service to parts of the affected areas may have been able to be completed sooner, or even potentially avoided, if these one-way systems had a second feed of natural gas.

Following Sandy, the State of New Jersey asked utilities to identify what actions could be taken to improve utility infrastructure resiliency, to mitigate the number and duration of future outages, and improve the ability to safely respond to service disruptions before the next super-storm comes our way.

In July 2014, NJNG received approval from the state's regulatory authority for our New Jersey Reinvestment in System Enhancement (RISE) program. RISE was designed to improve the reliability and resiliency of our distribution systems. Over the following five years, NJNG will have invested approximately \$100 million on a series of storm-hardening and mitigation projects, including the installation of new distribution mains as secondary feeds; the relocation and/or reinforcement of existing regulator stations; and, the installation of service meter protection in the most storm-prone areas of our service territory.

“It In order to meet the strict timelines of this program, NJNG sought Design-Build solutions.”

It is the installation of these new secondary feeds which will be reviewed here – and where the trenchless technology of horizontal directional drilling has, and continues to play, a pivotal role.

In all, four projects were approved for installation of secondary feeds as part of the RISE program, requiring horizontal directional drills from 1,200 feet up to just over 14,000 feet. All four system enhancement projects consist of installing a new 12-inch steel (API-5L-X52, 0.375-inch wall thickness, FBE coating with ARO) distribution pipeline under a major body of water between specific connection points on the mainland and respective barrier island. In order to meet the strict timelines of this program, NJNG sought Design-Build solutions to construct these facilities. The design of these crossings, in particular the longest HDD's, required creative and innovative approaches due to permitting requirements, available working space, seasonal restrictions, and other constraints.

In order to meet the program deadlines at the end of calendar year 2019, NJNG decided the Design-Build process, integrating HDD engineering, design, permitting, project management and construction services would be the best way to narrow down already long expected timelines for these types of projects. NJNG solicited bids from several well-known HDD contractors which each

partnered with an established engineering consulting firm. In general, the HDD contractor designed the drill crossing while the engineering consultant handled other key aspects of the project such as route assessment, permitting, and workspace acquisition support. Experience with environmental permitting in our state was deemed critical.

The first step in each project included a route assessment study, which required a series of conceptual design activities, beginning with the selection of a preliminary preferred distribution main route. The design teams began by preparing a route study that compared the constructability of alternate routes provided by NJNG, including identifying permitting requirements and their general timeline, project cost estimates and a general summary of any other critical and intangible factors and risks which would affect the cost and timeline of each project.

Constructability, schedule, and impacts to the general public and local businesses were the primary factors in determining the preferred route. From an HDD perspective, selection of routes considered length and depth of drill, estimated drill duration, the need for compound and horizontal curves, and work space and access issues for the needed equipment. Permitting, however, had the greatest impact on route selection over these many factors. Most of the RISE projects



Figure 3 - Sea Bright, pullback string

required US Coast Guard/US Army Corps of Engineers, Coastal Area Facility Review Act (CAFRA), Waterfront Development, Flood Hazard Area, Freshwater Wetlands, Tidelands, and Soil Erosion and Sediment Control approvals, as well as local road opening permits. Two projects also required what is known as a Green Acres Diversion, when in cases where land that has been dedicated in perpetuity for use solely for recreation or conservation purposes is proposed for any other use. In our case, two small areas at the end of the roadways leading to the water where the crossings were proposed had been dedicated as small parks; one a scenic river overlook, and the other a boat launch area. While typically under town control, a change in ownership, even for an easement to drill under the area, requires approval by the State Department of Environmental Protection and a special State House Commission. Even though both crossings qualified as “minor diversions,” the typical timeline for approval is at least one year.

Two of the RISE project water crossings were relatively straightforward from a route selection and constructability standpoint. Route options for crossings on the Sea Bright and North Seaside projects were extremely limited, and by most measures, were straightforward HDD’s.

Completed in May 2018, the Sea Bright project consisted of a 1,200 foot HDD crossing under the Shrewsbury River from Rumson Borough into Sea Bright Borough. Other than the need for a Green Acres

diversion, the primary issues were work space on the receiving side, and the layout of the pullback string, as well as its impact to local homeowners and traffic [See Figure 3]. Prior to pullback, the pipe had to be strung out along heavily trafficked roads, requiring a creative detour to access an adjacent bridge

The North Seaside project, completed in January 2018, included the directional drilling of 3,000 feet of 12-inch steel pipe crossing under the Barnegat Bay between the mainland in Brick Township and the northern end of the Seaside peninsula in Mantoloking Borough (near the area in



Figure 4 - North Seaside, HDD sending site, Mantoloking



Figure 5 - South Seaside, pipe strings awaiting pullback. The drill site is near the building in the distance

Figure 1). In this case, workspace was also an issue, and our contractor needed to be particularly creative in laying out both the sending and receiving areas. The sending area in particular required the closure of several local streets for almost two months [See Figure 4].

By far the more difficult HDD’s were the now completed South Seaside project, and the Long Beach Island Reinforcement project currently in progress.

The South Seaside Reinforcement project had a variety of routes, eight in all, that were assessed for the various issues mentioned earlier. These routes ranged



Figure 6 - South Seaside, pipe being pulled in

in length from 8,000 feet to 14,000 feet. Following a desktop assessment process, three routes were recommended by our contractor for consideration. (This process is discussed in full detail in Paper TMI-T4-02 prepared for the NASTT's 2017 No-Dig Show, by Laney Directional Drilling/Stantec Consulting.) Based on this analysis, NJNG chose to proceed with the primary recommended route, a 9,000 foot crossing from the mainland of Berkeley Township to a potential parcel in Seaside Park Borough on the peninsula [See Figure 1]. This route provided the lowest potential environmental impact as well as minimal inconvenience to the public while allowing for an HDD that was feasible and could meet our intended schedule. It also avoided the need for a Green Acres diversion. The main challenge to this route was that temporary workspace and permanent pipeline easements were required on both sides, and a portion of a county road would need to be shut down for an extended period of time. Additionally, as would be the case on most routes, at least two pipe strings would be required during pullback operations. This recommendation was selected in June 2016, with the schedule calling for permits to be received by September 2017 and construction lasting from October through November 2017.

The proposed HDD was to be an "intersect" drill, with one drill rig on each side of the crossing that drill toward each other using a guidance tracking device.

What may likely be one of the longest double intersect HDD's ever done is expected to be completed and in service by June 2019.

Once the pilot bores are within a certain distance from each other, the main rig advances its drill string, following behind the secondary rig's retreating downhole string. The advancing drill string is then steered forward into the vacated borehole produced by the secondary rig, creating a continuous single borehole that is then reamed using both rigs and the pipeline is then pulled in.

Construction began in February 2018, and after successfully completing the 9,000-foot pilot hole of the intersect drill, and approximately 1,800 feet of reaming, Mother Nature struck again. In March 2018, Winter Storm Riley hit the area. Both drill sites were compromised due to abnormally high tides that extensively flooded back bay areas, impacting the drilling mud. These tides resulted in infiltration of brackish water into the drill pits. Additionally, the increased hydrostatic pressure resulted in groundwater penetration into the HDD bore hole below the surface, thus compromising the integrity of the hole. Our contractor was unable to recover approximately 7,000 feet of drill pipe and the 24-inch reamer from the hole. They then had to redesign the bore path, relocate the HDD equipment

on the mainland side, reinstall the 24-inch conductor barrel and re-bore a majority of the pilot hole.

After another successful pilot bore, reaming began again – and another setback hit. Although multiple soil borings had been performed during design, both on land and in the bay, a short layer of extremely dense, sticky dark gray clay was encountered about 2,400 feet from the mainland side. This gummed up the reamer and resulted in it getting stuck. After several efforts to move the reamer, the decision was made to once again abandon the hole.

As the saying goes, the third time is the charm. After bringing in a mud specialist to analyze the clay material found, a series of additives were designed to improve the reaming process. The hole was fully reamed and the pullback process was ready to begin. During the above issues, two 12-inch steel pipe strings of 4,800 and 4,200 feet were set up on the mainland side [See Figure 5]. This required the closing of the roadway for a period of three months – so needless to say a great working relationship with local officials as well as sensitivity to the impact on local homeowners was crucial. As the pipe was



Figure 7 - South Seaside, pipe being pulled in, overhead view 1



Figure 8 - South Seaside, pipe being pulled in, overhead view 2

pulled in, extra care was needed in dealing with the complex bending of the pipe while it was being handled [See Figure 6]. The pullback was successfully completed in 20 hours, two of which were needed to weld the two pipe strings together and wrap the weld joint [See Figures 7, 8 and 9]. The newly drilled pipe was pressure tested and put into service in May 2018. Installation of additional distribution main on the mainland and peninsula is in progress and will be completed in June 2019.

The final RISE project, the Long Beach Island Reinforcement, is currently in progress. Similar to the other projects, a route assessment was completed – in this case, the mainland side was limited to two possibilities, as only two roads extended from the primary corridor in Eagleswood Township towards the Barnegat Bay. Multiple options existed on the Long

Beach Island side, but the required space needed for the drilling equipment also narrowed these down to two possible sites – resulting in either a 14,400 or 15,200 foot drill [See Figure 2]. The shorter route was chosen. The permitting for this project scheduled to be completed by September 2018, with construction to begin in November 2018.

Like the South Seaside route, the route selected was chosen to minimize environmental impacts and inconvenience to the public. It did unfortunately require a Green Acres division, as at the end of the mainland road was a public boat launch area and drilling under the site was unavoidable [See Figure 10]. As with the South Seaside project, this also required an “intersect” drill, although not just one, but two. This required the construction of a 20-by-40-foot cofferdam in the middle of Barnegat Bay, from which HDD equipment

situated on barges will drill in either direction. A section of pipe connecting the two drills will be completed within the cofferdam once the drills are completed [See Figure 11]. Another unique requirement for this project is the need to float the pullback pipe strings in the bay, as there is not enough room on either side of the crossing to stage the pipe. Both pullback strings will be welded together on the mainland side of the project and pulled into the water as they progress. When ready for pullback, they will be towed into position in line with the drill string for entry into the cofferdam site. This method also avoids the need for intermediate welds during pullback.

Installation of the cofferdam was completed in November 2018. The Green Acres process delayed the mobilization of drilling equipment until December 2018. The first pilot bore, for 6,700 feet out of



Figure 9 - Long Beach Island, HDD site, Eagleswood



Figure 10 - Long Beach Island, cofferdam site

the total length of 14,400 feet, was started on the mainland side in January 2019. Completion of what may likely be one of the longest double intersect HDD's ever done is expected to be completed and in service by June 2019.

With the final completion of these four vital projects, along with other RISE initiatives, NJNG will be in a stronger position and better able to respond to major weather events to effectively and expeditiously meet our customers' needs in the future – although we certainly hope another Superstorm Sandy never again comes our way...

New Jersey Natural Gas would like to acknowledge the following HDD contractors and their partnering engineering consultants for their expertise on these projects:

- *South Seaside Reinforcement – Laney Directional Drilling and Stantec Consulting*
- *Long Beach Island Reinforcement – Carson Corporation and CDM Smith*
- *North Seaside Reinforcement - Carson Corporation and CDM Smith*
- *Sea Bright Reinforcement – InterCon Construction and J. F. Kiely Service Co.*

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Figure 11 - South Seaside, HDD pull site, Seaside Park

ABOUT NEW JERSEY NATURAL GAS:



New Jersey Natural Gas, the principal subsidiary of New Jersey Resources, operates and maintains over 7,400 miles of natural gas transmission and distribution infrastructure to serve over half a million customers in New Jersey's Monmouth, Ocean and parts of Morris, Middlesex and Burlington counties.

ABOUT THE AUTHOR:



John B. Wyckoff, P.E. is the Director of Engineering for New Jersey Natural Gas. With 30 years of experience in the natural gas utility industry, he holds a Bachelor's degree in mechanical engineering from the University of Delaware, and a Master's degree in material science and engineering from Rutgers University.

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30-Inch Cast Iron Cured-In-Place-Lining Rehabilitation

Longest run of 30-Inch natural gas pipeline CIPL footage in the world to date!

By: Phillip Hoffer, Progressive Pipeline Management

Taking on the challenges of renewing aging infrastructure with trenchless solutions, and the lessons learned along the way.

THE LONGEST RUN

In an aggressive effort to utilize a high volume of Cured-In-Place-Lining (CIPL) for the renewal of natural gas mains, a record-setting total of 3 miles of 30-Inch cast iron natural gas main will be rehabilitated throughout 2019 in a major city in the northeast. Using the Starline CIPL product designed by the Karl Weiss group in Germany, Progressive Pipeline Management (PPM) is currently working to achieve that record on three different project locations.

past few years to handle larger diameter pipes and the addition of our new state of the art inversion drum, will be invaluable as we continue to tackle larger and larger infrastructure renewal projects.”

The lessons to be learned in a venture like this will prove very valuable going forward and indeed those lessons came along quickly, as anticipated once the project was underway. Both we ourselves and the utility were challenged and forced to adapt and make adjustments to meet those challenges.

BACKGROUND

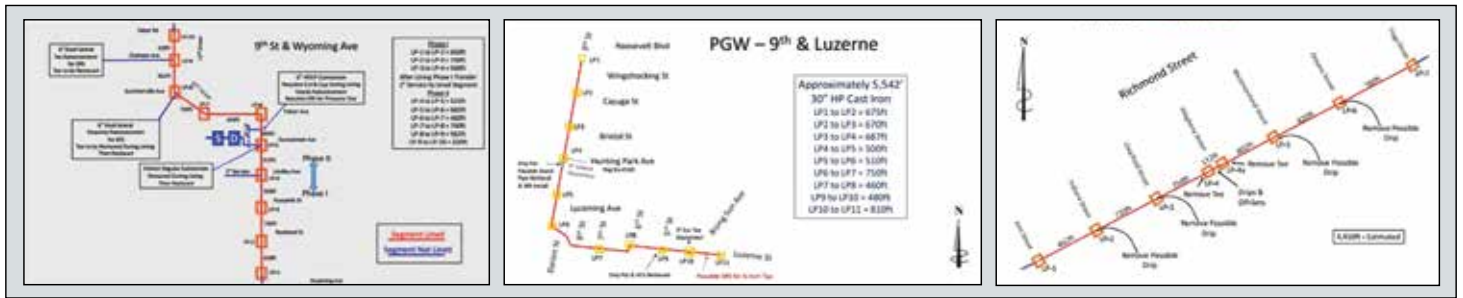
The utility is no stranger to CIPL rehabilitation, as they were directly involved in the research and development process in the



Liner is readied for installation. An incredible length and volume of 30-inch liner is being used – a combined total length of 3 miles of CIPL pipeline rehabilitation

As Dave Wickersham, President of PPM, noted, “We’ve had projects with a few 30-inch inversions before, but this will be an unprecedented total project length for natural gas lining in overall linear footage. The equipment refinements we have made over the

90s when gas operators across the nation were first looking into this technology. One of the first CIPL projects completed in the United States by a licensed contractor for a gas utility was the rehabilitation of a 12-inch cast iron main at the Navy Yard in South



Three Projects

Philadelphia in 2000. Later that year, and again in the summer of 2001, a major 20-inch lining project was also conducted on Market St. in West Philadelphia under the elevated rail line.

