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Direct Pipe® Installation under the Calumet River

Part of a multi-faceted project to retrofit a 36-inch steel gas transmission line in Chicago involved a record-setting 1500-foot installation under the Calumet River. Completed on time, safely and under budget. Successfully executed projects stem from a good working partnership with the pipeline contractor.

Twelve Best Practices for Gas Pipeline Construction

Every pipeline installation faces unique challenges. This article identifies twelve best practices that work effectively to reduce the occurrence of some of the more common environmental, regulatory and permit hurdles which can result in work delays, public relations issues, and increased costs. Some help in navigating these potential obstacles.

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ALSO:

Departments:

NASTT NORTHEAST REGIONAL CHAPTER

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TRENCHLESS TECHNOLOGY PERSPECTIVE

George Ragula, Public Service Electric & Gas

Welcome to the second annual edition of the NASTT-NE Chapter *Trenchless for Gas Infrastructure 2020* which again provides compelling case examples on the many advantages associated with utilizing varied applications of trenchless technology in the renewal and repair of natural gas facilities.

With aging distribution infrastructure and increased gas consumption driving demand for more new and replacement gas construction work, it is important to be familiar with all the major trenchless installation/renewal options. How knowledgeable are we in their applications and benefits? How do we become more knowledgeable? Applications such as CIPL (cured-in-place lining), HDD (horizontal directional drilling), pipe-bursting and slip lining are well-established techniques used in gas construction projects, but are they utilized to their fullest extent? Experience shows trenchless methods deliver huge cost savings on construction projects as well as significant social and environmental benefits.

Smaller surface footprints, limited excavations, minimal use of asphalt and/or concrete, sand and stone materials, and greatly reduced energy and surface restoration costs all significantly decrease the CO2 equivalent impact when trenchless methods are used on 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. Importantly, the impacts of necessary gas system repairs and infrastructure upgrades on nearby residents, businesses and communities are also greatly alleviated by using trenchless technology applications.

"Well documented economic, social and environmental benefits are driving research and development efforts"

These well documented economic, social and environmental benefits are driving further research and development efforts towards improved leading edge innovative technologies and a widening range of uses available for trenchless technology methods. Real world experience acquired from completing underground construction projects using trenchless applications is filtered into research and development, which yield fresh innovations, improvements and inventive new construction techniques. Networking, education, and sharing information are key drivers, providing focus and the foundation for this collective effort.

Throughout my 42-year gas industry career, I have seen this natural upward progression of technical competence and prowess as various trenchless construction techniques move from theoretical considerations during planning into the realm of practical application in actual construction projects, and then followed by eventual improvement as experience is gained. More than 30 years involvement in the North American Society for Trenchless Technology (NASTT) has allowed me to maintain an up to date awareness of trenchless technology methods and best practices, along with recent technological advancements. If I don't know the answer, I am confident I can find it through my NASTT peers.

By being able to network among numerous industry experts on various underground construction applications/techniques, and with access to a rich storehouse of technical peer-reviewed technical papers, I have been exposed to numerous ideas that have enabled me to devise unique and cost-effective solutions to the challenges encountered on various gas construction projects over the years. The world record lining of a 42-inch trunk main in East Orange NJ detailed in these pages is a prime example of this sort of technical evolution building on past achievements and relying on new ideas generated from a variety of sources, both inside and outside the gas industry.

Because a large proportion of North America's gas pipe inventory is well beyond the midpoint of its life-cycle, the time has come to look more closely at trenchless technology as offering the most effective and comprehensive toolbox of renewal and rehabilitation techniques applied to gas infrastructure. Articles in this magazine provide insights into the advantages of some of these methods.

Special thanks to the NASTT-NE Chapter for helping sponsor this magazine and for their continued support for outreach efforts to the natural gas industry.

George Ragula

George Ragula, PSE&G
NASTT Hall of Fame Member

WELCOME MESSAGE FROM NASTT-NE CHAIR

Babs Marquis, CCM, NASTT-NE Chair

Welcome to the Spring/2020 edition of the NASTT Northeast Regional Chapter's ***Trenchless for Gas Infrastructure.*** This issue is a great follow-on to the 2019 inaugural publication and continues with articles reporting on trenchless design and construction projects that continue to push new boundaries in the gas infrastructure portion of the trenchless industry. This includes advances that have led to setting a new world record for largest diameter CIPL of 42-inch gas main in complex U-Tube configuration, with seven bends, running under the Garden State Parkway in East Orange, NJ; the use of robotics for in-situ condition assessment, reconditioning and repairs of live gas mains; and HDD Best Practices for Gas Pipeline construction projects, to name a few.

In addition to the technical article line-up in this edition for your reading pleasure, I am pleased to announce some of the changes that has taken place since the first ***Trenchless for Gas Infrastructure 2019*** publication as we continue our mission to inform, educate and promote trenchless construction methods for gas delivery infrastructure.

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 as they develop and implement a plan to establish a Center of Excellence in Trenchless Technology and Underground Engineering, to facilitate research, and advanced studies which aid in the education of the next generation of trenchless professionals. We are also delighted to welcome the formation of our second student chapter at the Quinnipiac University School of Engineering, Hamden, CT.

Regretfully, as the final touches and coordination planning for the 2020 NASTT No-Dig Show in Denver, CO were being put into place, and printing of this edition of the Journal being finalized, we received the sad news that due to the Coronavirus (COVID-19) pandemic and public health order canceling events at the Colorado Convention Center, the 2020 No-Dig Show had to be postponed. Soon after the No-Dig show cancellation, the entire country has gone into a lock down as the spread of the virus threaten the global economy as our humanity and resolve is tested. Conferences and large gathering events have been suspended for the foreseeable future with measures to contain, control and prevent the spread of the virus – Our safety comes first!

As we plan for our 5th annual Conference in Portland, ME we are actively monitoring the measures and on-going advisories to combat the pandemic and the likely resulting effects through the fall. For now, our 2020 annual Trenchless Technology conference is scheduled for Tuesday November 10th 2020. Please visit our website at **www.nastt-ne.org** for the latest information, registration and hotel details.

> *"Our safety comes first!"*

A note of thanks and appreciation to George Ragula for his continued dedication and collaboration with A to B Publishing along with the support of the NASTT Board of Directors. Thank you everyone else who played a part creating and contributing to the success of this Journal. We hope you continue to find the Journal a valuable resource to further advance the case for trenchless technology in the gas industry.

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 the publication of this Journal, and visit with our vendors if you are able to join us at the annual conference in November.

Babs Marquis

Babs Marquis, CCM,
Chair, NASTT-NE

NASTT-NE SITE

MESSAGE FROM THE NASTT EXECUTIVE DIRECTOR

Matthew Izzard, Executive Director, North American Society for Trenchless Technology (NASTT)

GAS INFRASTRUCTURE MANAGEMENT BENEFITS FROM THE USE OF TRENCHLESS TECHNOLOGY

Underground infrastructure is a complex and crucial component of our modern society. The needs of North America's underground municipal services continue to expand as existing infrastructure reaches the end of its lifecycle. Our public works and utility professionals face challenges in their efforts to modernize and maintain this infrastructure. Gas distribution organizations operate over 2.4 million miles of gas mains and service lines. According to a recent US Department of Energy report, the cost to maintain and repair these pipeline networks is over $7 billion annually. A significant proportion of these networks consist of aging cast iron and unprotected steel pipe and dealing with this issue is critical to the gas industry. Trenchless technology innovations can be used to rehabilitate existing systems and install new systems in an economically feasible, environmentally sensitive and socially responsible way. Techniques such as impact moling, horizontal directional drilling, pipe bursting, insertion and vacuum excavation have long been techniques that gas utilities consider and use in growing numbers.

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.

The intent of NASTT is to advance trenchless technology and to promote its benefits for the public and the natural environment by increasing awareness and knowledge and by providing technical information, research and development, training and education. Because these innovative methods have been used successfully for all underground utilities including water mains, storm and sanitary sewers and gas mains, as well as with electrical and fiber optics conduits, the future of underground infrastructure rehabilitation success is strong.

On the forefront of techniques that can and should be employed by gas utility organizations is the Cured-in-Place-Liner technique. The technique creates a protective, structural pipe inside an existing host pipe system, without digging or destruction to buildings or landscape. NASTT's CIPL Good Practices Course provides an in-depth overview of the technique and process 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. There are also other exciting developments in the field of condition assessment, robotic repair systems and keyhole technology to provide options to install or replace a vast range of pipe sizes and materials.

For the past several years NASTT has offered a Gas Industry Day in conjunction with the annual No-Dig Show. This special feature of the conference includes entrance to the gas track during the technical program, an exhibit hall pass, networking luncheon and attendance to NASTT's Gas Good Practices Course, taught by industry leading gas technology experts. This information packed day is beneficial to anyone involved in gas distribution.

It is an exciting time in both the energy industry and the trenchless technology realm when the innovative techniques can be deployed with positive results that are beneficial to everyone involved. The research in this field continues to grow and expand with problem solving and challenge mitigation priority. This certainly helps continue to improve our society and the environment for us all.

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

Matthew Izzard

Matthew Izzard
NASTT Executive Director

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New World Record CIPL Achieved with Planning, Experience and Networking

Challenging Renewal of 42-Inch Trunk Gas Main under the Garden State Parkway in East Orange, NJ Sets New World Record

By: George Ragula, Public Service Electric & Gas

INTRODUCTION

Technical innovations gained from previous experience, detailed planning, field innovations, and the knowledge base provided by industry research and development were key elements in helping us achieve a new world record last summer lining the largest diameter gas pipeline ever renewed using CIPL.

The new world record diameter milestone set on July 19, 2019 lining 573 feet of 42-inch high pressure cast iron (CI) gas main crossing under the Garden State Parkway at the Central Avenue Bridge in East Orange, New Jersey was accomplished because of the lessons learned by ourselves and lining contractor Progressive Pipe Management (PPM) of Wenonah NJ, in overcoming challenges on previous CIPL projects renewing progressively larger diameter CI gas mains. This breakthrough milestone was achieved with help and expert advice from NASTT industry colleagues.