With one of the older gas distribution systems in the country it is not unusual to find that there are still quite a few miles of cast iron in operation. A good deal of that remaining cast iron inventory is large diameter pipe. "When you consider the high cost of replacement in larger size gas mains (20- to 42-inches diameter) due to increased excavation and paving costs combined with the fact that there is little or no room to relocate the main due to underground pipeline congestion, it is not surprising that the decision was made to utilize the Starline cured-in-place liner... a proven product with a successful track record and a 100-year service life," said Wickersham.

PHMSA/NYSEARCH STUDY

A study recently conducted by PHMSA together with the NYSEARCH group has encouraged gas utilities to use CIPL because of favorable results from testing conducted at Cornell University. In this research project segments of lined cast iron pipe that had been in service for the past 10-15 years were cut out of the ground and taken to Cornell for rigorous testing. The segments of lined cast iron pipe performed well and demonstrated an attainable life expectancy of over a hundred years.

THREE PROJECTS

The three projects comprising this record-setting three mile length of CIPL were designed and situated in Philadelphia. The first CIPL project is named "9th & Wyoming", located in the Wyoming area of the city. The second project location was on Richmond Street in Port Richmond. The third CIPL project is at 9th & Luzerne in the Hunting Park section of the city. All three involve 30-inch cast iron pipelines, which are the longest combined length of 30-inch CIPL rehabilitation to date for natural gas distribution systems. This incredible length and volume of liner – a combined total length of 3 miles of CIPL pipeline rehabilitation – shows the effectiveness and economy of the CIPL trenchless approach as an alternative to replacement.

FIVE CHALLENGES

1) LINER ORDER AND SHIPPING

One of the first challenges came with ordering the liner, which

"We've had projects with a few 30-inch inversions before, but this will be an unprecedented total project length for natural gas lining in overall linear footage."

– DAVID WICKERSHAM, PRESIDENT, PPM

is manufactured in Europe and shipped from Berlin. Because the rehabilitation business is booming world-wide increasing the demand for liner, lead time for ordering larger diameters can take as much as twelve to sixteen weeks. The larger size diameters and the number of rolls required for ever greater distances, creates a tremendous challenge for the manufacturer to deliver on time, and then there is still overseas shipping and US Customs approval that always adds time to expected delivery dates.



Liner rolls are shipped from Berlin on heavy stationary reels

Additionally, a new style of liner shipment was implemented this year shipping the liner roll on a reel. Each reel is then secured and made stationary for the long overseas voyage or flight. As a consequence PPM had to fabricate a custom system to move the very heavy stationary reels onto rollers wheels thereby allowing the liner to be unrolled evenly from each of the reels. Then we designed

and fabricated another separate system to receive the liner, and begin to wrap it neatly onto smaller reels that could be loaded onto the box trucks and transported to the jobsites.



Effectiveness & economy of CIPL trenchless projects includes small surface footprint

2) OVER-SIZED AND OVER, OVER-SIZED PIPE

When work began on the first project, 9th & Wyoming, in preparation for shutting down the main, it was discovered that the pipe was an over-sized cast iron. The normal sized couplings for cast iron had already been ordered and delivered, but these would not be large enough for this pipe. Fortunately, there were enough spare couplings available to use for shutting down the gas and isolating this section of main to begin the work, but another supply of over-sized couplings needed to be ordered immediately for the whole project.



End cap bolted to pipe at end of day. Utility crews moved road plates, and removed end caps each morning

As internal sandblasting and cleaning of the pipe in preparation for lining began, the crews had to race around and locate every kind of protective device that could be found to cover the ends of the individual segments of pipe at the end of each day

and overnight. To make matters worse, the spring and early summer of 2018 had unusually rainy weather, which of course, flooded the excavations as a result. On several occasions, there was water infiltration that occurred in some segments along with mud and debris which required dewatering, drying and re-cleaning.

To avoid this experience and be proactive for the second project on Richmond Street, we ordered over-sized couplings to replace the couplings already in stock for that job. However, when the Richmond Street project started, we discovered this particular cast iron pipe had an even larger outer diameter. Measurements as large as 32.5 inches were taken at some of the excavation locations as the pipe was being prepared for saw cutting.

Fortunately, the crews were again able to re-utilize some of the existing couplings on the pipe for shut-down use, taking this portion of main out of service for the work. Additionally, four of the smaller couplings were taken to the shop and modified with saw-cutting and welding to provide temporary overnight caps. The remaining couplings were returned to the manufacturer to be heated and expanded. Once again, the weather did not cooperate during the Richmond Street lining project. On several occasions flooded excavations and water infiltration caused delays.



Crews often encountered flooded excavations during an unusually wet spring

Preparations for the third 30-inch project - 9th and Luzerne in the Hunting Park area are now underway. Because the pipe at this third project location is part of the same pipeline worked on earlier during the first 9th and Wyoming project, the same over-sized couplings can be used for this

next phase of construction. From this experience it is clear to us that digging test-hole excavations during the design and planning phases to get accurate circumferential measurements of outside pipe diameters of the pipe, saves a lot of money, material and heartache.

3) OVERLAPPING LINER R&D

An unfortunate error in the process of lining one of the segments afforded an opportunity to utilize an overlapping technique that PPM has designed and used successfully in gas pipe in the past. In this particular instance, a hydraulic failure on the pressure drum during liner inversion forced the crew to stop short of lining the entire length of the pipe. They decided to keep the liner pressurized in place until it cured and then proceeded with the overlapping technique to finish the rehabilitation of the entire pipe segment.

The overlapping procedure involves lining from one direction and then stopping at a midway point and allowing it to cure. The end of that liner is cut out and a second liner is then inverted from the opposite direction traveling up to and then past that

midway point, overlapping the first inversion. Once the second liner inversion has cured, its end is cut out and the entire length of pipe is renewed. The overlap extends 40-50 feet and is well bonded to the first inverted liner. Using this process it is feasible that a pipe could be lined that is twice as long as the inversion length currently possible with available equipment. PPM has been experimenting and developing this method towards the ultimate goal of longer inversion lengths while reducing the number of excavations needed.



Liner is inverted through host pipe with continuous air pressure until it reaches end catch. Some lining segments are over 800 feet

4) TEAM WORK

To save on construction costs the gas company crews provided daily support for PPM. The gas utility crews would set up traffic in the morning, move the plates and remove the end caps so that the lining crew could get started right away. The utility crew would then move to another location on site and continue with their portion of the project. At the end of the day the utility crew would wrap everything up when we were finished for the day.

It is often a challenge in these endeavors with getting everybody on the same page. A trenchless technology such as CIPL is still relatively new to people who work daily in the gas industry. Standard operating procedures and work habits are learned, deeply ingrained, and become second nature not only to workers in the field, but also for supervisors, engineers and administrators back in the office.

When a new technology contractor comes on the scene, a whole new and different set of procedures and practices is introduced that needs to be communicated diplomatically, clearly and repeatedly. It is not uncommon for a foreman or supervisor to be gone for a week's vacation or a crew to be relieved at the end of a shift with personnel that have not been involved with the technology before. Even with an experienced crew, somewhat familiar with the process, details associated with the new technology may not have become second nature and a force of habit yet.

For example, during this project, a relief crew came on duty at four o'clock on a Friday afternoon, right before a three-day holiday weekend. The importance of securing the dead-end couplings on all the pipe ends before plating the excavations at the close of the day was not clearly communicated to them. As one might

“It is not unusual to find that there are still quite a few miles of cast iron in operation. A good deal of that remaining cast iron inventory is large diameter pipe.”

guess, naturally, it rained throughout the holiday weekend and the pipe was completely flooded as a result. So once again the lesson learned is one can't assume that what seems like a simple basic detail is properly understood by all.

5) RECOVERY OF DUST AND BLASTING GRIT

From previous experience on large diameter CIPL in the past, PPM has learned that the correct vacuum set-up needed for cleaning 30- and 36-inch cast iron pipe before lining is utilizing a custom-designed Venturi system in tandem with a dust collector and three Guzzler vacuum trucks. This is the equivalent of seven separate vacuum units, and provides the optimal air flow required to move debris and blasting grit without leaving behind stranded grit piles and trails.



Optimal vacuum setup for cleaning 30 & 36-inch CI pipe before lining is equivalent of 7 separate vac units

Unfortunately, even with that kind of preparation there were still odd times when a breakdown with one of the units occurred and went unnoticed temporarily. The result of course, was the unwanted piles of blasting grit. In past situations, PPM crews have literally spent several days pigging excess grit piles out of pipelines. With several long segments on these 3 projects ranging from 750 to 820 feet PPM did not want to get bogged down with delays using this long slow painstaking process. As a solution, PPM used a modified custom roller pig, a tool designed to cradle a foam pig two inches smaller in diameter than the host pipe. This roller frame is then attached to a winch cable, allowing the pig to be held back

against the air flow. This reduction of the annular space around the pig causes the air flow to increase and move the grit out. The progress of grit removal is observed with a camera mounted right behind the pig.



Custom pig was fabricated to remove stranded grit by reducing annular space to increase air flow

SUMMARY

As the teams get ready to move into the third and final phase of the 30-inch work the challenges they encountered early on have prepared them to move into this phase with confidence, knowing they've had the chance to work the bugs out of the system and that they're more inclined to recognize potential pitfalls before they occur.



Team work, careful coordination of different elements, and proper communication of procedures & practices are essential for project success

Construction is planned to begin in March with the excavations for the 9th & Luzerne phase of the project. We have also had very

productive meetings together with the utility to save on costs wherever possible. At least two excavations from the original design plans have been eliminated by planning longer inversions and ongoing discussions continue to examine ways to save on overtime costs with the support crews.



New pressure drum built for larger diameter liners and longer inversion lengths was pressed into service for the final lining segment now underway on Richmond Street

There is also a brand-new pressure drum that has arrived from Germany built for larger diameter liners and longer inversion lengths. The new drum was immediately pressed into service for the last segment that was lined on Richmond St. and promises even greater potential for meeting the challenges ahead in the gas pipeline renewal industry. 💧

ABOUT THE AUTHOR:



Phillip Hoffer, is Regional Manager for Progressive Pipeline Management (PPM) with over 40 years in the construction industry. Phillip was a member of the first Starline team to be trained in the technology here in the United States by The Karl Weiss Group from Berlin, while still an employee with PECO-Exelon before moving with the technology to PPM when they took over the North American License in 2002.

"Much Ado about Nothing"

More than You Ever Knew, or Cared to Know, About Vacuum Excavation

By: John Walko, Excavac

First in a series of articles on Vacuum Excavation Technology

It was around 1600 AD that the beloved William Shakespeare wrote his famous play with the above title. With all due respect, I find it appropriate that 419 years later the title is very suitable for an article about the long coming acceptance of vacuum excavation. Vacuum: an emptiness, an absence of matter, nothing!



Multiple utilities are safely exposed in a common trench (gas, electric, and fiber). Probe shows hole where high voltage electric line faulted.

With the advent of vacuum technology to the excavation industry, many are under the impression that this is a fairly recent phenomenon. In truth, the technology has been around a lot longer than one would think. To better understand where the vacuum industry is headed, let's look back to where it came from. It was in the mid-1950s, 60 odd years ago, that the industry innovators at Con Ed in New

York City, developed an external sealing material for leaky cast iron gas mains. This new material was called Conseal-Ex (the internal pipe sealer was simply called Conseal). Working with an outside contractor, Ford, Bacon, & Davis (FB&D), it soon became apparent that the expense of digging a normal 3 foot x 4 foot excavation to apply the sealer made the process cost prohibitive. Credit is given to FB&D process supervisor, W.D. Kleppinger, for developing the first of what morphed into what we now call vacuum excavators. Kleppinger and his group pioneered both the machine and the techniques involved in applying this new technology. The term "Keyhole excavation", that they coined early on, endures until this day. Their new technology enabled creating so small an excavation that the Conseal-Ex process now became viable cost-wise.

The new vacuum technology grew right along with the market for the Conseal-Ex pipe sealing product. Markets included Minneapolis, Chicago, as well as NYC. All of this work was performed by FB&D with their newly developed equipment. However, due to limitations in applying the Conseal-Ex, as well as the material's own short-comings, the success rate of the process was so low that the material soon fell into disfavor with the gas utilities. Not so with the vacuum excavating technology. Other chemical companies became involved, and better sealing compounds and application processes were created, with most of the chemical people working with FB&D for the application of their material. The 50s gave way to the 60s, and FB&D soldiered on with their vacuum technology, applying it where ever it would fit. It was in the early 60s that Miller Pipeline of Indianapolis became an early

"The future is bright for this technology that is based on... nothing."

adopter of the vacuum technology. The truck mounted vacuum systems that both companies used were very similar in design and performance, a design that served both companies well throughout the next two decades and beyond. As such, those two contractors basically owned the vacuum excavating work that was done in the gas industry throughout those years. For obvious reasons, gas was the primary industry to embrace the technology. Excavations to deal with gas main leaks were now done faster and safer, win-win.



Vacuum excavating over buried control lines INSIDE a high voltage power station



Attaching anode for cathodic protection to steel gas line using cad welding

However, even with the acceptance by gas utilities, especially in the Northeast, vacuum technology remained on the fringe of the excavation industry. This remained the case from the very early years, and all through the 70s.

It was not until the 1980s that we saw a notable jump in the use of vacuum excavators. A major driving force in this growth was that Federal regulators began increasing fines on gas utilities that were out of compliance in mandated anti-corrosion programs. In lieu of installing expensive rectifier beds along distribution mains, the practice of attaching sacrificial anodes to the buried pipes became an attractive solution to the compliance problem. It didn't take long for the gas companies to realize that vacuum excavators could install these anodes very effectively. By the late 80s the gas utility demand for installing anodes using vacuum excavating far exceeded available capacity. Another gas application, the cutting off or "killing" of unused laterals from the mains, became another win-win use of the vacuum technology. Conventional excavating contractors began to adapt to the "new" 30 year old technology. The growing demand also provided an opportunity for a few manufacturers to make vacuum machines available to the average utility contractor. This was a major

“It was in the mid-1950s that industry innovators at Con Ed in New York City, developed an external sealing material for leaky cast iron gas mains.”



Air/Vac system on 4x4 extended cab chassis

change in the status quo, and helped open up the market considerably. As we moved into the 1990s, what had been primarily a Northeast quadrant market, quickly began to spread across the country. Maricopa County/ the City of Phoenix, Denver, Texas utilities, and finally the California gas companies began to see the benefits of using vacuum excavators. The market grew steadily throughout the 90s, with more manufacturers getting involved, and contracting companies being formed that specialized in offering mainly vacuum excavating services.

The gas industry leak and corrosion issues were not the only things raising demand for the vacuum excavators. In the early 1980's, So-Deep of Manassas, VA realized an important use for the technology, and it wasn't necessarily gas services. So-Deep used the vacuum technology to assist in finding and positively identifying buried utility lines, no matter what kind. And later in the 80s, another multi-discipline company was created, named Soft-Dig/Underground Services, out of West Chester, PA. It focused on both gas work and locating buried lines, plus it had the good fortune



Vac truck working next to busy Interstate south of Chicago

to draw on early links to FB&D for technical assistance. As was typical up to that time, these companies custom built their own vacuum systems. While I expect that there were other equipment builders that experimented with vacuum type excavating systems, vacuum excavation per se remained the domain of the contractors that had the wherewithal to build and maintain their own machines. Giving credit where it's due, the true technical foundation for digging with vacuum was created by FB&D, with the concept further proven by Miller Pipeline. It should be acknowledged that these two contractors also provided the base of vacuum technicians that would serve the developing vacuum excavating industry up until this very day.

Another separate, but soon related, industry was growing in parallel to vacuum excavation. Horizontal Directional Drilling was really taking off in the early 90s. As HDD technology improved, the horizontal drilling became, well, more horizontal. This made resolution of conflicts with previously buried lines more and more critical. It was a natural application for digging small vacuum “potholes” to expose the crossed lines to minimize these conflicts. In addition, there is the backend of the HDD procedure, which usually ends with a large puddle of drilling mud. The easiest way to remove the drilling mud was to simply vacuum it up. This proved to be another win-win for vacuum excavators, and another big jump in the vacuum excavation market.

The attention generated through the 90s by vacuum excavators managed to draw interest from most of the large commercial vacuum manufacturers of the day, especially if their equipment was truck mounted. It wasn't long before the larger industrial cleaning systems, and especially sewer jetter vacuum systems, were adapted to this new and developing market. Up to that point, the current builders of vac excavators would say, “we don't clean sewers and they don't dig holes “. But that distinction was soon very blurred, leaving us now with the two camps, air and water. Nonetheless, demand still exceeded machine availability, so most anyone building vacuum machines didn't have a problem finding customers. As the market expanded, a variety of vacuum designs and adaptations became available, but they still seem to split into the two main camps. As I mentioned above, these two types of popular excavating systems are the original concept air/dry vacuum systems, and the adaptive water/wet vacuum systems. There are merits and drawbacks to both types, so homework has to be done when choosing which is best for a given application. And yes, there are a few hybrids that incorporate both reducing technologies.

The big boost that the vacuum excavation market garnered in the 1990s set a positive growth trajectory through the 2000s, and then on to 2010s. More manufacturers have stepped up, and the market remains very healthy. However,

the very curious aspect about this technology is that it continues to be looked at like the red-haired step child of the excavation industry. Among the reasons for this are the following: a) it is a two-phase procedure, not a single-phase like most other excavators; b) it is often labor intensive, especially with the smaller machines; c) its efficiency is very dependent on soil conditions, far more than most other excavators; and d) the technology is rarely understood, often by the very technicians operating it. These concerns will be resolved as the industry matures - after all, it's only been about 60 years since Mr. Kleppinger put his first vac machine on the street!

In light of all the new advances in conventional excavators, why will the market for vacuum excavators continue to grow? Here are a few salient points:

1. Vacuum excavation, in its purer form, i.e. compressed air reduction/ vacuum removal, is the safest form of excavation ever devised by man!
2. Any variations from the original concepts will compromise the safe dimension, some more than others. Please Note: even aggressive air or water jet vacuum systems are considerably safer than mechanical excavating devices, including the simple spade shovel.
3. A hole as small as 12 inches diameter is often suitable for a vacuum excavation. Holes can be smaller, or larger, but with excavations beyond 36 inches diameter, mechanical devices are often a more practical consideration.
4. As most existing buried lines were set in open trenches, many vacuum excavations are therefore done in fill dirt. When excavating over HDD installed lines, one will probably be digging in virgin soil.
5. Vacuum excavations are typically less than 10 feet in depth, but 20-30 foot depths are not uncommon. Some have gone deeper, but the physics involved gets to be tested, especially with hydro-vac systems.
6. Since buried utility lines are often less affected by weather than aerial lines, increased effort is given to putting new lines underground. These lines are best served by vacuum excavators.



Removing soil with 4-inch vac hose, exposing two buried cables

7. A well trained vacuum crew is an asset to any excavation contractor, be it from “potholing” to assisting with site clean-up.
 8. Vacuum excavators are inherently environmentally safer. Soils, contaminated or otherwise, are collected into a sealed vessel, and returned to the environment only under the control of the operator.
- The future is bright for this technology that is based on... nothing. 🔥

ABOUT THE AUTHOR:



John Walko is a designer of industrial and commercial vacuum systems since 1973. Founder and President of Excavac Corp since 1989.

Charter member and Lifetime Board Member of NULCA (National Utility Locate Contractors Assn) 1993-present. Served on Steering Committee of Common Ground Study 1998-99. Participant on Common Ground Alliance Transition Team 1999-2000. Remains active with the Common Ground Alliance.

Live Gas Main Internal Visual Assessment Delivers Benefits to Remediation Projects

By: Ryan McGowan, ULC Robotics

Critical segments of gas distribution mains tend to be located in urban areas with congested roads, complex substructure, and sensitive neighborhoods and business districts. When these pipelines approach their 'end-of-life' gas utilities are faced with the need to replace these mains, which can be a costly and disruptive process.

Trenchless rehabilitation methods such as internal robotic cast iron joint sealing, lining and insertion are used by a growing number of gas distribution utilities to extend the life of the pipe while lowering costs and reducing disruption. However, due to outdated mapping and unknown features within the pipes, even rehabilitation projects have their challenges.

The internal visual inspection of natural gas distribution mains is a critical component of gas main rehabilitation projects. Pre-inspection of the mains prior to rehabilitation has proven to be an



VGC Crawler gets close up look at an unmapped drip pot



Unmapped drip pot identified by ULC crawler

important step in large-scale remediation projects. To ensure project efficiency, accurately estimate project costs and make informed go/no-go decisions, these inspections should be carried out before shutting down the gas main and before committing to large scale excavations.

Thanks to advancements in technology, internal inspections of gas distribution

mains can now be performed under live conditions from very small excavations.

THE CHALLENGES OF PRE-REHABILITATION INSPECTIONS

Traditionally, gas main pre-rehabilitation inspections are carried



Gas main valve in open position



Partially open valves may obstruct or block pipeline rehabilitation efforts



ULC Robotics' M1 Crawler being prepared for deployment

out immediately prior to rehabilitation after the gas has been shut down or bypassed, leaving gas utilities vulnerable to unexpected challenges including unmapped drip pots, offsets, excessive debris, protruding services, and partially closed valves. These unknown conditions can result in project delays, increased costs, and a greater demand on utility resources.

Another major challenge associated with remediation projects includes issues surrounding the age of the infrastructure records. Many gas main remediation projects are carried out on older assets, for which there is frequently outdated or missing mapping. A lack of accurate mapping impedes informed decision-making – leaving gas utilities to make go/no-go decisions based on some assumptions, which can increase project risk and result in unexpected project cost increases.

Projects that are cancelled due to complication still incur high costs relating to excavations, main shutdown, and reights. Even when complications are faced, projects that are approved to proceed may accrue additional costs relating to extra equipment, additional excavations, and other resources.

LIVE GAS MAIN INSPECTION TECHNOLOGY

Live gas main pre-rehabilitation inspections help deliver improved project planning and cost estimating by delivering critical information before mains are taken out of service and prior to large scale excavations. The information obtained from these inspections helps utilities resolve potential issues related to unmapped pipe features that may impede



Large VGC Live Gas Main Inspection Crawler inside a gas main

or block the rehabilitation method or damage the materials used in the process. When problems are identified early in the process, issues can be remediated as



Identification of debris in gas mains aids in project planning



M1 Launch Tube enables the newly developed crawler to enter live large diameter mains

a planned item of work or project plans can be adjusted to ensure a successful and efficient outcome to the rehabilitation process.

The camera and crawler systems developed by ULC Robotics, Inc. enter live mains through a very small opening

in the street and through small tap holes to avoid the need to stop the flow of gas or make a costly main cutout. The live gas main inspection technology enters the main through specialized launch tubes which adapt to mains using a variety of standard fitting and valve combinations, including saddles repair sleeves, weld fittings, and electrofusion fittings. Once inside the main, the systems travel hundreds of feet in either direction to capture visual data and provide a detailed inspection of the main, identifying unknown features and features that may lead to complications in the duration of the project. Knowing the location of such features is critical in project planning to ensure less time in street, minimal service outages, and controlled project cost and duration.

large diameter gas mains requires the use of a motorized inspection crawler. The VGC (Variable Geometry Crawler) Live Gas Main Inspection System launches into live cast iron, steel, and plastic gas distribution mains up to 99psi to assess the condition of the main and its features. High-resolution pan/tilt cameras allow crawler operators to obtain a detailed inspection of the pipe walls, joints or look up into tap holes – all without having to take the main out of service. The smaller crawler is designed to launch into 12 - 18-inch mains through a 3-inch tap hole. The larger version of the crawler is designed to launch into 20 – 48-inch mains through a 4-inch tap hole.

M1 LIVE GAS MAIN INSPECTION CRAWLER SYSTEM

The M1 Live Gas Main Inspection Crawler System was developed to expand internal inspection capabilities



Small VGC Launch Tube installed on a 16-inch cast iron gas main for CISBOT pre-inspection

VARIABLE GEOMETRY CRAWLER LIVE GAS MAIN INSPECTION SYSTEMS

The visual inspection of medium and



M1 Live Gas Main Inspection Crawler System

in large diameter mains as well as enable inspections in mains not previously accessible by existing technologies. The M1 operates within 24 -48-inch pipe to enable the pre-inspection of mains with internal mechanical seals and to provide accurate mapping of buried infrastructure. The crawler enters live distribution mains through a 6-inch tap hole. Equipped with a high-resolution pan/tilt camera and high-intensity LED lighting, the crawler provides a 360-degree view of the main, pipe wall, and its features, including tap holes, joints, and valves.



ULC's field crew conducting inspection of mains with internal mechanical seals

PRX250 LIVE GAS MAIN INSPECTION CAMERA SYSTEM

Internal visual inspection in live gas distribution mains ranging in diameter from

2 inches up to 12 inches is carried out using a pushrod style camera. The camera head is able to enter mains through a 1.5-inch tap hole or 1.75-inch drilled hole using a range of fitting and valve combinations. To deliver a high quality and detailed

inspection, the camera system offers remote motorized operations and a self-deploying centering system to keep the camera head above any debris and water typically found at the bottom of the gas main. 🔥

ABOUT ULC ROBOTICS:

ULC Robotics, Inc., a NY-based Robotics-as-a-Service contractor, works with utility and industrial companies to develop and deploy robotic systems, inspection systems, unmanned aerial vehicles and sensors to improve the way critical assets are inspected and maintained.

ULC Robotics' CISBOT gas main rehabilitation technology enters live large diameter cast iron gas mains through a very small opening in the street and then travel hundreds of feet in either direction to internally inject a proven anaerobic sealant into each joint. Using a computer-controlled process, CISBOT has sealed more than 40 miles of large diameter cast iron mains since 2010 with a success rate well above 99%.

Prior to deploying CISBOT, ULC Robotics' crews deploy the Large VGC live gas main inspection crawler system to pre-inspect mains and conduct a detailed assessment of the joints. Internal visual inspection of gas mains also helps resolve a wide range of operational issues including water intrusion, poor pressure, damage investigation and identifying features within the main.

To talk to our team about gas main pre-rehabilitation inspections, CISBOT or other technologies, contact our team at 1-631-667-9200 or visit www.ulcrobotics.com.

ABOUT THE AUTHOR:



Ryan McGowan is the Vice President of Field Operations at ULC Robotics. Ryan manages, oversees, and provides contract management to a wide variety of gas utility field

operations ranging from robotic pipeline rehabilitation to internal gas main inspection programs across the US and UK. Ryan has been working in the pipeline industry for more than 15 years and holds a number of operator qualifications through Northeast Gas Association. Prior to working with ULC Robotics, Ryan worked with pipeline robotics and internal video inspection in the pipe rehabilitation and pipeline installation field.

Raritan River and D&R Canal 16-inch Steel HDD

By: Sergey Wortman-Vayn PE, PSE&G



1948 Installation downriver of twin 16-inch CI which failed in 2014

The decision to proceed with the project came after several joint leaks of a 24-inch cast iron (CI) main were confirmed by underwater inspection using a diver. The main operates at 35 psig MAOP, and is located under the Raritan River and historic Delaware & Raritan (D&R) Canal between the towns of South Bound Brook and Middlesex in NJ. Recent histories of failures involving similar vintage pipe at other river crossings in the nearby area made it an easy decision to proceed with the project. After extensive analysis, a specific plan of action, which included contingencies for unexpected main failure, was developed and executed successfully. The scope of work included a 1,200-foot

directional drill of 16-inch Steel (ST) main under two water bodies and 600 feet of 16-inch ST main installed using conventional open-cut construction. Both portions of the project were successfully completed and gassed-in before the June 30, 2018 deadline.

Cast Iron piping joined with Inner-tite joints (a type of mechanical joint) was used by PSE&G throughout the 1940s and was a common joining technique. PSE&G had recent history with another similar crossing just downstream of this one in Middlesex. This 1948 construction was a typical open cut installation of parallel 16-inch CI pipe assembled and attached to wooden frames with empty barrels filled with air used as flotation devices. This entire joined piping assembly was then floated across the Raritan River and sunk for eventual connection to the land-based facilities. Fast forward 66 years to February 2, 2014 where this crossing sustained a complete mechanical failure and separation of both mains due to unusually high water levels from rain and snow combined with ice flows, tree limbs and other heavy debris carried downstream by the river. Subsequent underwater dive inspections revealed that large portions of pipe was completely exposed on the river bed due to scouring and several sections had debris wedged against the main. Excessive amounts of precipitation in the fall of 2013 and winter of 2014 contributed to increased water level and volumetric flow in the river. Evidence of wedged debris, large presence of ice and high river flow were all contributing factors of the failure. This suggests the main was exposed to outside forces for a significant amount of time, which eventually led to a major piping failure.

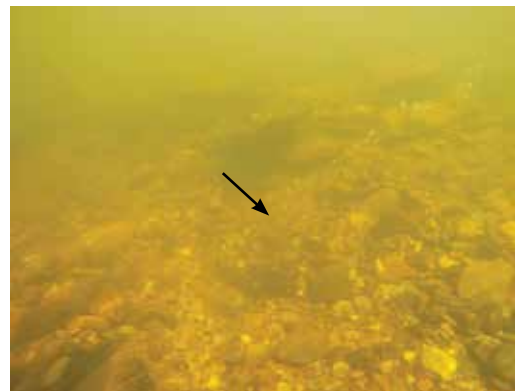
Once bubbles were reported near the Middlesex main, located north of this previous failure, an underwater examination of this 24-inch CI crossing was performed in June 2017. The dive inspection reported six of approximately fifteen pipe segments partially exposed. Four buried sections of the main were leaking at joints,



Exposed 24-inch CI main under Raritan River



Exposed 24-inch CI flange under Raritan River



Bubbles show location of leaking 24-inch CI main under Raritan River



Pilot drilling operation commenced May 10 using a 9-inch drill



Drill, Bentonite Mixing & Recycling Rigs

which had burial cover of less than six inches. Although the level of piping exposure to the river's flow and debris was not as extensive as compared with the previously failed twin 16-inch mains, the risk of total loss due to a major failure was still quite high. The next step was to review the overall system impact of a potential failure from a gas system modeling perspective.