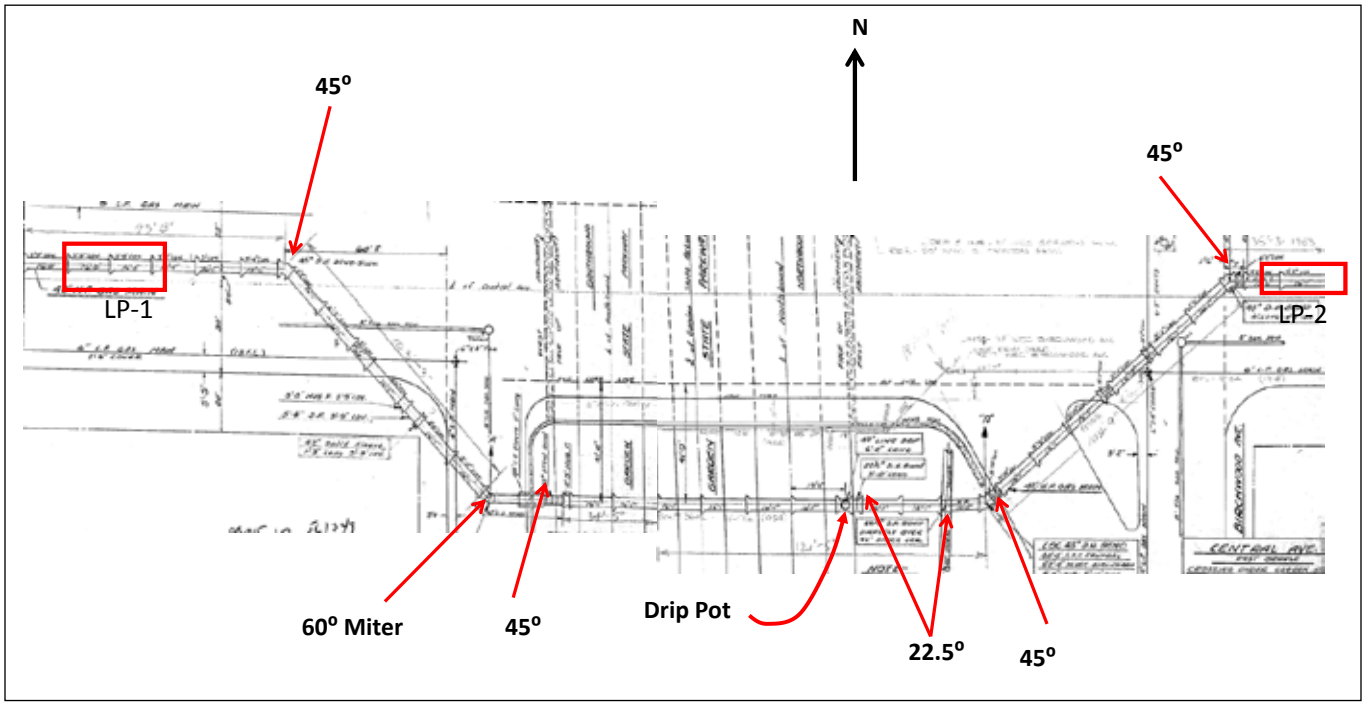
Records are made to be broken, and surpassed with even greater achievements.

"A tremendous win from a well-engineered plan!"

-David Wickersham, President/CEO, Progressive Pipeline Management

Research and development, based on acquired experience, provides the foundation for this effort. Two years ago in September 2017 we set a new world record, and a major breakthrough for CIPL at the time, when we lined 2,000 LF of 36-inch CI feeder main in nearby South Orange. Largest diameter ever back then, it was one of the most challenging projects I'd ever faced. The lessons we learned lining the 36-inch pipe became invaluable in planning future projects with larger diameters and longer inversions. The obstacles we overcame on this landmark 36-inch project in 2017 were instrumental in driving the new technical innovations that were crucial in setting the new milestone World Record 42-inch CIPL in summer 2019.

World record 42-inch CIPL was accomplished because of lessons learned on previous projects



Pipe segment was inaccessible and difficult to repair with seven bends in total

LAYOUT

The Garden State Parkway (GSP) is the longest highway in New Jersey, a key toll road stretching from south to north across the state. East Orange, known as "The Crossroads of New Jersey," is centrally located only a few miles from the Newark Airport and less than half an hour away from New York City. The 42-inch main runs directly under Central Avenue, the main artery through East Orange, which crosses over the GSP at the Central Avenue Bridge.

Installed underneath Central Avenue in 1954 using inner-tite mechanical joints, the 42-inch main descends down a steep embankment right before the bridge to cross the Garden State Parkway at roughly 7 feet below the freeway lanes. The Parkway itself is situated 25 feet below grade level from the surrounding streets. After crossing underneath the GSP, the pipe climbs back up under the opposite highway retaining wall, snaking westward after a series of bends directly below Central Avenue.

In order to negotiate the steep grade change and cross under the below grade eight-lane GSP, the 42-inch pipe was originally built in a shallow basin shape, essentially a flattened "u-tube" configuration. This segment of pipe was a very complicated layout to repair with seven bends in total: three 45-degree bends, one 45-degree steel miter bend included in a short section of steel pipe, which also contained a 60-degree miter bend, and two 22-1/2-degree bends. Because of the below grade construction of the GSP, the section of pipe crossing under the freeway lanes was a low point in this area for the gas distribution system, which meant there was also a drip pot fitting for liquid collection and removal, a holdover from the early days of wet manufactured gas. The drip pot created a 48-inch gap in the pipe, which had to be bridged with a custom fabricated steel structural reinforcement sleeve (SRS).

Careful planning of the Central Avenue project was necessary to overcome this extremely challenging pipe layout and geometry, and we knew the solutions had to be very well thought out. Based on the knowledge acquired from our experiences in previous lining projects, we were able to anticipate many of the challenges encountered with the large 42-inch diameter, which resulted from the inaccessibility and unusual pipe layout on this project. Carefully designed and serendipitous technical innovations were implemented which resulted ultimately in a well-coordinated smooth liner installation, with no issues, and a very successful outcome with ample time left before the September 1 gas-in date.

CIPL

When the New Jersey DOT announced in late 2014 it was planning the reconstruction of the Central Avenue Bridge, along with improvements to the adjacent highway shoulder areas where our main was located, a preliminary survey of this segment of pipe done by PSEG revealed significant leakage at the inner-tite mechanical joints. This was no surprise with inaccessible pipe of this type and age.

Most of the aging inventory of large diameter cast iron pipe used in gas mains is still in remarkably good condition. The pipe walls are very thick and graphitization is uncommon and generally inconsequential, however leaking joints are the weak link regularly encountered in large diameter CI pipelines. Generally, leaks at these joints are costly to point repair due to their size and depth. Because the joints in large diameter gas mains are usually spaced at 12- or 18-foot intervals, excavations or potholing these joints

It was important that Central Avenue and the Bridge remained open during construction

to repair them by encapsulation is both time consuming and difficult. CIPL offers a practical and cost effective trenchless repair and renewal alternative due to these time and cost challenges, therefore its use continues to expand in the gas industry.

At the outset of planning back in 2014, we determined that because of the challenging layout of the 42-inch pipe and deep, inaccessible location under the GSP, CIPL renewal was the best, in fact only, viable option to repair and renew this section of main. Excavations or potholing across the GSP traffic lanes were out of the question, and with the East Orange Hospital nearby, it was imperative that Central Avenue and the Central Avenue Bridge remained open during construction. Additionally, CIPL provided the advantage of being able to locate the sending and receiving pits on each side of the GSP far enough away to minimize any interference with the simultaneous Central Avenue Bridge reconstruction work, which already was creating traffic gridlock.

INNOVATIONS

The close proximity to the bridge reconstruction, and requirement for traffic flow to stay open along Central Avenue for the duration of the project, were key considerations in planning. Careful planning and a detailed game plan was critical, and considerable time was invested in a comprehensive design effort to prepare for the lining work. Our ingenuity and resourcefulness were stretched to meet the challenges posed by the diameter, geometry and inaccessibility of the main. Helped along with some advice from industry experts, innovative solutions were found during the design phase that arose from the lessons learned on previous lining projects.

These first-ever technical innovations for lining CI gas pipe included:

- New inversion drum & transport hose to handle large diameter liner
- Injected curtain grouting preventing water penetration into depressurized pipe
- Robotic self-propelled sandblasting unit for cleaning pipe
- Dust collectors (64,000cfm) used for high velocity post-clean grit removal to prevent stranded grit issues.
- Largest fabricated steel SRS ever built to bridge 48-inch long drip pot gap
- Inverting a large diameter liner through seven bends & multiple grade changes
- Additional reinforcement to liner tail and catch end

BRIDGE RECONSTRUCTION

With the formal announcement in early January 2019 of the start of the Central Avenue bridge reconstruction in the summer, intensive, detailed final planning for the gas main renewal project immediately ramped up. Because this was a critical major gas main feed for the overall gas network, there was an extremely limited window for service outage with gas-in and completion mandated by September 1. We had to work fast and get materials into place quickly. Lining this pipe size and configuration had never been attempted before, so it was important that every detail was meticulously reviewed and mapped out before construction began.

Preliminary live CCTV inspection was done in late January using a variable geometry crawler installed through a 4-inch tap hole. The inspection showed the interior of the pipe was relatively clean and confirmed there were no anomalies or

fittings that could interfere with the lining, aside from the 48-inch gap created by the drip pot fitting.

After the locations of the sending and receiving pits along Central Avenue were established on either side of the bridge, a total of 700 feet of the Starline® liner product was ordered from the German manufacturer, Karl Weiss Technologies GmbH. This gave us enough left over for wastage and the expected 12-week delivery turnaround would ensure the liner was in place by end of May, well before the excavating contractor move-in date.

Project contractors PPM specialize in gas infrastructure construction and, since 2002, are exclusive North American installers of the Starline® liner product. Developed specifically for renewing high pressure large diameter natural gas mains, the patented Starline® liner system has undergone ten years of rigorous testing with PHMSA, Cornell University, and NYSEARCH, demonstrating the potential for a 100+ year service lifespan. According to David Wickersham, PPM President and CEO, "There are simply no other liners available for use today in the gas industry that have a similar testing pedigree." All PPM crews are thoroughly trained and familiar with installing the liner, which uses a specially formulated two-part epoxy to bond the liner to the host pipe. The epoxy is mixed onsite and applied to the liner just before inversion.

INVERSION DRUM

The 700 feet of liner ordered was well inside the load capacity of the new liner inversion drum, purpose built for installations on large diameter gas mains. Developed and custom fabricated by the German lining manufacturer, the new inversion drum incorporated lessons learned from previous large diameter lining projects including the world-record setting 36-inch gas main CIPL renewal project two years ago in South Orange.

The new inversion drum featured a transport hose for the liner that significantly decreased aboveground equipment footprint, reduced the size of the sending pit, and also protected the liner from inadvertent chafing due to angle of entry during inversion. Increased liner capacity, and a redesign of the drum outlet mechanism were additional new improvements which dramatically reduce set-up time and greatly increase crew efficiency during liner installation. The improvements to the liner installation equipment, in conjunction with excellent surface preparation and cleaning beforehand, led to a problem-free liner installation.

GROUTING FIRST

Before cleaning the pipe interior, it was important to first ensure the inner pipe wall was dry, and eliminate any water inflow once the pipe was taken out of service. Experience hard won on prior jobs had shown how water infiltration can derail even the most carefully designed cleaning and liner installation process. Due to the high water table, and pipe depth over 30 feet below grade where the main crossed under the GSP, we expected substantial water intrusion once pressure was off the line.

The main was abandoned June 26, and when the pipe was CCTV inspected a week later during the contractor move-in on July 3, we found the drip pot at the low point had already collected over 70 gallons of water inflow. Close inspection located the source of inflow at the 45-degree mitered steel bend on the short section of steel pipe.

Several potential solutions to stop water inflow had been closely examined during the planning phase and the preferred method selected was curtain grouting, which injects an expanding hydrophilic grout into the surrounding soil. The grout forms a dense semi-rigid foam barrier around the pipe exterior preventing water intrusion from the outside. Avanti AV-275 Soilgrout was recommended for this application since it is designed to bind together and waterproof loose granular soils, and withstands repeated wet/dry cycles.

This was the first time the curtain grouting method had ever been used on a gas main to prevent water entry. Subcontractor Camden Group from Butler New Jersey was brought in for this challenging first-time application of grout from inside a gas main. Man entry was required for the grouting operation, so extensive safety precautions were taken, with rescue harnesses, fresh air circulation, gas monitoring equipment and a confined space rescue team onsite. A body board and pulley system was employed to get workers down to the infiltration site, at the mitered steel elbow. Crews then injected the grout into the soil surrounding the area of inflow by pumping it through check

More than 70 gallons of water collected in the drip pot a week after main abandoned

First-ever application of curtain grouting from inside a gas main required man-entry

Grout pumped into soil through check valves stopped inflow from heavy rainfall

valves in multiple 3/8-inch holes drilled into the pipe.

Surprisingly, after pumping only five gallons of grout into the soil surrounding the pipe, the water inflow stopped. As Scott Laubshire of Camden Group noted, "Based on the project specifics we planned to pump at least 60 gallons into the soil. You can imagine the look on my face when we pumped five gallons of AV-275 grout, and the infiltration stopped!" This was confirmed the next day when, following a significant overnight rainfall of more than 2 inches, the pipe interior was still completely dry at the infiltration site. The grout then cured over the weekend, and on Monday July 15 the operation was completed when excess grout was removed, and the check valves ground flush with the inner pipe wall.

With the first-time use ever of injected curtain grouting to prevent inflow and infiltration prior to cleaning we created a dry interior for sandblast cleaning the pipe, and overcame a major potential cause of liner disbondment. This innovation is an important milestone certain to be used in future projects as a crucial step before cleaning, where water intrusion is encountered in depressurized pipe.

GRIT CLEANING

Thorough cleaning of the pipe interior to remove debris and built up residue is necessary to ensure proper bonding of the installed liner to the host pipe. Ensuring sufficient air velocity to first sandblast clean the inside of the pipe, and then recover the leftover grit, was expected to be a significant hurdle, considering the diameter and geometry of the pipe, combined with the effects of gravity.

Maintaining a minimum 45mph velocity was an achievement, considering pipe diameter and geometry

Self-propelled robotic sand blast unit, "The Beast" efficiently cleaned the metal to a NACE-2 finish

There had been challenges on several previous jobs, especially the record-setting 36-inch CIPL in South Orange, where it had taken a lot of time and effort to remove all the residual grit after sandblast cleaning, almost critically delaying the entire project. Because of this previous experience, we did extensive testing and assessment of different configurations of vacuum equipment ahead of time in the planning phase, in an attempt to find the optimal equipment configuration for maintaining adequate airflow velocity.

In consultation with well-known vacuum excavation expert, John Walko of Excavac, we finally opted to use two dust collectors, with an equivalent 64,000 cfm vacuum capacity, in lieu of eight vacuum trucks. This decision significantly reduced our onsite equipment footprint and potential impact to traffic. Additionally, we determined that upsizing the inlet hoses from 8-inch to 16-inch created better airflow. Considering the large pipe diameter and difficult geometry descending down then back up under the steep embankments on either side of the GSP, maintaining a minimum 45mph velocity was a considerable achievement. For the first time ever on a CIPL project, we had air velocity and vacuum measuring gauges available for real time monitoring during sandblast cleaning and grit recovery operations.

Initial attempts to winch a sandblast head through the pipe didn't work effectively, so we deployed a self-propelled robotic sand blast unit, with an electric motor, designed in California, which was recently purchased by PPM. The unit was very effective in cleaning the pipe even though man-entry was necessary to guide the unit through each of seven bends, as it would frequently topple over due to its high center of gravity. Nevertheless, the sandblast unit, nicknamed "The Beast" by the PPM crew, efficiently cleaned the metal down to a bright-white NACE 2 finish.

According to Wickersham, "It worked brilliantly. The video camera on the unit allowed real-time views of results during cleaning. Very quick set-up, the crew was cleaning within 10 minutes. We'll be using it again on large diameters. Another progressive step up for gas CIPL."

LARGEST SRS

After post cleaning CCTV inspection confirmed the inner pipe surface was ready for lining, one final critical step was necessary before installation could begin. The drip pot had been kept active throughout the cleaning in order to collect the expected water inflows following abandonment of the main prior

Resourceful Miller Pipeline crew successfully installed largest SRS bridge ever fabricated

to grouting. Since this fitting was at the low point under the GSP it helped reduce excess accumulations of water in the pipe before the curtain grouting stopped inflow. When the main was abandoned, we had replaced the existing steel standpipe with a temporary plastic standpipe, which was removed once the water intrusion was stopped.

Using man-entry, with all the necessary safety protocols, a 6-foot prefabricated SRS made from ¼-inch thick carbon steel, was installed by Miller Pipeline crews to bridge the 48-inch drip pot gap, with a 12-inch overlap extending onto the existing pipe on both sides. The SRS was designed to eliminate any sharp edges which could potentially tear the liner. It was rated to a maximum allowable operating pressure (MAOP) of 66 psig – well above the usual 15 psig MAOP of the 42-inch main, and the 22.5 psig intended for the pressure test at the end of construction.

It took time and effort to position the bridge within the pipe. After several unsuccessful attempts to pull the SRS in two halves through the several bends to the drip pot, it was disassembled into four quarters in order to have adequate clearance moving it 140 feet through the pipe and 45-degree bends Reassembling the SRS at the drip pot was challenging since there was a 22 ½-degree bend connected to one end of the pot. A lot of cutting and fitting work was necessary to finally get it to lay flat on the limited straight section of pipe before the start of the bend radius. The experience and resourcefulness of the Miller Pipeline crew were instrumental in the successful installation of the largest SRS bridge ever fabricated to date. Just before lining commenced, the Miller Pipeline crew also installed Weko Seals in two segments of pipe that were also abandoned as part of the shutdown outside of the immediate CIPL work area.

Because of summer heat-wave, work began at 4am installation day

SUMMER HEAT

Because of the heat wave in the northeast, there was concern the resin could cure prematurely, so a 4am job start was planned on the day of the liner installation, Friday, July 19. We hoped to get the liner wet-out and inversion completely done well before onset of the mid-afternoon heat. The wet-out process involved mixing 40 cans of two-part epoxy, which is then poured into the liner, saturating it. The resin soaked liner is then squeezed through pinch rollers so that the

Inversion pressures required six tail bolts

Careful planning ahead of time helped the liner installation run perfectly

Sending pit, Central Avenue East

Receiving pit, Central Avenue West

epoxy is spread out evenly, impregnating the full length of the liner.

This intricate and tightly choreographed assembly line process involved many people spreading the 2,000 pounds of resin, folding the liner and helping to load it into the inversion drum. Large amounts of lubricant were also applied to the outside of the liner to minimize the friction from the seven bends and two vertical inclines that needed to be traversed during the inversion process.

Based on our previous experience on the 36-inch job using the pressures required to successfully invert the liner through large diameter pipe, six tail bolts were installed in the liner tail to prevent a blow-out at the catch end.

Fittings were then installed onto the abandoned pipe in the sending and receiving pits at either end, and the inversion drum transport hose containing the resin soaked liner was connected to the open pipe end in the sending pit on the east side of the GSP.

SEVEN BENDS

Inversion began at approximately 1 pm, taking just over an hour, with air pressure ranging from 5-7 psig, for the liner to hit the catch end at the receiving pit on the west side of the GSP. In total, the 570-foot 42-inch liner was inverted through 7 bends and two steep slopes on either side of the GSP.

New custom built inversion drum has transport hose for liner

The transport hose was then removed and nitrogen was hooked up to supply make up air to maintain 8-10 psig inside the pipe while the liner ambient cured. Ambient curing took only two days because of the heat wave, so the following Monday, July 22, both ends of the liner were cut and trimmed flush to the pipe.

Final post-lining CCTV inspection confirmed the liner was very tightly bonded with the host pipe, smooth, and entirely free of anomalies. The final pressure test was done immediately afterwards in order to prevent any potential water infiltration from causing liner disbondment.

The test of 22.5 psig held steady overnight. It dropped slightly to 22.44 psig, because hot compressed air in the pipe had cooled overnight.

Following the successful pressure test, pressure was reduced to 10 psig to maintain positive pressure within the pipe until tie-in scheduled for 3 weeks later. Finally, the renewed 42-inch main was successfully gassed-in on Thursday, August 22nd, and everyone involved with the project breathed a sigh of relief for meeting the tight outage window deadline.

Final post-lining CCTV

Lining this complex challenging segment of pipe was done in record time, and the overall construction process completed two-and-a-half weeks ahead of schedule. The precision coordination during construction, and seamless execution of a complex design plan were possible because of the upfront amount of time and effort we invested in the detailed planning and design of this CIPL project, and the incredible teamwork among ourselves, PSE&G crews, PPM, bridge contractors, and the subcontractors.


Detailed planning and incredible teamwork were keys to success. From left to right: Holger Turloff, Karl Weiss Gmbh, Shane LoPresti, PPM, George Ragula, PSEG, Tom Nestoras, PPM

"Tremendous coordination and careful planning were employed among ourselves, the subcontractors and also the state bridge contractor to ensure the safe and productive work environment we needed to tackle this challenging job", Wickersham summarized, "The successful permanent renewal of this difficult and inaccessible stretch of 42-inch main set a new world record for the largest diameter gas main ever renewed using CIPL technology! A tremendous win from a well-engineered plan!"

LOOK AHEAD

Our achievement in setting a world record for the largest diameter gas pipeline ever to be renewed using CIPL was spurred along by several necessary first-ever technical advancements and improvements to equipment and procedures. These innovations will help improve and speed up work on all future projects lining gas pipe. The technical advances we made establish CIPL as a viable renewal technique on any large diameter gas pipe moving forwards. Because of the upfront planning, expert advice and sheer hard work invested to set this new world record milestone in the gas industry, there are no longer any upper limits to pipe size that can be renewed using CIPL methods. Inventive and curious, humanity's leaders will continue to build a better future using trenchless technology. World records are made to be broken. Research and development, the process of continuous innovation, lights the path.

"If we knew what it was we were doing, it would not be called research, would it?"

(Albert Einstein)

ABOUT THE AUTHOR:

***George Ragula** is the Distribution Technology Manager at Public Service Electric & Gas (PSE&G) with over 42 years of experience in gas industry engineering, operations, construction, research/development/deployment and management. George is a noted authority on trenchless applications for the gas industry having spent 32 years specifically focused on trenchless. He received his B.S. in Mechanical Engineering from Polytechnic Institute of Brooklyn in New York. George is a past Chair of NASTT and serves on the NASTT No-Dig Show Program Committee. He also teaches several NASTT courses on various trenchless technology topics, including CIPL for the Gas Industry.*

Direct Pipe® Installation under the Calumet River

Longest Direct Pipe® installation of a 36-inch gas pipeline to date

By: Joe Tassone, Peoples Gas

Meeting the challenges that come with utilizing a new trenchless technology (Direct Pipe®) to facilitate an infrastructure replacement project successfully in a major metropolitan city.