This 24-inch crossing was a critical feed within PSE&G medium pressure system. Network modeling examine overall system performance assuming a potential crossing loss, and potential system solutions were developed to ensure adequate pressures could be maintained. The analysis confirmed the criticality of this main as the design day model revealed large areas of Middlesex Township below minimum allowable pressures along with potential outages. The local distribution network did not have enough flexibility or capacity for a system solution, so there were contingency measures implemented over the winter of 2017 before a permanent solution was executed.

The interim contingency plan was developed to provide increased gas volume to the affected area and bring the local distribution system above minimum pressures in case of crossing loss over the heating season prior to the HDD project execution. The plan consisted of a two-step solution. The initial step included upgrade of the flow capacity out of two local regulating stations. The second step involved developing an emergency operating plan, which included raising local regulators and potentially operating

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24-inch Reamer and Swab. Approx. 300,000 gallons of water were used during the pilot and reaming operations



Three 400 foot strings of 16-inch pipe were staged on the exit side of the river

It is typical for multi-permit acquisitions to run into delays, so starting the process early in the project is critical.

system separation valves to introduce gas from a neighboring system of a different pressure.

The modification of one regulating station involved adding a new 16-inch diameter valve and 70 feet of 20-inch diameter main to the existing outlet of the station to increase flow capacity. Rebuilding and upgrading the second regulating station consisted of:

- Upgrading regulation to increase flow capacity, which consisted of three parallel runs with a working regulator and monitor regulator in series. Each run has 50 percent station capacity, with the third run acting as a backup.
- Increasing outlet pipe size to reduce pressure loss at the distribution takeaway point and accommodate the higher station flow.

- Adding a scrubber to remove any potential pipeline liquids.
- Adding a second heater to support the increased flow capacity.
- Constructing a new building to enclose the new pressure regulation, instrumentation, and control equipment.
- Installing new relief valves to handle the higher relief capacity requirement.

Both contingency projects completed as planned in 2017 prior to the heating season.

Confirmation of the capacity requirements, leak locations and exposed main condition eliminated lining and insertion as potential solutions. Several options outside of HDD were considered and eliminated. Open cut construction at current or alternative locations would not be practical, as it would require extensive permitting and environmental considerations since the Raritan River still had to be crossed. This would also impact the historic Delaware and Raritan Canal site. Three bridge crossings at nearby alternative locations were also considered. One bridge crossing would not work as it already carried an existing 6-inch diameter main and did not have sufficient room to support an additional 16-inch diameter main (the required size needed). The remaining two bridges were state highway bridges where the extensive permitting process would not work with the short project schedule. With HDD being the most suitable solution for the project, several



Welding of second string of 16-inch pipe



Start of pullback operation



Maneuvering the last string of 16-inch pipe

crossing locations were further examined. The existing location of the 24-inch CI main was selected as the alignment best fitting the project needs, since it was already in an established ROW. It eliminated the need for another easement acquisition and already had access to large takeaway mains that supply the area as well as adequate laydown areas for the necessary equipment.

PSE&G's ability to take the existing 24-inch CI main out of service during a warmer part of the year dictated the project window. Based on system network modeling, the main was a critical feed and final tie-ins had to be completed during the non-heating season. Due to the close proximity of the drill path to the existing main in the same ROW, PSE&G also wanted to mitigate risk of an emergency shutdown by not starting the drill activities until after the winter weather broke. Although the completion of two station flow capacity upgrades previously described extended the window of opportunity by a few months, the overall project deadline was set for June 30, 2018 to allow extra time for any potential unforeseen setbacks.

The general contractor selected for the work was Ferreira Construction Company, who partnered with Carson Corporation to perform the HDD portion of the project. Maser Consulting provided engineering services, and InRock provided steering guidance services.



Pullback completion within 12 hours



ParaTrack Gyro Module

INROCK's newest guidance offering, the **ParaTrack Gyro Module (PGM)**, extends the capabilities of the Vector Magnetics ParaTrack system. Utilized in conjunction with the ParaTrack Steering Tool, the PGM is seamlessly integrated with the entire ParaTrack suite of tools and software, giving the operator complete flexibility in selecting the technical solution best suited for each project. The fiber-optic PGM is accurate and rugged as proven on over 60 bores, including hard-rock environments, tolerating high vibration with no lengthy down-hole re-orientations.

The PGM adds a valuable tool to the overall ParaTrack system. Users have the ability to run multiple technologies in tandem including: Pressure Monitoring, At-Bit Inclination, Beacon Tracking, Passive Magnetic Ranging intersect technology, and surface coils. These independent technologies provide multiple sources of location verification and monitoring, leading to better project outcomes. The ParaTrack Suite offers an unrivaled ability to tackle the specific challenges of any project, making the system completely unique in the HDD marketplace.



Site visit by Rutgers University NASTT Student Chapter members

Carson selected a medium size rig for the operation consisting of American Augers DD-220 together with Tulsa Rig Iron MCS 750 System and E477 Mud pump. For guidance services, InRock utilized a ParaTrack Gyro wireline tool. All of the rigs, support equipment and field trailer were set up on the entry side of the drill on the east side of the river.

The path of the 1,200-foot HDD section was designed with a 14-degree entry angle, 12-degree exit angle and 600-foot radius and maximum depth of 60 feet below grade. The pipe specification for the 16-inch steel main was API 5L X42 with 0.375-inch wall thickness. Piping was mill coated with multi-layer Fusion Bonded Epoxy (FBE) consisting of 15 mil DFT of base coat and 20 mil DFT of abrasion resistance coat. Welded joints were field coated with 30 mil DFT FBE. The pipe was staged, welded, coated and tested in three 400-foot strings on the exit or west side of the river.

The pilot operation commenced using a 9-inch drill on May 10th and concluded on May 30th which took a little longer than anticipated due to some equipment setbacks as detailed below. During the drill, the location of the mud motor cutting head was constantly monitored and recorded. Drill fluid pressure was monitored continuously while sand content, weight, viscosity and pH were checked on an hourly basis, and adjusted as needed. Hole expansion was performed using a 24-inch reamer and took place May 30th to June 12th followed with a 20-inch swab. Approximately 300,000 gallons of water was used during the pilot and reaming operations.

Pullback took place on June 13th and was completed within 12 hours. The operation included welding, coating and testing the three 400-foot strings and continuous monitoring of pullback pressure.

There are inevitably unforeseen challenges with any project. The first challenge came to light after reviewing ROW access conditions for the large rig equipment on the west side of the river where the original drill equipment was sited. The drill entry and exit locations were switched to overcome this issue.

The permitting process to drill under the Raritan River and D&R Canal pushed the project schedule back approximately one month despite the drill contractor's familiarity with the D&R Canal Commission approval process and completing a similar project under the canal that same year. To keep the project on schedule, sufficient resources were reallocated to welding and testing the pipe strings in preparation of the pullback operation.

The easement width on the east side of the project was 25 feet and narrowed to 20 feet as the ROW crossed to the west side. In order to expedite the project, amendments to the existing easement were not requested for the drill. With the existing main in the same easement and operating at full pressure, this left little flexibility for drill head maneuverability and required a compound angle.

The narrowing easement width came into play during pilot operation when the signal to the receiver in the pilot head was temporarily lost twice due to downhole wire shorts. Both times, the pilot was pulled back partially, the short repaired, and

drilling operations resumed shortly thereafter. These wire shorts extended the pilot operation.

The time required for permitting was under estimated, especially when dealing with multiple state and local agencies. It is typical for multi-permit acquisitions to run into delays, so starting the process early in the project is critical. Having alternate work options is just as important. In the case of this project, work shifted from drill preparation to pipeline fabrication in order to keep to the schedule. Performing the open-cut portion of the project would have been another option.

The width of the existing easement made it challenging for the pilot drill operation. A wider easement would have given more path design flexibility, and more generous operational tolerances. Due to the project schedule restrictions, any easement amendments were not pursued. In hindsight, future projects will be looked at more closely for sufficient easement space.

Last, but not least, is site security. There was a minor incident involving theft of equipment from a small area that did not contain secured fencing or other security means.

One of the more positive lessons from the project was the communications and interactions with the local community. This project required the closure of one street for most of the summer. Communication with local residents regarding this closure was immediate with frequent follow-ups. The street closures and pavement restoration were well coordinated resulting in a positive experience for the community and the company.

Due to the project's many constraints, HDD was the only viable option on this project and the installation successfully completed

“One of the more positive lessons from the project was the communications and interactions with the local community.”

on time and on budget, despite several challenging moments. The valuable lessons learned are applicable to all future projects. 🔥

ABOUT THE AUTHOR:



Sergey Wortman-Vayn, PE, Design Engineer, Gas Asset Strategy, is responsible for executing and managing PSEG's federally mandated Distribution Integrity Management Program and coordination of Metering and Regulation Station and transmission project work with interstate pipeline companies. As a NASTT member, Sergey is active with the local Rutgers University student chapter. He is an AGA member and serves on the AGA DIMP committee. Sergey has 19 years of engineering experience and holds a B.S., in Mechanical Engineering from Rutgers University and Masters in Mechanical Engineering from Lehigh University.



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Trenchless to the Core!

National Grid Combines Core-Keyhole with Mini-Directional Drilling

Jim Schill, Technical Writer



National Grid mounted its keyhole drills on platform trucks for easy transport to and from jobsites. The trucks are also equipped with bentonite mixing and delivery systems.

When it comes to leadership and pushing the boundaries of trenchless technologies, it's hard to match the impact that the gas industry has on the usage and development of new tools and the acceptance of a variety of trenchless methods. Gas utilities have been on the forefront of trenchless technology for decades, starting with live insertion in the 1960s, the use and deployment of piercing tools in the 1970s, the advent of directional drilling in the late 1980s and the development of pipe bursting in the late 1990s and early 2000s.

National Grid is one of the largest investor-owned energy companies in the world. Based in the UK, the utility has a long history of utilizing and

implementing trenchless technologies. In the US, with a service territory including Massachusetts, New York and Rhode Island, the company provides electricity to approximately 3.3 million customers. According to its website, National Grid is the largest distributor of natural gas in the northeastern U.S., serving approximately 3.4 million customers in New York, Massachusetts, and Rhode Island. In Great Britain, the company delivers gas and electricity throughout the entire the country.

With a continually growing service area, National Grid has incorporated a unique pipe installation approach that combines two trenchless methods, keyhole through coring and directional drilling. The Grundopit-K keyhole mini-directional drill

from trenchless equipment manufacturer, TT Technologies, Aurora, Ill., is helping National Grid perform a range of service installations.

National Grid's Director of R&D and Advanced Field Services Dennis Ruppert explained that his first exposure to this technology occurred in Europe. He said, "National Grid is a UK based company. So we had seen the technology while we were in Europe. At the time, we went with our colleagues in the UK to Paris where the unit was working in a historical district. They were working in a core to push a service to a building and put a new service



Grundopit K Keyhole Drill from TT Technologies was developed to bridge the gap between keyhole work and pipe installation. The mini directional drill is able to work within a 24-inch diameter core.



National Grid crews are able to control all of the keyhole drill's functionality through an above ground control panel.

in without any additional excavation, except the original core. So when we saw that, we thought this had great potential for our work in the States. So we partnered with TT Technologies and that's how we got involved in utilizing the equipment."

TT Technologies President/CEO Chris Brahler said, "The merging of these technologies, coring and pit-

"The merging of these technologies, coring and pit-launch directional drilling, is definitely a global initiative..."

– CHRIS BRAHLER, PRESIDENT/CEO, TT TECHNOLOGIES

launch directional drilling, is definitely a global initiative that includes some of TT Technologies' affiliate companies in Europe and Asia. The conditions in Europe, specifically the age of the infrastructure and the desire to preserve the historical nature of many of towns and communities, requires that next step of trenchless technology. In this case, it's combining the coring and HDD technologies.

"With National Grid, their service area is unique, along with some of the regulations that are in place regarding protected roadways and winter work restrictions. It makes sense that this technology would find its way into the National Grid toolbox here in the United States."

CORING THROUGH TIME

National Grid has been utilizing coring technology and keyhole applications since

the early 1990s. Ruppert said, "National Grid is a group of companies that merged together, but our legacy company, Brooklyn Union Gas, developed a technique to work in small holes. So at that time we were digging 1-foot by 1-foot holes or 18-inch by 18-inch holes, square. We would jackhammer them, vac them out and do our work. But we discovered that the restoration costs for even that small hole were running about the same as if we had excavated a 3x3 or 4x4 pit.

"So we really didn't see a whole lot of savings. But when the round core technology came out, it allowed us to take the core out and reinstate that exact same core. And really reduce the cost of the work. That was the transition that made it a really efficient tool."

By the early 2000s, National Grid was using the coring technique for a variety of applications such as valve box adjustments,



National Grid typically installs 1-inch MDPE services with the keyhole drill, however, the unit is able to install pipe up to 2 inches in diameter.



Quality of the core reinstatement is one of the most important and impressive aspects of the keyhole directional drilling process.

corrosion work, installing anodes, bell joint leak repair, injection of anaerobic sealant and more. While crews were able to do a lot of different work inside the small holes, the ability to install service lines with that technology was always lacking.

THE MISSING CAPABILITY

While National Grid has been coring and working in the small windows for decades, the advent of the K-drill Grundopit Keyhole mini-directional drill brings the long desired capability of installing new pipe within the small 24-inch diameter core.

The Grundopit-K drill was developed to bridge the gap between keyhole work and pipe installation. The unit is a fully automated, mini-directional drill that is able to work in a 24-inch diameter circular excavation. It is contained within its own shoring cylinder that fits within a cored excavation. The unit is able to install service installations up to 2 inches in diameter.

Brahler said, "With the core providing very limited working space, the machine needs to be controlled from the surface. So all of the directional capabilities can be controlled above ground. But while the operator has the control, much of the drill stem loading and vice cycling operations occur automatically."

Ruppert said, "The technique can be compared to arthroscopic surgery. That's kind of the analogy a lot of people use. The core is removed with a 24-inch diameter hole saw, basically the same principle as a drill bit that you would use to install a doorknob. Crews vac out soil and the drill is lowered into the 24-inch hole and secured by attaching the stand-off legs.

"Compared to a large directional drill unit, the compact drill works on the same principle, but instead of 15-foot drill rods, the pit-launched drill has rods that are only 9 inches long. So you drop these rods into the top of the machine. They automatically flip and align with the drill and thread into place. We have two of these units and had them mounted on trucks."

IN THE FIELD

Typical installations are 1-inch MDPE, however, National Grid has used the K-drill to install pipe up to 2 inches in diameter. While extensive back reaming is typically not necessary with the installations that the National Grid crews are completing, the unit does have bentonite capability, and a water-bentonite slurry is often used during operations depending on conditions.

National Grid has completed service installations between 125 and 130 feet long. But often, crews use the keyhole drill to move the project from the road surface to the soft surface behind the curb. According to Ruppert, this basically means installing the line from the road to the green space area beyond the curb and completing the installation using standard techniques such as horizontal boring with a piercing tool.