RECORD Direct Pipe® INSTALLATION

As part of a multi-faceted project to retrofit a 36-inch steel gas transmission pipeline in Chicago, a portion under the Calumet River was replaced involving a record setting 1500 foot installation employing Direct Pipe® technology. The project was successfully completed on time, under budget, and safely in the fall of 2017 to allow for subsequent pipeline pigging and assessments in early 2018. Additionally, the completion of the Direct Pipe® installation allowed for the decommissioning of an existing facility within a tunnel structure that previously had created challenges for pigability and warranted costly inspection and maintenance programs.

Unique projects like this don't come around very often for most operators, so it is important that when they do all viable options are looked at to ensure new evolving technologies are considered. While traditional trenchless methods like horizontal directional drilling (HDD) and jacking and boring tend to be the first installation types on everyone's mind, the Direct Pipe® method was found to be the best fit for our application. The newness of the technology coupled with the aggressive timeline and project scope produced many challenges along the way. These challenges were met through continually collaborating with our contractor (Michels Corporation) until the project was completed.

PROJECT BACKGROUND

The Calumet #3 transmission line was constructed in 1959 to provide gas supply to the bustling Southeast side of Chicago through a 36-inch gas main responsible for a number of large scale industrial and residential customers populating the growing city at the time. The installation path traversed 6 miles across bodies of water, inside tunnel shafts, and under railroad tracks. Aside from the obstacles encountered as part of its path, it was constructed at the time with several types of unpiggable fittings (elbows, tees, etc.) making it nearly impossible to assess through inline inspection technology. In an effort to gain the ability to utilize inline inspections of the asset, and abandon costly and time consuming inspection and maintenance programs, it was decided that the pipeline would be updated and retrofitted through a number of identified project locations. After identifying and assessing the pipeline "imperfections" on the line, a multi-year effort commenced to ensure proper funding was budgeted and secured to handle all capital investments needed to fully retrofit the line. After a considerable amount of planning concluded, construction at the first project location commenced in 2013.

In 2017 after 3 station rebuilds, 1 railroad crossing replacement, several non-pigable fitting replacements, and 1 river crossing project (performed via HDD) were completed on the Calumet #3 transmission line, the only remaining obstacle from making the line pigable was a unique river crossing under the Calumet River on the southeast side of Chicago. Based on soil boring data acquired during the project planning phase, the pipeline at this location ran 30 feet under the riverbed in a narrow corridor above existing bedrock posing concerns on what the best installation method would be for the new line. In an effort to keep the project progressing forward the next logical step was to perform a detailed evaluation of our viable options for installation.

INSTALLATION EVALUATION

As part of the evaluation process for the project we immediately considered the two most commonly used trenchless methods we'd been exposed to in Chicago which were horizontal directional drilling (HDD) and jack and bore. These methods had been used extensively in prior applications for us and were something we were both familiar with and were proven. Through some additional research and discussions with industry pipeline contractors, a third technology was identified as a potential and viable solution to also consider. It was called Direct Pipe® and was referenced as a hybridized installation method that combined micro tunneling and horizontal directional drilling technologies. It utilizes a hydraulic thruster to push a micro tunneling head and sacrificial/production pipe along its installation path to a receiving pit. The one pass installation takes place on only one side of the boundary being crossed and is applicable in nearly all geological conditions. The method had been originally introduced in Germany and was first utilized in the U.S. in 2011 in Florida for its first pipeline installation. Though

it was not as mature as other traditional trenchless installation methods, it had been utilized successfully in nearly 150 projects worldwide and considered viable for our application. As we built in all of our factors and constraints into the evaluation (project footprint, risk of inadvertent returns, types of soil, cost, etc.) we found that Direct Pipe® was our best option for the project.

The selection was based primarily on the benefits offered by the Direct Pipe® technology that significantly reduced our risk profile on the project. The reduced hydraulic pressure at the devices tunneling head during drilling operations provided us the safest route to traverse between the river and bedrock without experiencing "frac out" from the riverbed. Additional critical factors that led to the selection were its ability to tunnel through various unforeseen soil types as well as the limited installation footprint required to achieve its tunneling path from one side of the river.

Initial set up took just over a week

PROJECT TIMELINE

With the installation methodology selected for the project, discussions soon commenced with a limited number of pipeline contractors equipped for the work. Project Director for Peoples Gas, Jon Czarnecki recalls, "As Michels Corporation gave us more information about Direct Pipe®, we started to get a little more comfortable. It felt like a partnership."

Record-setting 36-inch direct pipe installation 30 feet under the Calumet River

Michels was subsequently selected as the pipeline contractor for the project and the partnership on the river bore began. Planning meetings were scheduled for several months leading up to the project construction start to prepare for the execution of the work. Many important topics such as logistics, materials, project milestones, easements, and deadlines were discussed to ensure that expectations were understood by both parties. After some unforeseen delays with land easements, construction started on August 10, when crews mobilized to the site.

The first two weeks consisted of site preparation activities with extensive right of way clearing of foliage and staging area set up for the pipe and equipment. Once completed, the sacrificial and production pipe were delivered to the site for welding and coating. The Direct Pipe® installation would incorporate the use of sacrificial pipe as the lead pipe prior to the production pipe as a precautionary measure. The Direct Pipe® equipment was then delivered, installed, and setup in just over a week to position the installation to start on September 21.

When the microtunneling began on the 21st, a 24-hour, 7-day work week was instituted (2- 12 hours shifts) for the

> *"Selecting direct pipe was a bit of a gamble, but in the end it paid off and further advanced the technology."*

Mining was done 24-7 to maximize production

duration of the mining to ensure the equipment was continuously progressing and not idle. Once the equipment started its entry, it progressed at approximately 10 feet per hour in softer soils and 1 foot per hour in rockier soil. After 9 days of operation and approximately 420 feet of tunneling, an issue was identified with a pump in the boring head which halted production. After efforts to troubleshoot the problem from both above and below ground failed, it was decided that extracting the equipment to perform repairs was the best option.

Installation recommenced on October 9, when repairs were completed on the pump and the equipment was repositioned for tunneling. After 4 days of operation and approximately 976 feet of tunneling, a communications issue with the device was encountered that again halted production. After additional efforts to troubleshoot from above ground, as well as a confined space entry, came up short, it was decided that another extraction to perform repairs would be the best option.

Meetings with Michels and the equipment manufacturer from Germany were held to discuss the challenges encountered and to figure out the best approach moving forward. Though these discussions were difficult for the group, everyone was committed to maintaining their composure and working through the challenges to complete the project. It was also explained that extractions weren't uncommon as part of the installation method and that there were contingencies available including bringing in a larger tunneling machine. The team decided to continue with the original plan based on these discussions.

Extensive right of way was required as staging area for the pipe

Installation once again recommenced on October 19, when all communications issues were resolved with the equipment. After four productive days of boring, the microtunneling head emerged on the other side of the river at its destination. Soon thereafter the sacrificial pipe was pushed out and the production pipe installed in its place. With the production pipe in place, the team had a small window to celebrate their hard work as several other critical tasks needed immediate attention to meet their deadline to put the asset back in service. Over the next month the team excavated the two tie-in openings (including the installation of dewatering systems), hydrostatically tested the

Fittings and final tie-ins were completed ahead of schedule

line, ran a caliper pig through the line, and installed the remaining pipe runs up to the tie-in locations. Over a two day shutdown period each side of the crossing was tied-in to the existing line without any issues. The main was brought up to line pressure and placed backed into service on November 24, which was 6 days before the agreed upon project deadline for system reinstatement. The project ended both ahead of time and under budget based on the collaborative partnership formed to execute the complex installation with the new Direct Pipe® trenchless technology.

SUMMARY

When I look back on this project a couple of years later I am always reminded of a couple key takeaways from our internal lessons learned discussions that are critical to executing pipeline projects with newer technologies.

The first takeaway is that in order to make the best decision on a project you **must** explore **all** viable options regardless of how much risk they may present based on their maturity and newness. The utility industry as a whole is fairly risk averse and slower to adopt new technologies in order to ensure stability for its investors and shareholders. More often than not they rely on interstate pipeline operators and transmission companies to lead the way for them and follow along when the technologies have fully matured. Direct Pipe®, while being a proven installation methodology, had less than a decade of domestic use for pipeline installations. Selecting Direct Pipe® was a bit of a gamble, but in the end it paid off and further advanced the technology for other natural gas utilities to follow.

The second takeaway is that all successfully executed projects stem from a good partnership with your selected pipeline contractor. Understanding that prior to the selection is important in assembling appropriate criteria to ensure that they are not **only** equipped to perform the work but are aligned with other important company values. The partnership on the river bore project fostered personal responsibility for results by both parties, the importance of jobsite safety of all personnel involved, and acting with a true sense of urgency when issues arise. All of these shared goals led to a successfully executed project utilizing a new technology without allowing safety to be compromised.

ABOUT THE AUTHOR:

***Joe Tassone** is a Construction Manager for Peoples Gas. His primary responsibility is to provide oversight and leadership in executing the system modernization program within the City of Chicago. Prior to this position, Joe served in various roles with increasing responsibility at Peoples in Corrosion Control, Operations, and Engineering. Joe received both his Masters in Business Administration and his Bachelors in Science in Industrial Engineering from the University of Illinois at Chicago.*

PROJECT SAFETY STATS:

- **0 OSHA or LTI, 0 first aid**
- **Total Contractor hours: 61,289 PGL: 1,508**
- **(40) 24 hour shifts, (46) confined space**

Twelve Best Practices to Avoid Pipeline Construction Environmental Shutdowns and Fines

By: Tony Finding, Brownfield Science & Technology, Inc. (BSTI)

Since 2005, innovative technologies such as hydraulic fracturing (i.e., fracking) and directional drilling (trenchless technologies) have made it possible to access valuable hydrocarbon resources from Pennsylvania's Marcellus and Utica shale deposits. Domestic natural gas production has increased to the point that Pennsylvania produces 19 per cent of the total output, which ranks #2 behind only Texas at 24 per cent.

The increase in natural gas production has triggered a demand for additional pipelines across Pennsylvania and the surrounding region to deliver product to market safely and efficiently. To construct a new pipeline, energy companies must navigate complex environmental regulations, permits, and technical obstacles. Any misstep along the way can result in costly operational shut- downs, public relations challenges, sizable fines and lengthy project delays.

Every pipeline installation location faces unique challenges. The purpose of this paper is to identify some of the more common causes of environmental, regulatory and permit violations that can result in work delays, fines and public relations challenges. The information below is presented in no particular order of importance. It is our hope that this paper can serve as a valuable guide to energy companies and pipeline operators as they plan and implement their pipeline construction projects.