He said, "It's a really efficient way to use the machine. We'll shoot 10, 20 or 30 feet, from wherever it is in the roadway to



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behind the curb and then we'll pick it up from there and use one of our standard installation techniques.

Core reinstatement is one of the key aspects of the process and what allows the work to be done on protected roadways. According to Ruppert, the results are impressive. He said, "Once we complete work in the field, we backfill the core adding a small layer of small pea gravel and replace the core itself. We leave it approximately 1/2-inch low. Then we mix up a cementitious material that we pour back into the hole and set the core. We're actually able to float the core back into place.

"And if you see pictures of some of the work we've done, as close as 5 or 10 feet away, you can't even tell we've been there. That's how well the core reinstatement goes if you do it correctly. We've always found that if you set the core correctly, use the right material, the ground around it will fail before the core actually will itself."

EXPANDING CORE SERVICE

National Grid uses the K-drill, for the most part, as a new business tool, often on protected roads that have been recently paved that the utility can't access through any other means. Ruppert explained, "Someone calls and says they need gas service and they're on a protected street. We'll use that particular tool a majority of the time for that. In the right location, it's sometimes the only way we can run gas service to a new customer."

Ruppert also views the machine as a way to potentially overcome winter work moratoriums the utility faces in some communities. He said, "A good portion of our service area has municipal winter moratoriums. So as soon as the asphalt plants close in the wintertime, we're locked out of work. If we had a request from a customer for new gas service, we'd have to tell them no, wait until April. Now we've been in discussions with several municipalities that have winter moratoriums, explaining to them that we can restore these excavations at any temperature and

provide gas service to the customer without having to worry about road patches. We're looking at trying that in

our Boston locations where many of the municipalities have winter moratoriums." 

ABOUT THE AUTHOR:



Jim Schill is a technical writer based in Mankato, MN. He produces equipment and contractor focused feature articles on emerging technologies, safe equipment operations and innovative methods and applications. He has been a regular contributor to a variety of construction and trenchless industry publications for over 20 years.

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Assessing Integrity of Natural Gas Pipelines with Robotic Inline Inspection Method

By: Rod Lee, Pipetel Technologies, Inc.

INTRODUCTION

Pipetel Technologies has been operating a fleet of robotic inline inspection robots, known as Explorer iLi, for the inspection of pipelines since 2011. Requiring minimal excavation, and inspecting under live gas conditions, these robots provide pipeline operators with high resolution integrity data of their pipes. Many of the pipelines inspected since 2011 had never previously been done by inline inspection. These pipelines were limited to hydro-testing or direct assessments methods. This article will provide an overview as well as field experience on the usage of Pipetel's Explorer iLi for long distance pipeline inspection and the nature of data acquired.

DIFFICULT TO INSPECT PIPELINES

Pipelines that cannot be inspected by conventional smart pigs are generally deemed "unpiggable" or "difficult-to-inspect". These pipelines can be assessed by hydro-testing, direct assessment, or robotic inline inspection, such as Pipetel's Explorer iLi. The most common culprits that render pipelines as difficult-to-inspect are pipeline features that prohibit the passage of conventional smart pigs or an insufficient pressure/flow-rate for propulsion. Pipeline features that may prohibit the passage of conventional smart pigs include short-radius elbows, mitered elbows, unbarred tees, back-to-back elbows, vertical segments etc. Moreover, most of these pipelines lack the launch and receive chambers required by smart pigs. Pipetel's fleet of Explorer iLi robots overcome these challenges and inspect

The operator of this pipeline continued to deliver gas to its customers downstream without the need to alter operating conditions for the inspection.

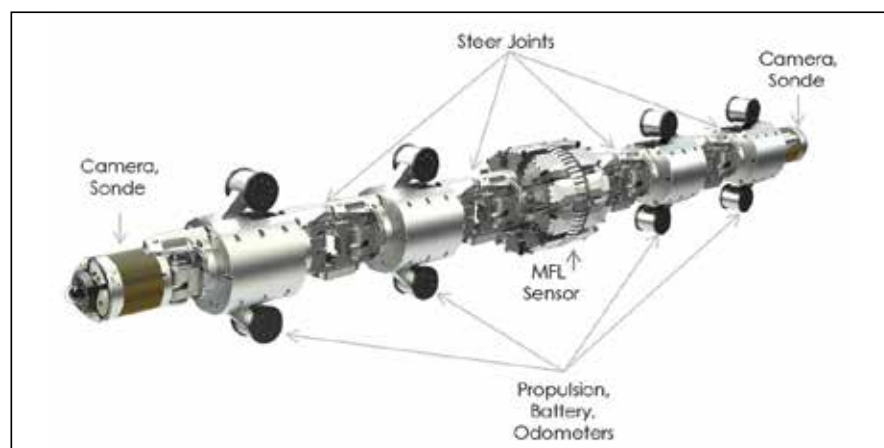


Figure 1. Explorer 10/14 – A tetherless robot for inspection of unpiggable pipelines

pipelines from 8-to 36 inches in diameter under live gas conditions from 0 to 750 psi.

LONG DISTANCE INSPECTION OF PIPELINES

The Explorer iLi robot fleet, powered by rechargeable batteries, can travel long distances from a single excavation and does not require a tether for power or data communication. Figure 1 illustrates Explorer 10/14 which is compatible with 10-, 12-, and 14-inch pipelines. From the point of entry, Explorer iLi robots can generally inspect 1,500 to 2,000 feet of pipeline before returning to the same point for exit. This is illustrated in Figure 2. Alternatively, Pipetel's

Explorer iLi robots can inspect 2,500 feet of pipe from the point of entry to a pre-determined charging location, all while remaining in-pipe under live gas conditions. Following a few hours of charging, the Explorer iLi robot can travel an additional 2,500 feet to the next charge location, thus minimizing the number of excavations required. This process repeats until the desired length of pipe is inspected. To date, the longest pipe inspected by Pipetel via this method is about 2.7 miles.

In the example depicted in Figure 3, Pipetel inspected 2.3 miles of 20-inch pipe with a total of 6 excavations. The operating pressure of this pipeline was 450 psi during the Explorer iLi inspection. The operator of this pipeline continued to deliver gas to

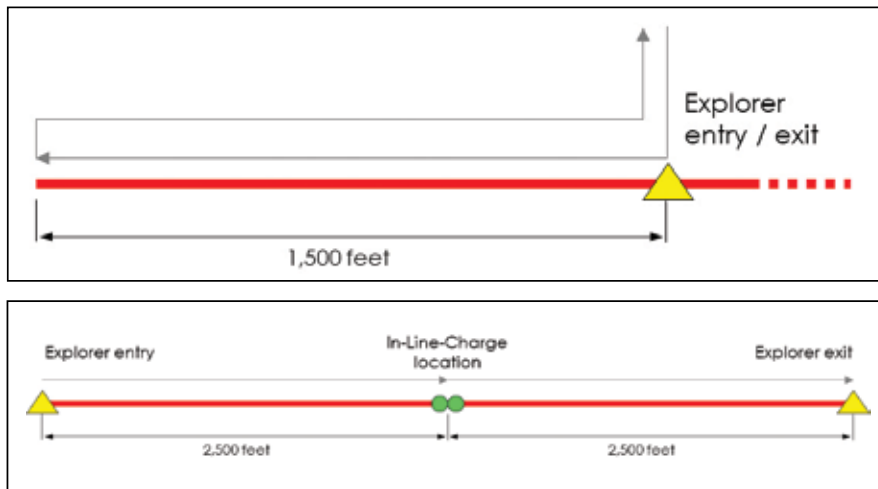


Figure 2. Schematic illustrating range of Explorer iLi Out & Back, vs Point-to-Point inspections



Figure 3. Schematic of a real-life inspection case

its customers downstream without the need to alter operating conditions for the inspection. Since existing launching and retrieving facilities such as pig traps were not readily available on this pipe, a size-on-size 20 inch hot tap fitting was installed at two locations for Explorer to enter and exit the pipe (see Figure 4). Charge locations were installed at the remaining four locations. At each charge location, two 2 inch fittings were installed to facilitate the charging process. Pipetel's operators controlled Explorer 20/26 to enter at

location A, inspect the pipe between A and B, followed by a charge at location B. Once charged, Explorer continued to acquire integrity data every 0.05 inches axially from location B to C where it was recharged again at C. This sequence of events was repeated until Explorer inspected the entire 2.3 mile span before exiting the pipe at location F. Travelling at a controlled and steady speed of about 1,000 feet per hour, the entire inspection cycle took approximately 2 days to complete. Had this pipe been assessed by hydro-test or direct

assessment, not only would a higher number of excavations be required, but the integrity information returned from these other methods would be significantly less.

INTEGRITY CONDITIONS

Every Pipetel Explorer iLi robotic inspection returns three primary datasets that depict the integrity condition of the pipe. First and foremost, Explorer measures internal and external metal loss and corrosion of the entire circumference of a pipeline through a magnetic flux leakage (MFL) sensor. A sample is recorded every 0.05 inches of the pipeline traversed capturing the location, o'clock orientation, percentage wall loss, and dimensions of all metal loss anomalies. In addition to metal loss measurements, every Explorer iLi robot detects and measures dents and mechanical damages with a geometry sensor. Finally, Explorer iLi records video footage inside the pipeline through its cameras, providing even more information about the pipeline and complimenting the integrity data. The video is viewed instantaneously during the inspection and subsequently by qualified



Figure 5. Dent in pipeline as seen by camera on Explorer



Figure 4. Sandwich valve isolating pipeline from launch tube used for Explorer to enter and exit pipe



Figure 6. External metal loss anomalies

analysts post inspection. All findings are included in a final report. Figure 5 is an image taken from the cameras on an

Explorer iLi. A dent is clearly visible in this image.

Figure 6 are examples of external metal

loss anomalies found and measured by an Explorer iLi that were subsequently validated on the pipes and repaired.

SUMMARY

Over the last 9 years Pipetel's Explorer iLi robotic fleet has been providing meaningful and highly accurate integrity data to pipeline operators. Compatible with the traditional launch/receive methods (point-to-point), the use of single hot tap fittings for entry/exit, and the ability to extend the inspection distances via charge locations, excavations are optimized and minimal. Each robotic passage includes MFL, geometry, and video data providing comprehensive pipeline integrity coverage. The unique and minimally disruptive inspection method, in tandem with advanced articulation, feature navigation, and data collection, Explorer iLi provides pipeline operators of even the most challenging pipelines with integrity facts to make informed decisions about their assets. 🔧

ABOUT THE AUTHOR AND PIPETEL:



Rod Lee is currently director of

client relations and strategic development at Pipetel, a company launched in 2010. He has held positions in management, operations, sales, marketing, engineering and technology commercialization over 20 years across several industries. He has co-authored a number of publications and patents on robotic pipeline inspection. He received his engineering and business degrees from Queen's University, UC Berkeley, and Duke University.

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EMERGING RISK:

Leadership to Address the Challenges of Elevating Inspector Performance by Utilizing Human Factor Technologies

By: Dan Lorenz, P.E., Joe Knows Energy

Introduction:

As the Utility Industry continues to replace its aging infrastructure, a Risk is emerging. The Risk: replacing pipelines in congested neighborhoods, with less experienced contractor crews, supervisors and inspectors, in an increasingly complex underground world.

Front line inspectors and construction supervisors who are selected with a focus on the Human Factors Technologies outlined in this article, offer the best prospects for achieving high performance and reliability.

Recent quotes from clients:

"1/2 of our 3rd party inspectors, 1/3rd of our internal supervisors, and 1/2 of our contractors are under performing, we are not sure what to do about it!"

"50% of the workforce is eligible for retirement in the next 5 to 7 years!"

NTSB Releases Urgent Safety Recommendations Related to Merrimack Valley Incident

U.S. DOT Announces Final Rule to Enhance Public Safety by Expanding Natural Gas Transportation in Plastic

Massachusetts Governor's Office Files Proposed Legislation to "Strengthen Natural Gas Safety Procedures"

Figure 1. Government agencies are responding (NGA Online Newsletter, November 2018)

Front Line Leadership and Human Factors Technologies Raising Performance:

Utilizing the following four Human Factors Technologies, we can raise the performance and reliability of the Front-Line Leaders. Typically managers spend most of their time with "C" performers, trying to correct poor performance. Figure 2 below shows that by understanding how the top performing front line leaders think, we can select those professionals who have the potential to perform at a high level and focus our time with "B" and "A" performers.

- Identification and Selection- Behavioral Analytics and Benchmarking exists that can consistently predict how someone will perform based upon how they think relative to a "high performer".

"Remember, the order is always People, Process, and then Tools."

- Training Behaviors -Scenario based training, utilizing the equation Event + Response = Outcomes, prepares front line leaders to respond under pressure.
- Motivation - Inspectors desire support, treating them as Valued Team Members by utilizing technology to provide transparency, results in attracting those who are accountable.
- Communications Technology – Now we communicate with a Platform of Pre-Qualified Professionals who can be selected based on the best fit.

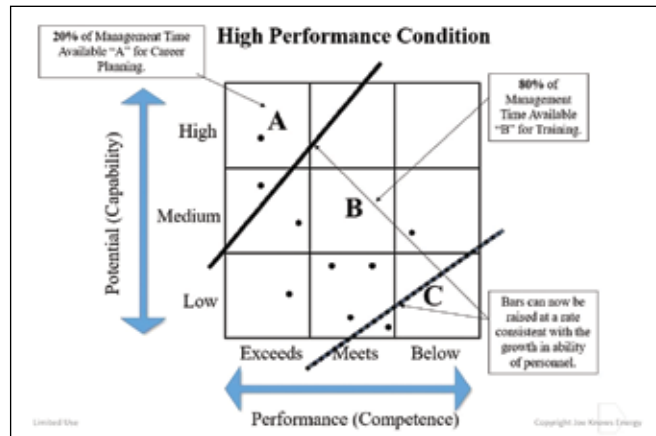


Figure 2. High Performance Condition Case Studies:

Case Studies

The best way to demonstrate how these Human Factors Technologies are applied, is through case studies and lessons learned. Following are two case studies where Human Factors Technologies were utilized to elevate inspection team performance and reliability, producing more predictable and measurable outcomes.

CASE STUDY #1:

This client has grown their inspection team over the past five years to provide oversight during their Leak Prone Pipeline

replacement projects. Recently they decided to focus on improving the overall performance of their twenty 3rd party inspectors, in response to the Public Service Commission increasing requirements and the perceived lack of transparency and accountability.

Assessment Benchmark

Utilizing behavioral assessment tools, identifying and benchmarking high performers, we identified that the critical behaviors, for this company and this position are “**Theoretical**” and “**Regulatory**”. This means that the people who best performer this role for this company are those who are high Theoretical, loving to learn, and are high Regulatory, hold themselves and others accountable.

This is because the client has the inspection team performing primarily quality assurance, requiring learning the companies, always being updated, Company Construction Standards, and holding others accountable. Note, at this company, the Foreman, an internal employee, is responsible for coaching the contractor.

With over 400 candidates considered, with 50 percent taking the assessment, the selected inspectors had a **Regulatory** score range of **58-83** with an average of **69** as compared to the average assessment of 34 with 2/3rds of the tested population in the 28-40 range. Their **Theoretical** score range of **66-83** with an average of **76** as compared to the average assessment of 42 with 2/3rds of the tested population in the range of 30-54.

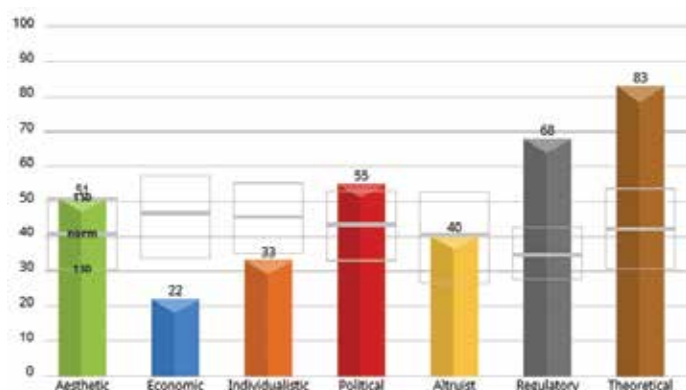


Figure 3. Critical behavioral factors for this company and this position were determined to be Theoretical and Regulatory

Emphasis Cultural Fit

There are 4 filters that we use to determine a candidate's fit. These filters are Technical Knowledge, Assessment of how they think, Feedback on Performance, and Culture Fit.

When considering candidates, we seek to understand what relevant technical knowledge they have given their experience and certificates. Second, we explore their assessment, do they think like a top performer in this position? Then we ask their previous employers to score their performance relative to established Key Performance Indicators (KPIs), fourth, how do they fit the company culture.

The lesson learned, given this client's desire to have inspectors who are committed to longer term employment of 5+ years, was

we made Cultural Fit our second filter, behind Experience, but ahead of their Assessment and Feedback. The candidates comfort level living and working in the region for this company, was a primary driver in the selection process. For example, Al had less gas industry experience than other candidates, but was selected based on his cultural fit and perceived long- term commitment to living and working in this region.



Figure 4. Candidate Al was selected on his cultural fit and long-term commitment to living and working in the region

Adjusted Key Performance Indicators

We have established standard Key Performance Indicators (KPI's), based on a broad range of responsibilities for inspectors, to measure their performance and provide feedback. In general, we find that most clients, due to the increasing demands on inspectors, are supporting their inspectors with others, therefore requiring the KPIs to be adjusted to fit the role. For example:

Key Performance Indicators:	
General	Specific to fit role
1. Understands and Delivers on Goals	1. Documentation
2. Clearly Defines Expectations	a. Photos
3. Influences	b. Reports
4. Identify and communicates risk	c. Mapping
5. Consistently documents	d. Time sheets
6. Team building	2. Inspection
7. Public concerns	a. Issues and skill gaps identified
8. Dedicated	b. Highlights critical performance areas
9. Develop Self	3. Communication
10. Develop Others	a. Foreman advised of critical events
	b. Public directed appropriately
	c. Contractor communication appropriate
	4. Training
	a. Acquires OQ's
	b. Relates lessons learned at team meetings

Measure Success

Measuring success of the inspection team is not always intuitive and needs to be quantified, with collection of data automated. Many factors should to be considered when determining the measures of success. What are the regulators looking for? What can the inspection team control and influence? What measure will help determine needed areas of improvement? Should we measure all results vs just the negative ones? Which measures can be predictive vs lagging?

Once the measure is selected, it is important to automate collecting this information, in order to capture data when everyone gets busy. Automating this information also allows it to be further evaluated in order to discover non- intuitive factors.

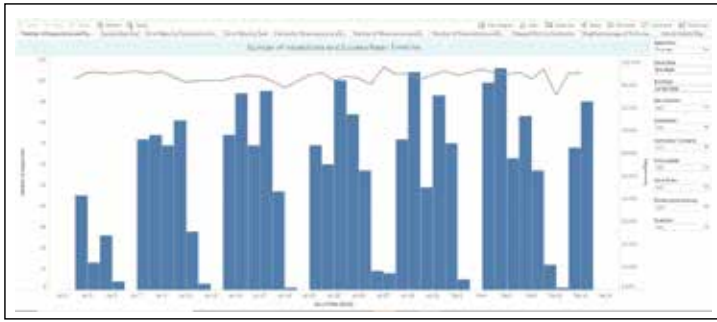


Figure 5. Automating collection of information allows for further evaluation and measurement of impact of Human Factors on performance outcomes

Compensation Structure Clarity

When building a high- performance inspection team, it is important to define how pay rates are determined and adjusted over time as well as being consistent and transparent.



Figure 6. Clarity of compensation structure is important when building a high-performance inspection team

CASE STUDY #2:

This client wanted to build a new inspection team in response to poor performing contractors, increasing workload, and regulatory oversight.

Assessment

Utilizing behavioral assessment tools, identifying and benchmarking high performers, we have concluded that the critical attributes for this company and this position are **Empathy** and **Practical Thinking**. This is because the client has the inspection/ consultant team performing coaching. With over 400 candidates, and 50 percent taking the assessment, the average scores of those selected are Empathy 8.7 and Practical Thinking 8.4. These compare to an average score of 6 for the baseline assessment population. The candidates selected possess superior ability to read people, and leadership qualities.

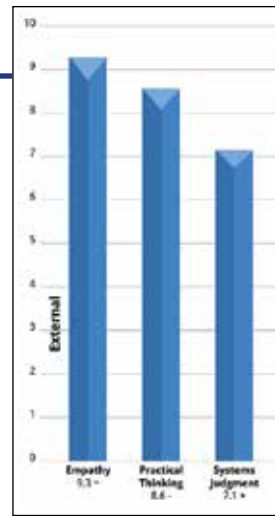


Figure 7. Critical attributes for this company and this position are Empathy and Practical Thinking

Understanding Employment Market

What is the reputation of the owner, how do other employers treat similar employees (work hours, pay, etc.), how many qualified candidates exist in the market? In this case, all of the market factors

worked for us, allowing us to hire very strong candidates, and 90 percent of the candidates offered positions with our client accepted.

Integrating Existing Leadership

The leader of this team decided to involve the managers in the process from the start. Once the candidates were vetted, using the platform and known requirements, the managers were engaged in the phone and face to face interviews of candidates. This helped to rapidly achieve clarity about what “fit” the management was looking for.

Common Clear Expectations

Once the identification and selection process are completed, another just as important process starts. During the onboarding process, clarifying expectations must align with what has been promoted and reality. Investing in a common understanding, with the new hire and the manager, of the; **Chain of Command**, the **Goals of the Organization**, how their **Performance will be Judged** using the KPIs, their **Assessment** including their strengths and blinds spots, and how to **respond to Critical Events** leads to a more rapid integration and likelihood of success.

Conclusion:

So far, the lessons learned from our work with gas industry clients indicate that **NOW** is time to take advantage of Human Factors Technologies to elevate performance and reliability and produce more predictable results. Remember, the order is always People, Process, and then Tools. 🔥

ABOUT THE AUTHOR:



Dan Lorenz P.E. is a Civil Engineer with over 30 years leading construction, training and inspection services companies. At Joe Knows Energy he is the Founder and President and is responsible for business development and strategy. JKE provides staffing, recruiting and consulting services to the utility industry. To find out more, visit their website: www.joeknowsenergy.com or contact Dan at 614-989-2228 or dan@joeknowsenergy.com.

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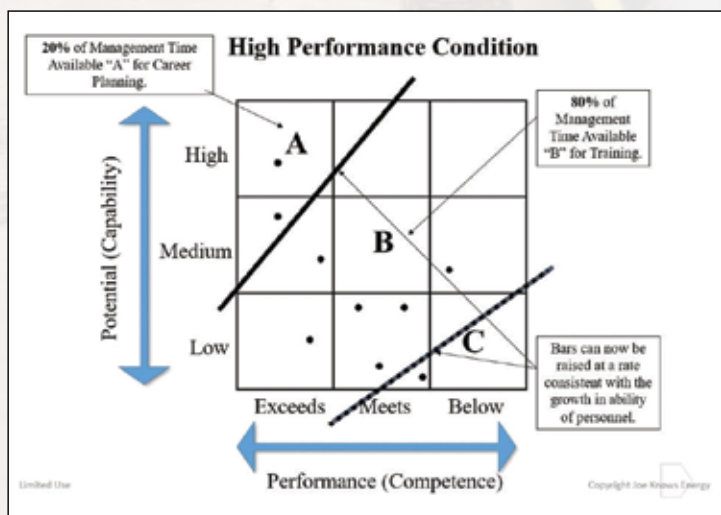
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Pipe Slitting Slashes NG Line Replacement Costs

Gas providers reporting 40 percent reduction in unit cost vs open cut, 25 percent vs HDD

By: HammerHead Trenchless

The pipe slitting method used in gas line replacement has been steadily gaining popularity the past 5-10 years. Mike Walk said it reflects the success of new, winch and customized tool designs. Bad experiences with the method prior to these tooling advancements may have caused some heartburn within the industry using the method. Operations are reporting that the method is not only reliable but reduces cost per unit as much as 40 percent over open-cut methods and up to 25 percent over horizontal directional drilling (HDD).

Walk has been involved in the evolution of these tools since mid-2000s as a field technician, application specialist and product manager for HammerHead® Trenchless, a Charles Machine Works company based in Lake Mills, Wisconsin. During that first decade he knew of only two or three companies who had adopted the trenchless slitting method as an essential part of their distribution maintenance strategy out west. Today it is being specified by providers on the East Coast, in the Deep South and in eastern Canada. Some of the companies are using it to replace up to 1,000 feet of pipe in a day in large-scale, legacy pipe replacement initiatives.

“We’ve seen it take off wherever gas providers have undertaken large-scale pipe-replacement programs,” Walk said. “And we’re on the verge of seeing it grow exponentially as gas providers in the Midwest and south-central region start replacing pipe with their own initiatives. That’s coming soon.”

The surge of confidence in the pipe slitting method is due to the effectiveness



Hydraulic rod-pulling machines are typically used for steel pipe and larger plastic pipe slitting operations. This rod-pulling machine is being set up for a 460-foot-long, size-on-size replacement of 4-inch steel gas line with 4-inch MDPE.

and reliability of the new tools, Walk said. HammerHead has added its patented, application-specific, pipe-splitting tools to its Same Path™ technology line. Tooling setups are available for plastic pipe

materials including Adyl-A, PVC, HDPE and MDPE, as well as for cast iron and steel. Specialized tooling for copper and steel pipe extraction is currently being field-throughout Canada.



Cable winch being used to slit 4-inch plastic pipe. Pulling force for the operation is kept in-line with the bore axis by means of a self-deploying boom, which needs only a small pit to work from.



Modern pipe-slitting tools are purpose-built to form configurable, flexible tool strings that navigate the irregular path of plastic pipe. The slitting head slits the existing pipe into multiple, uniform strips, creating a smooth, new bore for new pipe drawn in behind it.

PURPOSE-BUILT TOOLS

The evolution of advanced pipe-slitting tool design is rooted in the Southwest United States, Walk said. It began when natural gas providers there were looking for a safe, more cost-efficient way to replace legacy plastic gas line pipe in their distribution systems. A trenchless method known in the industry at that time as “pipe-splitting” held great promise. In principle, new product pipe attached to a splitting head can be simultaneously drawn inside an existing gas pipe by a hydraulic pulling machine as the head splits the existing pipe apart.

The method offered potential advantages over open-cut replacement and as an alternative to HDD technique. As a trenchless application, the pipe splitting method eliminates the time and expense of full-length excavation and restoration. Compared to using HDD for drilling in a new line, the pipe splitting method offers a much smaller footprint, utilizing smaller machines. And because a pipe splitting operation follows the exact same path of the existing pipe, it can often be used in conditions that prohibit the use of HDD.

Early on some contractors had attempted to use sewer-pipe bursting systems, utilizing a pneumatic hammer and winch. These tools were not ideal for use on plastic pipe, as the tool could not

navigate the bends in a plastic pipe bath. The method often caused plastic pipe to jam or buckle, overheat and melt due to excessive friction of new pipe against existing pipe. Tooling that jammed up midway through a run required excavation, defeating the purpose of a trenchless method and greatly compounding project costs.

In search of tooling designed to meet the unique requirements of plastic gas line replacement, the providers worked closely with Ditch Witch of California, who teamed up with HammerHead, a manufacturer that since its inception has dedicated itself to providing tools, equipment, consumables and education for trenchless pipe installation, rehabilitation, replacement and repair.

PLASTIC PIPE REQUIREMENTS

Walk said that while cast iron, steel and large diameter plastic pipes lie flat and straight in the pipe bed, plastic pipe sways and bends. The new design of modern plastic pipe tooling is based on a flexible, configurable tool string of more appropriately sized components. The string negotiates the irregularities in a plastic pipe path without excessive friction, while consistently slitting the existing pipe into multiple, uninterrupted strips throughout

the full length of the run. The increased effectiveness of the tool string gave rise to this method’s other term, “pipe slitting.”

The tool string also features an integrated breakaway to prevent stressing the new HDPE pipe midway through a run. The breakaway ensures the new pipe and tool string stop prior to encountering the stress on new pipe if the tool string encounters a change in direction too great to overcome.

The improved design of modern tooling also permits easy, individual replacement of components such as blades, expanders and breakaways, extending the tooling’s useful life expectancy.

Although plastic pipe was the focus of design in the beginning, it became apparent that designs of slitting tools available for steel gas pipe were also less than ideal. The standard tools in use for steel pipe splitting were basically modifications of earlier designs used to fracture cast iron. Unlike brittle cast iron pipe, steel pipe does not easily break apart. It is, however, a deformable material that, like plastic, can be slit.

Once again, HammerHead engineers worked closely with gas industry professionals as they studied the requirements of this pipe slitting application. One focus was on the optimum taper of the tool. Another was on most effective placement of its cutting



Because slitting and installation operations follow the exact same path as the existing pipe, the pipe slitting method can be used in closer proximity to other services than other trenchless methods.

wheels. The factors are now precisely engineered. The first wheel of the splitting head scores the pipe. The next wheel, or wheels, follows in its track to completely sever the pipe wall. A final wheel ensures that any fixtures that might be encountered, such as clamps or bands used with repairs, are also cleanly severed. The pipe is free at that point for the expander to broaden the pipe, reducing drag on the next pipe as it drawn into place through the smooth hole.

The pipe-slitting method is not limited to size-on-size replacement. Use of larger expanders permit upsizing the existing line as much as twice the diameter of the original pipe.

STRIKE ZONE SAFETY

Slitting heads for plastic pipe ½-inch to 4 inches in diameter are typically designed for use with cable winches, with units ranging from 3.75- to 22-tons in capacity. Slitting heads designed for steel pipe and larger plastic pipe diameters are generally

used with rod-pulling machines.

The cable winches and rod-pulling systems used in gas line replacement applications also required slight modification. Jurisdictions that permit joint utility trenching specify a minimum distance of required separation between gas lines and power lines. Gas line maintenance crews in one of the earliest demonstrations encountered discrepancies in “strike zone” tolerance so severe that at some points the two lines lay in contact with each another.