1. ESTABLISH CLEAR LINES OF COMMUNICATION

Insufficient responses, reporting delays, inattention to permit details and work crew variabilities have all been factors in pipeline construction shutdowns and fines. Communication challenges become more complex when the project involves multiple contracting parties.

Governing authorities will not accept a lack of communication at the project level as a valid reason for not complying with permit conditions. Repeated failure to comply promptly with permits can risk a forced work stoppage, imposed fines, and/or additional legal penalties.

A robust Communications Plan should be generated and implemented at all levels of the project. A clearly outlined project personnel structure and chain of communication is vital to the Communications Plan. Timeframes and processes to report instances of non-compliance are also an important part of the plan. Managers and on-scene inspectors must be fluent in permit reporting requirements. They should also have the authority to obtain the information they need in a timely fashion. Enabling a process for field crews to identify and report potential issues to inspectors and managers can save valuable time and kick-start mitigation efforts. A self-regulating project can keep regulators from becoming overly involved with day-to-day oversight.

2. PROPER SOIL SEGREGATION AND RESTORATION OF OPEN-CUT WETLANDS

When open-cut trenching methods are used to cross wetland areas, soil segregation is important to maintain the integrity of the resource during restoration efforts. Specifically, wetlands underlain

To construct a new pipeline, energy companies must navigate complex environmental regulations

Thorough geotechnical investigations should be conducted before construction in all areas of planned HDD activity

by an impermeable "fragipan" soil horizon are at risk of drainage if not properly restored.

Wetlands with endangered and/or threatened species, such as bog turtle habitat, will likely require additional measures to avoid long-term impacts and might not be approved for open-cut crossing methods.

It is recommended that during initial trench excavation, a wetlands specialist or similarly- qualified expert is present to verify that soil horizons are carefully removed, segregated, and staged during construction. Following pipeline installation, complete and appropriate restoration of the wetland should be documented and approved by this expert.

3. PREPARE FOR WATER INFILTRATION WITHIN CONVENTIONAL BORE EXCAVATIONS

Conventional bore crossings typically require the excavation of pits to attain a direct bore path beneath the feature to be crossed. Storm water runoff and/or groundwater infiltration into the pits may necessitate significant water management measures including temporary settling and containment structures. Often, additional space is needed to construct water management structures. Special attention to permit conditions is important to avoid management and discharge violations. Additionally, the time

Important to maintain clean and orderly project access points

required to purchase/rent additional land for workspace, or to modify a permit, can result in delays of weeks.

It is recommended that a pre-construction evaluation of bore crossings take place to improve the understanding of the subsurface. This information can be used to design construction plans for crossings that add in contingencies for expanded dewatering and storm water handling requirements.

4. MAINTAIN EROSION CONTROL DEVICES (ECDS) TO PREVENT RUNOFF INTO WETLANDS, STREAMS AND OTHER WATERWAYS

Continual inspection and upkeep of ECDs is necessary to prevent runoff from the construction site into water bodies and other resources. Over time and multiple storm events, ECDs become less effective and need to be repaired or replaced to avoid unpermitted discharges to waterways and/or complaints from the public.

It is recommended that personnel be assigned to directly inspect ECDs on a regular basis as well as just prior to and after any storm events. Sufficient resources should be allocated to repair ECDs expeditiously.

5. MAINTAIN CONSTRUCTION OPERATIONS DURING PERMITTED WORK HOURS

Most municipalities and townships have ordinances specifying the permissible hours of operations for construction activities. Installation contractors are under pressure to make progress and may opt to work beyond the permitted timeframes. Especially in areas of increased public scrutiny, such actions may trigger noise and/or nuisance complaints from nearby residences. Habitual

> *A robust Communications Plan should be generated and implemented at all levels of the project.*

violations of such ordinances can risk temporary shutdown or revocation of local permits.

It is recommended that site supervisors be fully informed of and comply with all local rules and work timeframes. Daily work logs should always verify the actual hours of operation.

6. SYSTEMATIZE PROCESS FOR CHANGES TO CONSTRUCTION METHODS/TECHNIQUES

Often a construction method/technique change can make good tactical sense given in-field conditions or circumstances. However, such changes often require modifications to existing permits, which will necessitate regulatory review and approval.

Failure to follow permitted construction methods or techniques can result in the suspension of all permitted activities, extended delays, and fines for failure to comply.

It is recommended that a thorough and detailed Communications Plan be adopted, and all personnel be trained on its content to prevent these issues from impacting the project.

7. MINIMIZE INADVERTENT RETURNS OF DRILLING FLUIDS INTO UNCONTROLLED AREAS

Trenchless technologies, such as Horizontal Directional Drilling (HDD), utilize circulated drilling "mud" to advance a bore path through the subsurface often to cross underneath a major roadway or a sensitive environmental resource. Sometimes, the pressurized drilling mud will travel through natural subsurface pathways such as rock fractures and reach the ground surface. This is known as a "frack out" or inadvertent return (IR). IRs that enter waterways, wetlands, or ponds may be viewed as unpermitted discharges and subject to fines. In addition, IRs may cause property damage to nearby structures or roadways.

An IR can be quite visible to the surrounding community and often creates a public relations challenge. Exacerbating the problem, once an IR occurs, it will have a higher chance of reoccurring once drilling resumes due to the establishment of that preferential pathway.

It is recommended that a thorough geotechnical investigation be conducted in all areas that will likely involve HDD methods prior to actual drilling. Although nothing can detect all possible subsurface structure and fractures, the geotechnical investigation can predict areas where IRs would be more likely to occur. Reducing the length of an HDD bore to a minimum greatly reduces the risk of an unwanted IR. In high-risk areas or threatened or endangered species habitat, it may be advantageous to evaluate installation methods other than HDD.

Reducing length of HDD bore path to a minimum can greatly reduce the risk of inadvertent returns

8. MINIMIZE THE EFFECTS ON POTABLE WATER RESOURCES CAUSED BY TRENCHLESS TECHNOLOGIES

As presented above, HDD drilling mud has the potential to migrate through the subsurface and can enter nearby domestic water supply wells. Although drilling mud is non-toxic, effects can range from increased drinking water turbidity to complete infiltration with drilling fluids.

Additionally, a horizontal bore may intercept a local aquifer which could cause drainage back through the borehole and lower the groundwater level. If groundwater levels drop below well supply- pump depths, the local water supply may be lost. Affected users must be supplied immediately with alternative water sources and a long-term solution for their water needs will need to be addressed; possibly involving the installation of a new water well or connection to a publicly-owned water supply.

Municipalities and townships have ordinances specifying the permissible hours of operations for construction activities

Site supervisors need to be fully informed of, and compliant with, all local rules and work timeframes

As noted above, it is recommended that a thorough geotechnical investigation be conducted during pre-construction in all areas of planned HDD activity. In addition, all potable water wells in the area should be identified and monitored before, during and after construction activities.

9. PROMPTLY REPORT UNPERMITTED INCIDENTS/CONDITIONS

Accidental situations occur during pipeline construction that sometimes result in unpermitted conditions. Self-reporting a mistake or incident is inherently difficult, especially when on-scene workers are facing daily productivity pressures. Most permits have specified timeframes to voluntarily report occurrences of non-compliance. However, failure to report such occurrences within the timeframes can incur additional penalties to the project, including the stoppage of work.

It is recommended that thorough training of on-site personnel be conducted so that all personnel recognize when an unpermitted situation occurs, thereby minimizing the reliance on individual discretion. It is also recommended that a clear and timely process for reporting occurrences is adopted.

10. MAINTAIN CLEAN AND ORDERLY PROJECT ACCESS POINTS

Pipeline installation requires that work be conducted in remote areas. Access to the construction sites is often over temporary gravel roads originating from a nearby public road. Construction permits require that project access entries along public roadways remain clear of mud and debris that can be tracked along with construction vehicles.

Such access points may be the only point of interaction with the local community. Failure to maintain good housekeeping and public sensitivity in these areas can result in public nuisance complaints. Continued problems of this kind could risk the revocation of local construction permits.

It is recommended that sufficient cleanup personnel are dedicated to maintaining public roadways.

11. ADOPT A REALISTIC AND USEABLE PREPAREDNESS, PREVENTION AND CONTINGENCY (PPC) PLAN

In addition to IRs, unpermitted discharges to public waterways can occur due to fuel spills, hydraulic line failures, etc. In most

cases, a Preparedness, Prevention and Contingency (PPC) Plan will be required for pipeline construction sites. The PPC Plan will include best practices to avoid such spills; methods to document the cleanup measures taken; and how to prevent further violations of permitted conditions.

Having mitigation supplies on hand at the time of a release is an important and sometimes overlooked factor in response efforts. Lack of adequate procedures and/or cleanup equipment can allow spills to migrate to nearby waterways, resulting in permit violations, fines and work delays.

It is recommended that a PPC Plan be developed using practical and applicable techniques. All countermeasure equipment should also be readily available so that any job-site spills can be contained and cleaned up with minimal migration away from the loss area. The on-hand presence of cleanup and countermeasure supplies should be verified before construction activities begin.

12. BE CAREFUL IN THE SELECTION OF DRILLING FLUID ADDITIVES

Additives to drilling fluid can help overcome challenges during pipeline installation. Depending on the circumstance, it may be advantageous to adjust the pH, add bactericides, corrosion inhibitors, or other agents to the drilling fluids. The Pennsylvania Department of Environmental Protection maintains a specific list of approved drilling fluid additives.

In most cases, on-scene modification to a drilling fluid may make tactical sense but it does require approval. Further, use of an unapproved additive may be a permit violation and could result in fines.

It is recommended that all construction personnel be trained on the use of approved additives and that any reformulation of drilling fluids on the job site require supervisory level approval. Routine audits of drilling materials are also suggested.

The above summary represents our viewpoint, and what we have witnessed as the most common environmental-related reasons causing construction delays, job-site shutdowns, public relations challenges and fines. This paper is not a comprehensive list of all the possible issues that could be encountered during linear construction of pipelines.

ABOUT THE AUTHOR:

Tony Finding *is a Vice President of Brownfield Science & Technology, Inc. (BSTI) with 23 years of environmental consulting experience. BSTI provides a broad range of applied environmental sciences associated with environmental site assessments, permitting, regulatory compliance, predictive modeling, remediation, and litigation support. For more information visit www.bstiweb.com.*

Leading Low-Dig Technology Solutions

GTI, with funding support from Operations Technology Development (OTD), is working to develop and assist with the implementation of various low-dig solutions including keyhole and trenchless 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.

Live Gas Pipe 3D-Mapping

GTI is working on development and commercialization of a probe to map existing buried utilities and help mitigate third-party pipeline damage. This probe can be inserted inside of a live gas pipeline to map underground pipes 3-dimensionally and provide accurate utility locations to avoid excavation damage. Researchers are addressing the need to extract data, provide software to accurately determine the correct x, y, and z positioning of the pipeline, generate integrated geo-reference video to locate fittings and joints to provide accurate positioning data within the pipeline, and directly download that information to a conventional GIS platform.

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. Focused on preventing damage from directional drilling activity, the system is being enhanced through ongoing technology development efforts and operator field tests. These efforts will help bring this "look ahead" technology to the U.S. market.