For that reason, all HammerHead winches and rod-pulling machines for gas line pipe slitting applications are equipped with Electrical Strike Identification. All HammerHead winches are available configured as pull-behind units or as track-carrier mounts.

SEEING IS BELIEVING

Plastic pipe replacement

A Georgia contractor added the pipe-slitting method to its capabilities while

helping in the scheduled replacement of approximately 750 miles of plastic pipe for an Atlanta Gas Light initiative in the Atlanta metro and Northern Georgia area.

Installed between the years 1965 and 1983, the original plastic pipe was at or nearing the end of its useful life. Over time, urban sprawl and its associated infrastructure made replacement difficult. The contractor had been relying on its fleet of 13 horizontal directional drilling (HDD) rigs to complete Class 1 pipe installations – those providing at least 8 feet of separation between the bore for a new gas line and any electrically charged line in a distribution trench.

Those providing less than 8 feet of separation are Class 2 conditions. In Class 2 conditions, the contractor had routinely trenched down to replace the line manually. Of the 104 miles of pipe the contractor was to replace for this project in 2016, however, nearly half were Class 2 replacements. Sizes ranged from service lines 1 ¼ inches in diameter to 4-inch-diameter plastic mains. A more efficient way to do these Class 2 jobs was needed to stay on schedule.

The contractor assigned its fleet of HDD crews all Class 1 portions of the job and designated three 4-person crews to be its pipe-slitting specialists. This enabled the contractor to complete the entire 104 miles of scheduled replacement on time, as well as avoid the inconvenience to AGL customers of open-cut replacement methods. They also did it at a fraction of the cost of trenching. In fact, the extensive demolition and restoration that would have been required for some Class 2 sections of the project were not considered feasible.

Steel pipe replacement

Mark Maxwell, who has been an operator, technician and field consultant in buried pipe applications for more than 32 years, is a pipe-bursting and pipe-slitting field technician for HammerHead. Maxwell is often asked to demonstrate the method for project owners, engineers and gas line contractors on a “real-life” scheduled job.

One request was from a utility foreman with 20 years of experience in gas line infrastructure maintenance. He said the city’s project engineers to

“Larger expanders permit upsizing the existing line as much as twice the diameter of the original pipe.”

date had favored “direct-bury and insert operations,” digging up the steel gas lines to replace them with new pipe or hiring an HDD contractor to create a new offset pipe path parallel to the existing line. Crowded urban conditions rendered those methods infeasible, he believed, for some future gas line replacement jobs.

The foreman identified an ideal project for the demo presenting similar difficulties to those jobs. It was a 460-foot-long, size-on-size replacement of 4-inch steel gas line with 4-inch MDPE. The steel pipe lay 3 feet below a 14-foot-wide paved alley in cobble and stone fill. Several asphalt surfaces overlay the pavement’s 8-inch cement base. In addition to the gas line, the narrow easement contained a water main, a vitrified clay pipe sewer line, and a conduit pipe containing phone lines running parallel to it.

This jurisdiction prohibited the use of HDD in such a crowded easement. The time and cost of full-length trenching and restoration in this location made it an ideal candidate for a pipe-slitting demonstration.

Maxwell arrived the night before to check the preparations. The HDPE had been fused up on the surface and a machine pit had been prepared. Pipe slitting operations started at 9 a.m. the next morning.

Although the foreman had known about the pipe slitting method most of his career, he had never seen an operation in person himself. As the tooling disappeared into the steel pipe, the foreman told Maxwell, “It’s just amazing to see it in person. The quiet sound of it working as it takes off down the pipe, slicing through it like it’s nothing.”

The foreman said a job like this would typically have taken four to five days as

a trenching job, not including full-length restoration of the 460-foot-long trench –compacting backfill, pouring a new base course and repaving the alley. They installed the new pipe and made the three connections to it in a single day.

The pipe slitting method also eliminated the extra steps sometimes required to decommission abandoned lines. The foreman said on open-cut replacement jobs, the crew must extract and dispose of the abandoned line. Their HDD jobs require them to purge the decommissioned line, fill its ends and sometimes even grout or slurry it. These steps to decommission a line adds time and cost to the project either way, whereas the pipe slitting method eliminates these steps because anyone who digs down to the 4-inch pipe in future excavations cannot mistake a decommissioned line from the active line within it.

INDEMNIFICATION

Alan Goodman, Strategic Account Sales Manager for HammerHead, has been following the rising trend of indemnification requirements in the U.S. The assurance of immediate, visual verification gives the pipe-slitting method added value in jurisdictions requiring indemnification of abandoned lines. The amount of time that utilities are spending on both locating and verifying active and inactive gas lines comes with a significant cost. Slitting an inactive pipe helps verify its lack of use when excavating.

One utility provider had been upgrading some of its low pressure, high-density polyethylene (HDPE) main and service runs to a smaller diameter, higher pressure system. It had been slip-lining 1.25-inch (HDPE) plastic pipe inside the existing

4-inch HDPE. While slip-lining is one economical alternative to extraction and disposal, switching to the pipe-slitting method offered them same advantages with the added capability for size-on-size and even upsize replacement on other jobs.

EDUCATING THE INDUSTRY

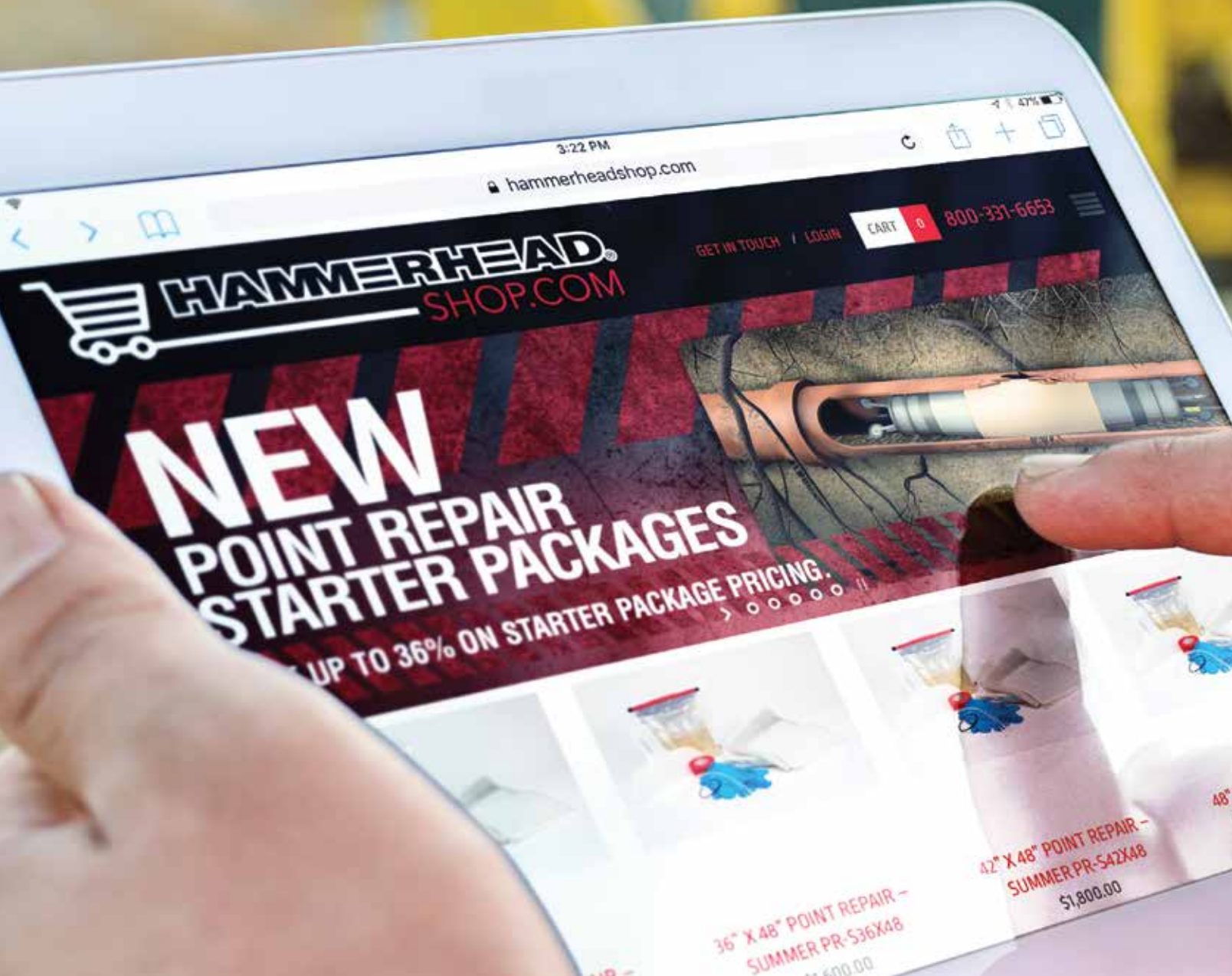
Walk said, “We’d see many more companies specifying pipe-slitting coast to coast, but a lot of things have to be in place before a company is ready. It takes the right people, who see the need and can embrace a unique method that’s new to them. It helps, too, if they’re faced with replacing a larger quantity of gas lines rather than just a couple of hundred feet. When they are looking for a faster, more cost-effective method, then pipe slitting makes sense. Even then, it is a difficult task, trying to talk with every gas utility and gas pipe contractor in such a large industry about how the pipe slitting method fits their goals.”

Goodman said HammerHead also makes education and training available in the pipe slitting method through HammerHead University, the world’s first training facility solely dedicated to trenchless pipe applications. Open since August 2018, the facility is located at HammerHead headquarters in Lake Mills, Wisconsin. Natural gas industry professionals can receive hands-on instruction in the use of state-of-the-art pipe-slitting tools and equipment in true-to-life, simulated “jobsites” constructed within a climate-controlled environment. Participants who successfully complete the training receive certification for the course. 🔥

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- Gas Technology Institute Tour (Wednesday)
- NASTT's Gas Good Practices Post-Conference Course (Thursday)

Gas Technology Institute (GTI) Tour

No-Dig delegates will have the opportunity to tour the GTI Campus from 2:30 – 5:30 pm Wednesday and get first-hand observations of demonstrations of various keyhole, trenchless, and low-dig technologies. Seating is limited and available on a first-come/first-serve basis.

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Broadband Electro-Magnetic Method (BEM™)

The Technology Capable of Accurately Determining Wall Thinning, Graphitic Corrosion and Cracking

By: Martin Roubal, Rock Solid Group

1. BACKGROUND:

Australia and the United States have many things in common, including thousands of miles of buried critical pipes of varying age, material type, diameter, wall thickness and condition. The technology capable of helping asset managers to prioritize renewal and/or replacement strategies has been evolving across global markets in the gas, nuclear power generation, water and wastewater industries.

Graphitic corrosion and other forms of corrosion such as pitting and wall thinning are the enemies of these largely Cast Iron (CI), Ductile Iron and Mild Steel ageing and very valuable assets. Many of the larger mains are in established densely urbanized areas and were manufactured and laid around the turn of the last century. Eventual replacement at the end of their asset life expectancy will be costly and is a growing concern for most service utilities and their end customer base.

Broadband Electro-Magnetic method (BEM™), is a leading technology in condition assessment. This technology, developed in Australia nearly 20 years ago, has evolved to meet customer needs and is now actively used on a global scale, to assess the condition of ferrous pipes. The technology records data at various frequencies which provides a significant advantage over more primitive eddy current techniques that rely on the acquisition of a single or limited number of frequencies. A benefit to users is the ability to survey through ferrous pipe coatings or linings.

In principle, the system works by inducing eddy currents to flow in close proximity to the transmitter. In a metallic pipe these eddy currents migrate with time allowing a complete profile of the metallic pipe to be obtained. Data recorded in such environments can reveal the location of perturbations in the thickness of the metallic pipe. With appropriate configurations, indications of fracturing can also be detected onscreen in real-time.



Figure 1: Cast iron gas pipe graphitic corrosion and pitting
[Source: Final Report, GTI Project Number 21874; p9.]

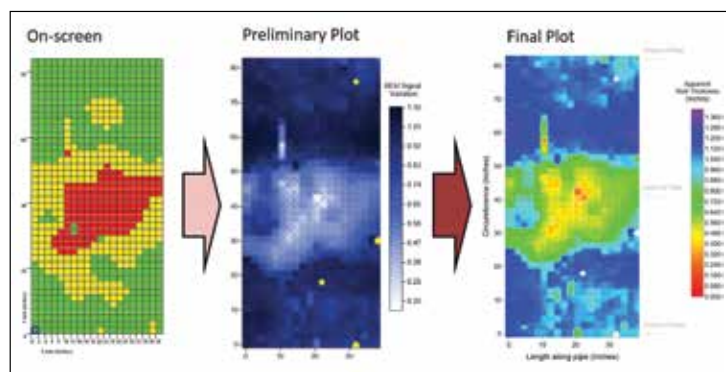


Figure 2: MetCon© software, real-time display and indication of processed data output

Ironically, the first Australian BEM™ prototype scanning project was on a “critical” wastewater pipe as part of the brewing waste discharge network for a Queensland beer manufacturer in 1998. At the time there were great concerns, as this single discharge pipe had failed and with their manufacturing operations was at a standstill, leading into a hot and thirsty summer. Thankfully, the isolated issue was assessed with speed and a potential ‘national disaster’ was averted!

Broadband Electro-Magnetic technology was initially specifically developed for CI pipe integrity assessment that can determine wall thinning, graphitic corrosion and cracks, either externally or internally.



Figure 3: Cheers

In the USA, BEM™ was first introduced as a corrosion assessment technique in the late 1990s via the water and waste water industries. The technology underwent a series of verification trials for the gas industry from 2003-05 and again in 2008-10 by GTI (US, Gas Technology Institute). This work was co-funded by the OTD (Operations Technology Development) Group - a select group of gas utilities from across the USA) and PHMSA (Pipeline and Hazardous Materials Safety Administration), a United States Department of Transport agency.

The primary goal of this work was to tailor the technology for the gas industry and to provide field demonstrations of the technology's ability to rapidly gather data about pipe wall conditions. The project outcome and the technology system were presented to the American Gas Association (AGA) Corrosion Committee on October 2010. The [DOT Prf#258] GTI Final Report was issued June 23, 2011.

The GTI Final Report "Characterization and Fitness for Service of Corroded Cast Iron Pipe" was released February 15, 2018. Page 94: "...a variation of pulsed eddy current testing where an external pulsed electromagnetic field is used to induce eddy currents in a pipe. The detected eddy currents and their decay is compared to a reference model based on the pipe's dimensions and composition. On this basis wall thickness can be estimated. The advantages of the BEM technique are that no direct contact with the pipe is necessary, coatings and corrosion products do not have to be removed, and several instrument configurations are available, full encirclement, in-line pigs, hand held, and a keyhole inspection device".

Over the past 20 years, the hardware and proprietary software, MetCon® have evolved considerably based on the learning from hundreds of field projects and analysis of data collected by Rock Solid Group and their third-party Licensees.