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. These systems are now commercially available and being implemented by utility operators.

GTI's Keyhole Consortium is expanding the adoption of keyhole technologies for utility system installations, repairs, and renovations to minimize environmental impacts and reduce costs. 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

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gti

Long Distance Inspection with Robotic Technology

Field Experience on Use of In-line Charging Technology

By: Scott Chamourian, Pipetel Technologies, Inc.

Manitoba Hydro is a natural gas and electricity supplier based out of Winnipeg, Manitoba, Canada with 580,000 electrical and 284,000 natural gas customers. Over the summer of 2019, Manitoba Hydro worked with Pipetel Technologies to plan and execute the robotic inspection of the Brandon lateral; approximately 5 miles (8.25 km) of 10-inch, otherwise "unpiggable" pipeline north of Brandon, Manitoba.

Across the globe, there are pipelines that prove difficult to inspect using traditional methods. Whether the infrastructure has challenging features, impassable components, or little to no flow; launching and receiving inline inspection pigs may be impractical or impossible.

Since 2011, Pipetel Technologies has been working to mitigate the challenges of traditional pigging by utilizing their fleet of tetherless robotic crawlers known as Explorer iLi. Ranging from 6 to 36 inches in diameter, Pipetel's Explorer iLi robots are able to perform Magnetic Flux Leakage (MFL) sensing, Laser Deformation Sensing (LDS), and video inspection on pipelines that are in or out of service. Additionally, Explorer iLi robots can be recharged inside the pipe using proprietary in-line charging (ILC) technology, allowing the inspection of long distances. The ILC system operates as illustrated in Figure 1.

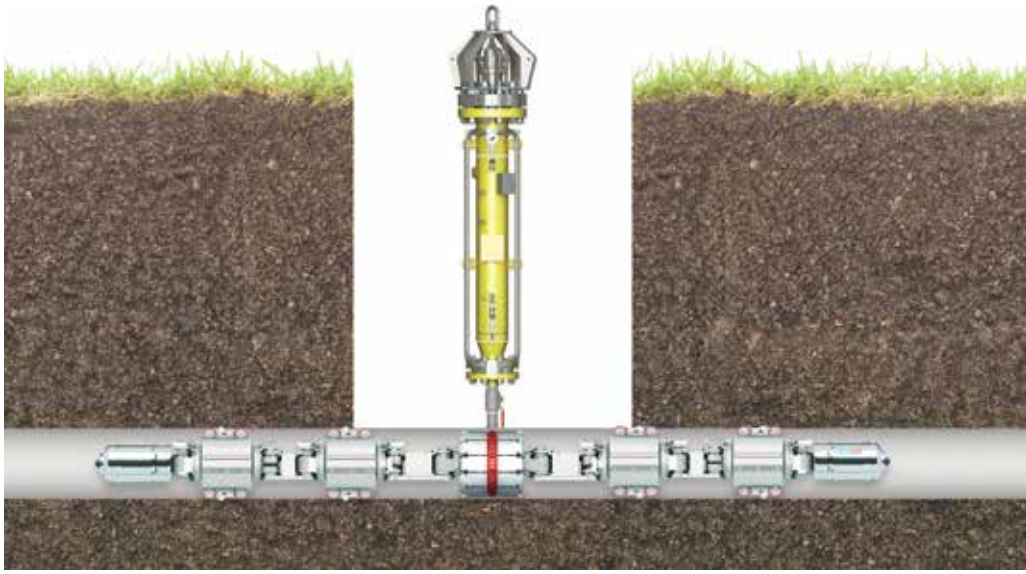

Figure 1: Explorer iLi with In-line Charger

THE PIPELINE INSPECTION CHALLENGE FOR MANITOBA HYDRO

The Brandon lateral stretches between the city of Brandon and the hamlet of Forrest; 5 miles of pipe that had never previously been inspected. The limits of the segment to be inspected were defined by a plug valve and a valve station; both unsuitable for launching and receiving traditional pigging equipment. Additionally, as the pipeline had been built in the 1950s, pipeline geometry, fittings, wall thickness, and cleanliness were all unknown factors. Furthermore, there was a possibility of different pipeline diameters within the segment and a feasible location to add a permanent pig launcher was not available. These were all reasons to look for an alternative inspection method.

The inspection of the Brandon lateral posed numerous challenges for inspection such as the unknown geometry of the pipeline, the number of fittings and excavations required, the trajectory of the pipeline through farmland, as well as potential weather delays. Given the uncertainties of the pipeline composition, the decision was made to inspect the pipeline out of service. In order to complete the project successfully, inspection solutions that can overcome these uncertainties and challenges were required.

Pipetel's Explorer iLi robots are tetherless and battery operated, which means they have a finite distance they are able to inspect before they must be recharged. In lieu of numerous size-on-size hot tap fittings, recharging stations were added to the pipeline thereby reducing the number of times the Explorer iLi robot would be removed from the line. Working together, Manitoba Hydro and Pipetel determined 13 sites were required along the pipeline length. Manitoba Hydro worked with the land owners and their farmland to determine the optimal locations.

Special consideration was given to how far equipment would need to travel over farmland, as rain and mud could make excavations inaccessible.

ROBOTIC PIPELINE INSPECTION

Given the 10-inch pipe to be inspected, the Explorer iLi 10/14 was used for the inspection of the pipeline. Explorer iLi 10/14, shown in Figure 2, is capable of inspecting 10- to 14-inch pipe both in and out of service.

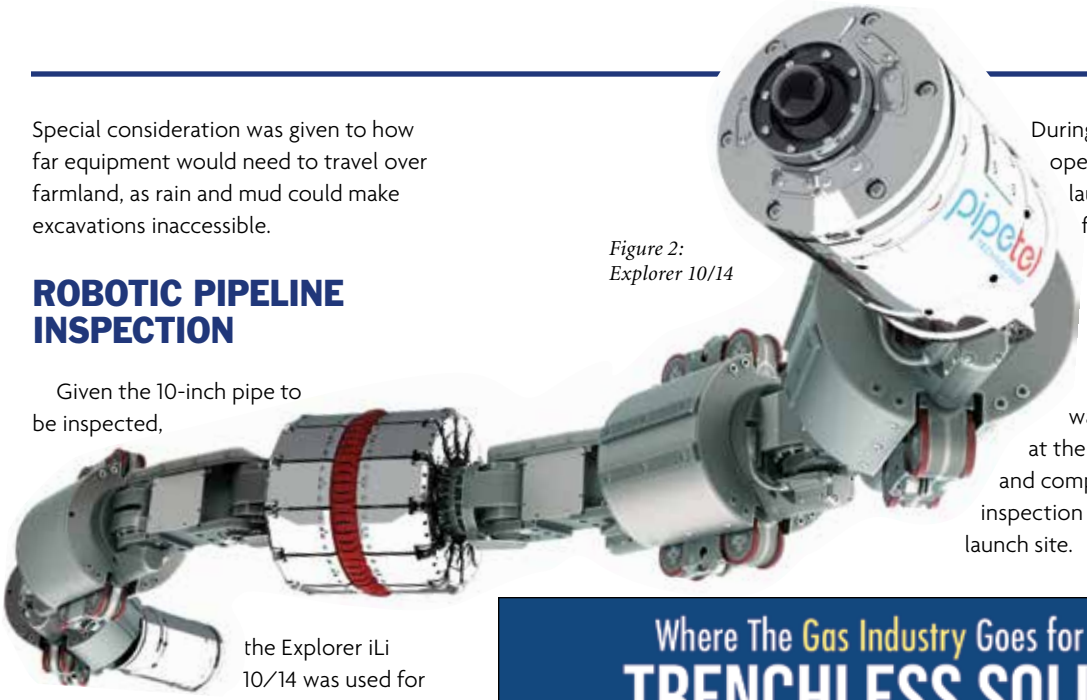

Figure 2: Explorer 10/14

Unlike a traditional pig, Explorer iLi robots are driven remotely by a Pipetel operator. The operator is able to control where the robot travels and how quickly it moves. Should the operator come across any previously unknown feature, it can be documented in real time and the decision to continue or turn back can be made. A view from the inside of one of the hot tap fittings is illustrated in Figure 3.

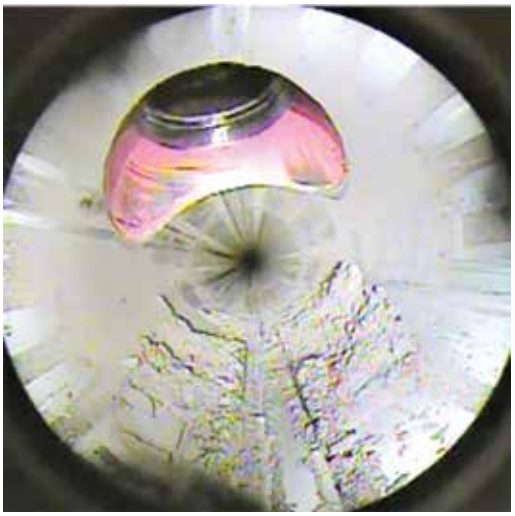

Figure 3: 10 Inch Hot Tap Fitting

Explorer iLi does not require permanent launchers and receivers to be installed on the pipeline. Instead, the robots are able to launch through size-on-size hot tap fittings. Manitoba Hydro set up four of these launch and receive sites along the 5 miles.

During an Explorer iLi inspection, operators have the ability to either launch and receive from a single fitting, or launch at one site and receive at another. Given the fittings on the pipeline, both methods would be utilized on the project. As outlined in Figure 4, Explorer iLi 10/14 was launched and received at the same location one time, and completed the remainder of the inspection by travelling from launch site to launch site.

Figure 4: Schematic of Brandon Lateral

Figure 5: In-line Charge Site on 10 inch Pipeline

Figure 6: Pipetel's Launch System for Explorer 10/14

As Explorer iLi robots are battery powered, their inspection range is limited by battery capacity. In an effort to extend the range of the Explorer iLi fleet, Pipetel implements a proprietary in-line charging (ILC) system. In effect, by adding "refueling" stations along the pipeline, the number of more costly entry and exit fittings can be reduced. Each charging location is much smaller than a launch site and proves less impactful on the pipeline surroundings. In total, nine charging sites were utilized during the inspection. An example of an In-line Charge site is shown in Figure 5.

By utilizing in-line charging technology, pipeline operators are able to execute longer robotic inspections than would otherwise be possible. Manitoba Hydro was able to leverage Pipetel's ILC such that the launch system, outlined in Figure 6, would only be utilized four times. Reducing the quantity of launch sites reduced capital expenditure and the time required for inspection. Since the Explorer iLi robot did not need to come out of line as frequently, the inspection was completed in nine days.

PIPETEL'S PERFORMANCE AND DATA

Whenever launching into a pipeline that has not been inspected before, the conditions of the pipeline are unknown. Be it pipe cleanliness, geometry, or inspection equipment malfunction; collecting high quality data can be challenging in these situations. For Explorer iLi, many of these challenges are mitigated by being able to control the robot in real time. While executing an inspection, real time video, MFL data, and deformation data are transmitted to the operator so that they are able to make informed decisions about tool passage and data quality.

Once the inspections began, the line was found to be quite clean, with minimal debris inhibiting Explorer iLi's travel. Through the 5 miles of inspection, Explorer iLi averaged over 99 percent for MFL and LDS data coverage respectively. Over the 5 miles, previously unknown taps and bottom out fittings were discovered.

SUMMARY

When inspecting the Brandon lateral, many of Manitoba Hydro's challenges and costs came from adding the multiple fittings required by the Explorer iLi robot and charging equipment. As Pipetel looks to the future, in order to reduce the required number of fittings on the pipeline, the range of Explorer iLi must be extended. Multiple initiatives are underway to both reduce the energy demands of Explorer iLi as well as optimize charging to prove less impactful on the inspection's surroundings.

Manitoba Hydro was successful in inspecting the 5-mile Brandon lateral using Pipetel's Explorer iLi and Pipetel was able to collect high quality MFL, Laser Deformation, and video data with over 99 percent coverage. By utilizing Pipetel's launcher and in-line charging, the long length of unpiggable gas line was inspected in only nine days.

ABOUT THE AUTHOR:

pipetel TECHNOLOGIES

Scott Chamourian *is a project manager and has worked with Pipetel Technologies since 2013. He has worked as part of the operations team as well as in his current role planning and executing inspections. Scott received his Bachelors of Engineering from Ryerson University.*

Vacuum Excavation Moves beyond the Gas Industry

Popular Uses of this Versatile and Valuable Technology

By: John Walko, Excavac

Second in a series of articles of Vacuum Excavation Technology.

In our previous article, we discussed the development of the under-appreciated, but critically acclaimed, vacuum excavation industry. The value of this technology has grown significantly in the past decade, and is being recognized as one of the safest ways to address multiple problems with buried utility plant of all types. This report will touch on some of the more popular uses of this valuable excavating technology.

Federal mandates in the 1970s, requiring all buried metal pipe to be negatively charged, set the stage for the nascent technology to get a foothold in the excavating market. But it wasn't until these mandates were enforced in the 1980s with larger and larger fines to the offending utility that the door really opened for major vacuum growth. While transmission lines and large distribution mains were protected with imbedded rectifier fields tied to local power grids, the smaller mains and laterals were often unprotected, and subject to major corrosive forces. Attachment of sacrificial anodes to these lines became a convenient way to get the out-of-spec lines back in compliance. The small size of the anodes enabled a much smaller hard-cap penetration, which was ideal for the new vacuum technology. It soon became obvious the savings in restoration costs alone would pay for the complete vacuum procedure. In addition to the cost savings, a big bonus was realized in the fact that a vacuum procedure could be performed 2, 3, or even 4 times faster than the typical mechanical excavation. This win-win was quickly embraced by the gas distribution industry, and interest quickly spread across the country. Even with the switch to yellow PE plastic pipe, the amount of iron/steel pipe remaining in the ground will assure a solid market for vacuum excavating technology for some time.

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

The 1990s saw the vacuum industry become firmly established thanks to the acceptance and encouragement of the gas industry. With early vacuum machines being built in-house by the few contractors using them for actually digging holes, their designs were very similar. They had a vertical collector tank with some filtration, and a bottom drop door or slide valve to empty the collected soil. Compressed air was used early on to break up (reduce) the soil, but a major jump was moving to the horizontal dump tanks that we see today. They not only held a bigger volume of soils, but the dump rate could be controlled, helping in the backfill part. Practicality dictated these designs, with this early equipment today being referred to as "air" or "dry-vac" machines. The hard-cap penetration holes were kept as small as practical, typically an 18x18-inch square, with the excavation often expanded to a bell shaped, or keyhole shape underneath. Using an air-lance to reduce the soil, the vacuum hose could now easily pick it up, with the soil rendered to a very workable

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

> *"In our previous article, we discussed the development of the under-appreciated, but critically acclaimed, vacuum excavation industry."*

consistency for backfilling the newly created hole. With suitable tamping during the backfill, all the soil would go right back into the hole, leaving a compacted base and an empty dump tank on the vacuum system. Like I said, practical, and efficient.

As vacuum technology came to be used more and more, occasions arose wherein the soil conditions were resistant to reduction by an air-lance. Hard clay in Ohio, caliche in the American Southwest, corals in south Florida, all present problems for compressed air reduction. Mechanical reduction by jackhammers of various weights proved effective, but deemed too aggressive to be considered a safe technology, like the air-lance. It soon became apparent that a middle-ground, still relatively safe and very effective, existed with the application of high pressure water to effect the reduction. I encouraged such use in caliche prone areas as far back as the mid-1990s. I also cautioned that water pressures should be kept in the 1500 psi range to maintain a safer procedure. The entrance of the large hydro-vac systems into the excavation market blew that all to hell. The horse power race was on, bigger trucks, higher pressures, larger water supplies, all sacrificing efficiency and safety. But they are fast and impressive, and expensive.

Precise location of conflicting buried lines is critical

And they are also approaching the gray area where new computer controlled mechanical excavators are just as safe, cleaner to operate, and more efficient. I expect the market will eventually determine the better technology going forward.

The 1990s also saw the advent of horizontal directional drilling (HDD), which created another major opportunity for vacuum technology. Directional drills are most often used for installing lines in close proximity to other buried lines. Technological advances have enabled control of the drill head to become increasingly accurate. This in turn makes the precise location of conflicting buried lines even more critical. Vacuum potholing, i.e. "daylighting", continues to be the definitive method to prevent conflicts between the horizontal drill head and an existing pipe or buried cable. While other electronic sensing systems, and ground penetrating radar technologies continue to improve, no one disputes the validity of actually watching a drill head safely cross another buried line. As such, many HDD crews will have a dedicated vacuum system as part of their program. These can be as small as a 30-hp trailer mounted rig using pressurized water reduction, to a somewhat larger truck mounted dry-vac, and even up to the very large hydro-vacs to assist in safely installing pipes and conduit via HDD. The bonus in using the right vacuum system comes in the ability to remove drilling mud from the transition pits, which is prior to refilling the hole with suitable backfill. As technology continues to improve in the HDD industry, vacuum systems will remain a vital part of their success for those reasons.

The 2000s have become the day of GPS/GIS, and the thirst for data to accurately locate buried utilities is becoming more and more critical. Old buried lines, moved lines, changing geography all have an impact on degrees of accuracy. It has been shown that most secondary locating technologies are very good most of the time, but in this day of critical accuracy, even the best of them can be suspect in certain conditions. The better technicians will use multiple technologies to zero in on a difficult locate, but at the end of the day, the "pothole locate" remains the gold standard. Being the most basic of vacuum procedures, the machines used for generating a "pothole" can run the gamut of available machines. As such, deciding factors are often predicated on whether the machine will have other uses beyond the locate interest. Therefore, even large hydro machines can be pressed into service for these basic procedures. However, as this market becomes more and more critical, specialized machines will make more sense. Suitably equipped trucks will make provisions to carry a full complement of GPS oriented instruments along with the computer interfacing necessary to collect, store, and transmit the freshly gathered data. The associated vacuum system turns out to be the rude, crude "go to" technology when questions arise as to what is really in the ground and where. This market appears to be the fastest growing segment in vacuum excavating, and it will remain so as long as the demand for data keeps increasing.

While the vacuum segment remains the red-haired step-child of the excavating industry, its versatility and range of uses is becoming more and more appreciated by conventional excavating contractors. Many of these contractors are realizing that a vacuum machine not only complements their backhoes and track-hoes, but can actually make them more efficient. This is especially true if used for spotting lines in front of ditch digging machines, among others. Vacuum systems can also be used very effectively for water or mud site clean-up, machine clean-up, for soil or gravel transfer, or general housekeeping where a 30-80 hp vacuum cleaner comes in handy. This can be especially true if one needs to clean out the dirt or gravel that often finds its way into a newly laid pipeline. Applications will continue to develop for this versatile technology, and it should remain a bright spot on the equipment horizon for some time. Stay tuned.

Vacuum potholing, or "daylighting", continues to be the definitive method

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 Association) 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.*

FORMING A "CENTER FOR EXCELLENCE IN TRENCHLESS TECHNOLOGY AND UNDERGROUND ENGINEERING"

The University of Massachusetts Lowell is forming a **Center for Excellence in Trenchless Technology and Underground Engineering (CETTUE)** in collaboration with Purdue and Rutgers. The planned NSF-supported Industry-University Cooperative Research Center (IUCRC) would build long-term collaborative partnerships among industry, academia, and government to address industry-relevant, pre-competitive research needs.

The IUCRC provides significant value to the stakeholders including (1) identify and address real-world challenges through multidisciplinary research, (2) innovate and enhance trenchless methods and underground engineering practices, (3) access to intellectual property and pre-publication research, (4) serve as training partner for practice firms and public agencies, (5) develop a skilled workforce and prepare work-ready engineers, (6) investment leveraging, and networking. Potential interests of the Center include trenchless installations, material science, rehabilitation and repair methods, subsurface investigations, inspections, underground engineering practices, and securing critical underground infrastructure.

The proposed Center is actively seeking partners from industry and government agencies. If interested in learning more about this initiative, please contact Prof. Pradeep Kurup (Pradeep_Kurup@uml.edu) or Prof. Raj Gondle (RajKumar_Gondle@uml.edu) at UMass Lowell, or Prof. Dulcy Abraham (dulcy@purdue.edu) at Purdue University, or Prof. Nenad Gucunski (gucunski@soe.rutgers.edu) at Rutgers University.

Reconditioning Cast Iron Gas Distribution Mains Using Robotic Technology

By: Stephen Sweeney and Rick Trieste, Con Edison

Consolidated Edison Company of New York (Con Edison) operates the gas distribution system in City (NYC) boroughs of Manhattan, the Bronx, and parts of Queens and Westchester County to serve over 1.1 million gas customers. The company began to provide gas service through its oldest predecessor company, the New York Gas Light Company, which laid its first cast iron (CI) pipe under the streets of New York in March 1823. Today, Con Edison maintains and operates approximately 137 miles of large diameter (›16-inch) CI mains that are integral to its distribution system in their function as supply mains. These supply mains are legacy infrastructure originally installed in to serve manufactured gas pre-conversion of the distribution system to natural gas, which occurred in the 1950s. CI gas distribution mains are constructed with bell and spigot joints (joints) that utilize a yarn like fabric called jute to fill the void in the bell and then cap the joint with cement or lead. The high moisture content of the manufactured gas originally transported by these mains kept the jute expanded in the joint preventing leaks. Conversion to dry natural gas resulted in the jute drying and making these joints subject to leakage. The typical repair to these CI mains is to seal the bell and spigot joints. The pipe walls are generally not subject to graphitic corrosion, the typical corrosion that could impact CI pipes. Large diameter CI mains have wall thicknesses in excess of half an inch with minimal corrosion, so the original integrity of the typical 100+ year old pipe segments is minimally changed.