2. REPLACEMENT OR RENEWAL OF A CI PIPELINE?

On too many occasions, the conventional thought of replacement or renewal of a CI pipeline is due to an uninformed decision as a result of lack of integrity-related data. Consequently, most retirement of CI pipelines are based on breakage history combined with operating pressure, with active leaks being considered as well. Technology available to the industry needs to be utilized to help determine appropriate replacement options and replacement rankings based on the existing integrity of the pipe, including taking measurements capable of determining wall thinning, graphitic corrosion and cracking.

Broadband Electro-Magnetic scanning provides the non-destructive technology necessary to capture this data. An informed decision maker can determine replacement options that increase safety, reduce installation costs, reduce unnecessary exposure and damage to underground utility infrastructure, reduce impact on surface strata, reduce inconvenience to the community, and potentially can reduce the carbon footprint of modern renewable technologies.

PHMSA has identified 40,000 miles of CI pipe as risk pipe. Gas utilities from the mid-Atlantic to the northeast region represent over 22,200 miles of CI facilities ranging in size from eight-inch to greater than thirty-inch diameter according to the 2017 PHMSA Annual Gas Distribution report.

These pipes are known to be concentrated in heavily congested areas (both pedestrian and vehicular) of our cities with wall-to-wall paving and increased depths due to multiple grade changes over time, making it extremely difficult to locate direct bury replacement corridors.

Furthermore, such mains in the larger diameters (16-inch and greater) are generally critical from a capacity perspective and cannot be readily replaced with steel in the same diameter which requires upsizing; adding to the difficulty of finding a clear corridor.

The need to utilize technology to identify pipeline health is not only recognized by industry operators but also by the governing bodies of the natural gas industry.

3. CASE STUDY – NORTHEAST USA GAS CI PIPELINES

In 2018, a series of pilot Broadband Electro-Magnetic method external scans were undertaken in the northeast region of the US, as part of a condition assessment project on large diameter

CI gas mains. The multiple site fieldwork schedule enabled the demonstration of the technique, to a number of gas utilities in the region. The reported results were presented as graphical interpretation and analysis in the first stage, which is represented by a Combined BEM™ Signal Final plot and Final Data Summary. Further models of the BEM™ signal interpretation include Apparent Wall Thickness (AWT) model, Antenna Lift-off model, Weld Condition model, Rivet Condition model, etc.

The participating gas utilities want to enhance their capability to identify and measure the integrity of ferrous pipe walls, particularly CI pipe. The Broadband Electro-Magnetic technology provides the critical data needed to determine the strength and expected life of the asset, while enabling the unique ability for utilities to determine appropriate replacement strategies in the context of a Distribution Integrity Management Program (DIMP).

This technology has the ability to provide this data and can be utilized on all ferrous materials transporting natural gas. Identifying the wall condition of CI and steel pipes enables the operator to make an informed decision on the most efficient manner to replace pipes and when.

Broadband Electro-Magnetic technology was initially specifically developed for CI pipe integrity assessment that can determine wall thinning, graphitic corrosion and cracks, either externally or internally.

When the operator has knowledge of pipe wall degradation, whether it be through graphitic corrosion or other means, an appropriate replacement or renewal strategy can be employed, including a replacement time frame or priority assigned. Direct bury replacement may be the solution to replacing inferior pipes, however, insertion and Cured-In-Place Lining (CIPL) are valid strategies for the renewal of a pipe that may still have sufficient structural integrity.

With the culmination of extensive validation tests, research & development investments and US strategic partnering pilot programs, Progressive Pipeline Management, a New Jersey based gas pipeline maintenance company with expertise in CIPL renewal, is set to become a service provider of BEM™ to interested gas utilities. They will have a selection of advanced BEM™ tools that will provide both external scanning and internal scanning capability for 4-inch diameter up to 36-inch diameter pipelines, with further room for broadening this range. The technology has no shape or size limitations.

The backing of a number of north east region gas utilities has been secured and plans are underway for scheduling preventative maintenance condition assessment programs. To date, interested participants have been identified as **Con Edison Co. of New York, National Grid and Public Service Electric & Gas.**

The inspection is a cost-effective technology for the survey of pipe wall conditions. The service will be provided with either a real-time external pipe wall condition assessment tool termed FAST (Flexible Array Scanning Tool) or for the survey of greater continuous distance, an internal PIG (PIG Inline Gauge) will be utilized.

The FAST system can survey wall integrity externally on pipe diameters from 4 inches upwards. This survey is performed allowing the main to remain on-line.



Figure 4: FAST (Flexible Array Scanning Tool) - BEM™ external scanning

The equipment range also allows for in-line scanning using PIG for pipe diameters of 6 inches and greater. This kind of survey can currently only be undertaken off-line. The pipe inspection with this device provides the ability to make an informed decision on the most appropriate manner to replace gas facility and accurately rank pipe replacement in your DIMP program.

The equipment for this technology is largely made up of universal components that can be retrofitted to a variety of tools.



Figure 5: BEM™ 6-Inch PIG gas main trial, 2016

“...advantages of the BEM technique are that no direct contact with the pipe is necessary, coatings and corrosion products do not have to be removed, and several instrument configurations are available...”

– GTI FINAL REPORT, FEBRUARY 15, 2018



Figure 6: Large diameter BEM™ PIG



Figure 7: Opportunistic scans during planned maintenance &/or emergency works

The internal scanning PIG's will have the capability to scan lengths of up to 1,000 feet from one entry point. To suit the wide range of gas main pipe diameters, multiple, interchangeable PIG bodies have been designed, each with adjustable antenna scanning positions.

Having a comprehensive range of BEM™ tools in the region also allows for timely, opportunistic condition assessment scans for unplanned access to gas mains. This may coincide with operational projects such as road or rail bridge widenings or tapping projects or even emergency repairs. Having the tools on stand-by between planned activities will be most beneficial for gas utilities, as often gaining access to the asset can represent the majority of the inspection costs involved.

For further information on this technology, please visit www.rocksolidgroup.com.au and regarding the north east region's newest service provider of this technology, please visit www.progressivepipe.com 🔥

ABOUT THE AUTHOR:



Martin Roubal, Managing Director, Rock Solid Group, developed technology patented by Rock Solid Research, and has acquired extensive experience globally, in non-destructive testing across the water, sewer, gas and nuclear industries.

Replacing Cast Iron Gas Mains?

BEM™ inspections provide essential information for asset life prediction. GTI testing of BEM™ confirmed that it provides condition information for gas piping infrastructure. So before replacing your cast iron gas mains, it's best to be BEM™ sure.

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Smart Infrastructure Improves the Detection of Gas Leaks

By: Dan Bennett, SENSUS



Certain priorities are no-brainers for gas utilities when it's time to upgrade their infrastructure. Leak detection, which has the potential to impact both safety and revenue, is one of these priorities. As utilities add more and more residential and commercial endpoints to their distribution systems, the ability to detect leaks and address them quickly has never been more necessary.

Thankfully, advanced technologies have emerged that allow utilities to harness new applications such as data analytics, remote monitoring and Internet-of-Things innovation to stay on top of leaks and address them before they create significant issues. By implementing these capabilities as part of a smart gas system, utilities can take a giant leap forward in improving safety and operational efficiency.

In this article, we'll review some of the new tools gas utilities can use to address leak detection and prevention while positioning themselves to capitalize on opportunities.

THE ADVANTAGE IN AMI

As increased connectedness has become the norm in the utility industry, organizations have had to deal with a whole new set of challenges. Keeping pace requires more advanced metrology and sensors, smarter end points, more bandwidth, stronger security and an exceptionally reliable network. That's where Advanced Metering Infrastructure (AMI) comes into play.

The capabilities of AMI systems have progressed well beyond consumption reads and now enable a host of new smart gas applications. With a communication system in place, utilities can deploy smart meters, sensors and analytics software to monitor the health and status of their entire distribution network. These insights help utilities get out in front of operational challenges such as:

- Keeping tabs on pipeline corrosion
- Understanding highs and lows with pressure monitoring
- Protecting and managing service connections
- Enhancing public safety
- Aiding economic development

Smart gas technologies help improve operational efficiency and enhance customer service. Additionally, when powered by the right communication network, they can be an effective tool for the detection and management of gas leaks to ensure the safety of employees and residents.

REAL-TIME NETWORK POSSIBILITIES

Solutions like the FlexNet® communication network from Sensus, a Xylem brand, allow utilities to transmit data to and from gas meters – a system that proves remarkably effective at helping identify issues with residential and commercial gas usage. Every utility knows that their gas transportation and distribution systems only work properly when the gas pressure levels are as they designed them to be. What providers may not realize is that they can use this same network to transmit pipeline pressure data to the head-end system and identify any system anomalies that may be the result of a leak.

An alternative to large chart recorders that don't communicate or expensive powered SCADA sensors, small, long life, battery-powered sensors are emerging and when placed strategically on the pipeline will help technicians receive pressure data at regular intervals—as frequently as every 5 minutes. With this data collection, utility crews can use their AMI communication network to automatically transmit data to headquarters, where they can use data analytics software to detect any pressure drops in near real time which could be the result of leaks. With the ability to analyze where the data was collected, the utility can then pinpoint the location of the leak with demonstrable accuracy.



Flexible smart sensors can use AMI systems to report pressure and odorant levels

Those service providers that have already invested in AMI with an advanced communication network already have the pressure sensing solution within their grasp. The technology is in place to leverage the existing infrastructure for real-time pressure monitoring with minimal add-ons.

The communication network used by AMI can also be leveraged to improve other systems for leak detection, including odorization efforts. Odorization remains the most common method for leak detection within residential and commercial environments. Utilities can apply the same kind of sensor technology used for pressure monitoring in odorization tank level monitoring. The real-time data transmission will help technicians better understand when odorant tank levels reach an insufficient point and more odorant needs to be added. The benefits might seem negligible, but when compounded with pressure monitoring capabilities, they can couple to form an advanced leak detection system.

For utilities that might be assessing a potential investment in AMI, pressure monitoring and improved odorization efforts are just two of the benefits to be considered. Combined with these benefits is an AMI system's ability to drive greater accuracy, operational efficiency and consistent billing which – as an all-encompassing solution – should help utility managers make a strong business case if they have been on the fence about making the move.

REMOTE MONITORING FOR GREATER CONTROL

The best way to manage leaks in the gas pipeline is to prevent them from happening altogether. This is another strategy in which AMI and advanced communication networks can serve as a remarkably effective resource based on their ability to support cathodic protection.

Cathodic protection is a priority for utilities for a host of reasons, not least of which is regulatory directives. All utilities take proactive measures to prevent pipeline corrosion and detect possible issues before corrosion reaches unacceptable levels that could lead to leaks in the system.



Remote corrosion monitoring device fits inside standard test point markers

However, cathodic protection monitoring can be a time and resource intense process since technicians are required to periodically go into the field to inspect pipelines for corrosion levels. This not only requires significant costs in terms of

equipment and gasoline, but it also has safety implications for the technicians and can divert them from more strategic tasks. Additionally, periodic monitoring only gives utilities a glimpse of any emerging issues that, if not addressed quickly, could ultimately thwart cathodic protection efforts.

An AMI system can be a useful resource for improving remote cathodic protection capabilities. For those utilities already using AMI systems, dedicated sensors can be deployed strategically in areas where cathodic protection monitoring occurs and leverage the advanced communication network to report corrosion levels to the utility in near real-time. This remote monitoring reduces and, in many cases, eliminates the need for technicians to go into the field. This lowers safety concerns and allows the technicians to focus their attention to strategic initiatives that impact customers. The near-real-time reporting also means that utilities can get a comprehensive picture of their pipeline assets and proactively address corrosion before it leads to issues such as leaks.

An AMI system with the right communication network is essential to powering this type of strategy. The network should have two-way communication capabilities that allow the utility to transmit data both to and from the sensor quickly. The network should also operate on a licensed spectrum to ensure fast, protected data transmission and enhanced security.

This kind of technology is available to utilities looking to update their systems. For those that are already using AMI, it's worth the time to investigate whether their current network can be leveraged for remote cathodic protection monitoring. The benefits of leak prevention speak for themselves, while the reduced costs, improved technician safety and real-time monitoring capabilities all help make this investment that much more valuable.

EVOLVING TO MEET FUTURE DEMANDS

Improving leak detection and safety, an AMI system combined with an advanced communication network can help utilities reap major benefits in both safety and revenue. Enhancements in system performance and network operations also allow for greater decision making about the allocation of resources, which can help save considerable cost.

As utilities evolve, leaders will continue to evaluate the potential in leveraging future investments in technology to continue advancing operations and improving efficiency across the board. A smart gas system serves as the platform for utilities to stay on the cutting edge of technology today while providing the ability to reach farther tomorrow.

ABOUT THE AUTHOR:



Dan Bennett is the director of global gas marketing at Sensus, a Xylem brand. He has seven years of service with the smart technology company. He earned a Bachelor of Science degree in both electrical engineering and computer engineering from North Carolina State University in Raleigh.



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Protecting Your Pipeline and Your Brand

By: Rhino Marking & Protection Systems

Everyone uses pipeline markers & signs to protect their pipeline. In many cases the focus is on meeting the PHMSA requirements. Obviously meeting these requirements is critical, but since preventing damage is your main priority you may want to think past these basics. The top two purposes a pipeline marker:

1. Get an excavator who has not requested a locate to call before they dig
2. Warn an excavator there is a pipeline in the area, in case the line didn't get located.

If you agree with these points, why would you ever use a marker or sign with a message that cannot be read from all directions? Will a person with a rented auger know the post they see in the distance is a pipeline marker if they cannot read a warning

message? The fact is, a pipeline marker with visible, legible warning messages that can be seen from any direction, does not cost more than flat markers.

The visibility and legibility of the warning message is affected by two things:

- The shape of the marker
- The design of the legend

You can increase effectiveness dramatically with very little effort or cost.

Moving to triangular shaped marker, with 3 sides which can be seen from any direction, will add 50 percent more warning messages to your damage prevention system. Flat posts or dome style posts each have two warning messages, while a Rhino TriView has three – 50 percent more.

Warning legends have typically focused on content rather than visibility. This was partially due to costs associated with adding colors via screen printing.

Rhino has introduced the first digitally printed signs that last for 10+ years. Now you can use multiple colors to make your warning message extremely visible. Every pipeline marker is also a small billboard for your brand, and Rhino UV Armor signs allow you to add full color company logos at no cost. Increased protection and increased brand awareness at no extra cost. 🔥



Triangular shaped marker, adds 50 percent more warning messages



Multiple colors make your warning message extremely visible

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-Scott Landes on inventing the TriView®

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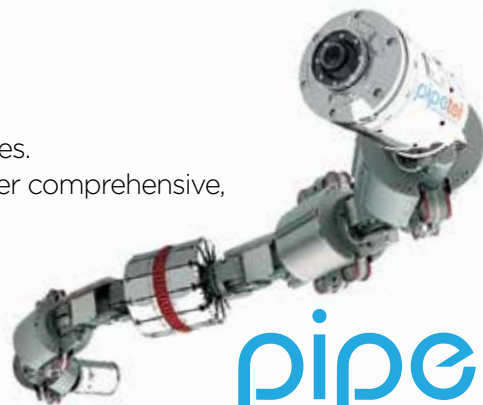
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