Most of these CI mains lie in heavily congested subsurface areas with almost two-thirds located on the island of Manhattan. The last six years have seen limited replacement activity with just over 1 mile of these mains replaced in Manhattan. The quantity of large diameter supply mains replaced each year is limited by the many intrinsic challenges (e.g. the size of the required excavation and accompanying disruption to traffic, the availability of space for the new large diameter mains, the temperature restrictions associated with the invasive work to remove from service those that are critical to maintaining service, etc.).

Example of leaking CI joint with leak detection solution applied

The repair of leaking joints in older distribution systems is a significant operating expense since these larger CI mains are generally deeper than the typical distribution mains, with excavations in excess of five feet required to install a traditional encapsulating seal around the joint. The sealing of joints by gas

Example of ground congestion at the corner of Wall Street and William Street, Manhattan 1917

distribution companies has been an area of technological advancements that evolved from mechanical joint clamps to shrink sleeves and then encapsulants. Technology further advanced to the early stage of a partially trenchless method that externally injected anaerobic sealant, a sealant that solidifies in the absence of air, through injection ports drilled in the bell to saturate the jute packing. This external injection did not require full exposure of the joint since the injection relied on the sealant wicking through the jute around the entire joint from the injection ports drilled in the upper portion of the bell.

Trenchless technologies are evaluated and utilized to recondition supply mains to mitigate many of these challenges. Cured in place liners are one example, and this process requires the main be taken out of service for about a twenty-four hour period for the curing of the epoxy. The Cast Iron Sealing Robot (CISBOT) developed and operated by ULC Robotics is another technology, and was selected to recondition these mains in Manhattan over the past three years due to its efficacy and its ability to be used on a live gas system with a minimal worksite footprint. Pipe

Crew preparing main for CISBOT

> *Repair of leaking joints in older distribution systems is a significant operating expense since these larger CI mains are generally deeper*

segments are typically 12 feet in length, and the joints of these segments are targeted by CISBOT for repair. The CISBOT drills access ports to inject anaerobic sealant into the jute from inside an in-service gas main with no impact on service. Sealing the joint effectively reconditions the pipe to its original performance. The use of CISBOT has led to a nearly 300 percent increase in the quantity of large diameter CI mains that have been reconditioned since 2017.

The application of the CISBOT technology requires installation of a top seal fitting that will remain installed for the life of the main and a slide valve that is installed for the duration of the CISBOT project. The main is then drilled to create a 12-inch opening, the size required for the robot to enter the pipe. Insertion of the tethered robot into the pipe is performed with no release of gas through a specially designed launch tube. The technology application process is compact, and the entire excavation site can be contained in a five foot wide by five foot long pit. Prior to insertion of the CISBOT, the main is inspected using a variable geometry crawler (VGC), and this inspection is performed prior to joint sealing to identify potential obstructions and to locate joints to create a sealing plan. The robot is tethered to provide for operation and control of all functionality by the operator that is stationed in a control vehicle.

The robot seals the joints by drilling an appropriate number of access ports, typically four to six, at pre-determined positions in each joint dependent on pipe diameter with the prescribed quantity of sealant injected in also in accordance with the joint diameter. The sealant forms a solid and flexible seal that ensures the integrity of the most leak-susceptible point in the main, the joint. CISBOT has a range of over 700 feet in either direction of the access point, as long as there are no impassable obstacles such as pipe offsets or drip pots.

The original robot to live seal CI joints from within the pipe was designed and developed in the 1990s for smaller diameter pipe (6- to 12-inch) by Enbridge Gas Distribution, Inc., Canada (Enbridge Gas). This earlier technology was further enhanced in part through field applications at Con Edison and National Grid NY, which both have license to use and improve the original intellectual property from Enbridge Gas. The use of the original joint sealing robot was gradually discontinued, as replacing small diameter mains supplanted reconditioning. Following the success of the small diameter joint sealing robot, Con Edison and National Grid contracted with ULC Robotics to develop a large diameter CISBOT. The first live test of the new robot took place in November of 2009 on Con Edison's 24-inch diameter main in the Bronx. The test included the removal of 16-inch and 20-inch diameter joints that CISBOT sealed for longevity testing at Cornell University [1]. The Cornell University testing included modeling traffic loading (flexure) to simulate a 50-year service period, and no samples developed leaks in this testing. The longevity and field testing confirmed the large diameter CISBOT is a tool acceptable to recondition CI mains. Leaks have been detected in less than 0.3 percent of joints sealed using

Cornell University flexure testing

CISBOT in Con Edison's system, and the isolated occurrence of leaks has been tied to a joint in which there were abnormal joint conditions, indicating the joint was not suitable for anaerobic sealing.

Locations suitable for CISBOT reconditioning are dependent on a variety of factors, from intrinsic system configurations such as the presence of impassable drip pots and offsets, to community concerns such as other planned Con Edison work and the NYC Department of Transportation (DOT) paving schedules. CISBOT can also serve a maintenance function for short segments where there is limited access to the site, and it was used at two such locations to repair leaks: a heavily trafficked intersection and a bus stop. The application of traditional leak repair methods at these leak locations, such as by keyhole encapsulation, would have only repaired the leaking joint while using CISBOT facilitated the reinforcement of the surrounding joints as well. The primary challenge with the application of CISBOT on leak repairs is the lag time between site identification and starting joint sealing due to site prep requirements. If main tapping is scheduled for capital improvements, the necessary time to schedule a CISBOT reconditioning or leak repair is greatly diminished.

CISBOT in 24-inch Main

> *"Trenchless technologies are evaluated and utilized to recondition supply mains to mitigate these challenges."*

CISBOT setup in East Harlem

A major lesson learned in applying CISBOT was the need for a longer span of work hours to maximize benefit. Limited work hours on some of the early applications reduced the production rate substantially, as the setup and breakdown times are consistent. To remedy this, Con Edison partnered with the NYC DOT to educate them on the low impact of CISBOT on traffic due to its small worksite footprint and limited noise from its application. Given the low impact and paucity of noise during operations, the DOT has often been amenable to extending the hours for chosen sites after the work on the site shifts from excavation activities and pipe preparation to joint sealing activities. Close coordination with the NYC DOT has also been used to recondition mains ahead of planned NYC paving. Reconditioning prior to paving is mutually beneficial, as it significantly reduces the risk of leaks and therefore reduces the potential for excavating a newly paved street to repair a leak, a situation that is also not palatable to the public!

Con Edison chose CISBOT to recondition a 20-inch diameter CI main at a site where NYC performed a very large multi-year municipal project replacing water and sewer mains, and the private utility infrastructure contained in a large excavation. The project's schedule only provided a small window to work on the gas main before the area would be inaccessible for more than three years. The reconditioning of this main was of paramount importance since any future leak on the main would have significant impact on the project and would pose potential liability to Con Edison for delaying the municipal work to repair a leaking joint. The site offered extended work hours with the entire street closed for twenty-four hours a day, which allowed the launch tube to remain in place. CISBOT was deployed in twelve-hour shifts per day that resulted in an increase of production by nearly 50 percent compared to a twelve-hour shift of a work site where the launch tube was setup and removed each day. Exploitation of this opportunity allowed the reconditioning of two city-blocks of CI main within the municipal work site in less than a week with no impact to the other scheduled work in the mass excavation.

The selection of CI reconditioning candidate mains after this municipal project were geographically based to complement other Con Edison capital work which included both natural gas and electric infrastructure. CISBOT was added to the scope of a project that combined electrical feeder and smaller diameter gas main replacement at a site also having a 20-inch diameter CI main that was to remain in-service. This project reconditioned approximately 3,400 feet of 20-inch diameter main and was done through four launch sites over a timeframe of 19 weeks, and sealed 286 joints.

The success of this reconditioning led to additional locations where small diameter gas main replacements coincided with 16- to 30-inch diameter CI mains that could be reconditioned. Following the successful completion of reconditioning in these areas, the focus shifted to apply reconditioning to a large gas improvement initiative in the East Harlem section of NYC in 2019 that contained about 4,000 feet of large diameter steel and CI mains. The plan for this project was to recondition 3,100 feet of CI in several different sections with CISBOT while using conventional means to replace 900 feet of steel sections along with short segments of CI, those being less than 150 feet in length. The 150 feet replacement criteria was determined based on the existence of mapped offsets that joined the steel and CI segments together, the presence of valves and drip pots, and the estimated cost of preparing a CISBOT launch site.

Pairing large diameter main replacement and CISBOT in operating regions like East Harlem maximizes the benefits of both approaches; CISBOT can recondition a much more expansive area with a lower impact on the community surrounding the worksite, and replacing the main in the short segments that were not suitable for CISBOT ensures the whole supply main system in the area is rehabilitated. The cost of CISBOT for the 3,100 feet sealed in the area is approximately one sixth of the estimated cost of a direct main replacement on a per foot basis resulting in far greater system rehabilitation with no additional cost to the rate payers. Experience showed that applying CISBOT to rehabilitate an area offers a great advantage for utilization of specialty main tapping contractor services required to create the CISBOT launch sites. The first group of closely situated work sites were all excavated at the same time, and it was learned that it is more effective

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ABOUT CON EDISON:

Con Edison, the principal subsidiary of Consolidated Edison, Inc., operates and maintains over 4,300 miles of natural gas distribution infrastructure to serve over 1.1 million customers in the New York City boroughs of Manhattan, the Bronx, the First and Third Wards of Queens and Westchester County.

to proceed with no more than three excavation locations open at the same time; CISBOT reconditions one location while the specialty main tapping contractor installs the completion plugs at one work site and taps the main in preparation for CISBOT at the other work site.

The selection of CISBOT to reinforce Con Edison's supply main system was influenced by its applicability to the company's service territory, the efficacy of the technology, and the low impact to the customers being served and the surrounding community. The robot has proved its superior applicability compared with previously used methods through its use in projects ranging from previously planned utility work to mass excavations for municipal projects to DOT paving coordination. The leak rate of less than 0.3 percent in sealed joints and its employment in fixing two existing leak sites supports the efficacy of the technology. The minimal site footprint of the CISBOT projects is the best reflection of the benefits to the community. Con Edison utilization of the technology has been accident/damage free with a perfect safety record on CISBOT projects, and no damage to neighboring utilities or customer property. CISBOT has proven to be a valuable tool for use on the supply main system, and its use will continue to be an integral component of the quest to further improve the gas distribution system.

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Developing Your Inspector Workforce:

5 Key Strategies to Elevate Your Safety, Environmental and Quality Culture

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

Raising the level of performance among inspectors is critical throughout our industry. Improving your inspector performance, safety culture, environmental culture, and quality culture is likely a critical piece of your company's strategy because it's good for business.

It's further necessitated by aging pipelines resulting in large replacement projects and regulatory oversight increases that result in broader demands for documentable, verifiable field records and degrees of separation observation data. Further, as competition for talent increases, your commitment to safety, the environment and quality is important to retention, loyalty, and talent acquisition.

A SURVEY OF THE UTILITY INDUSTRY

In 2019, our firm conducted an industry survey among twenty-five utility companies with the help of the American Gas Association. The focus of our survey was on the inspection workforce in these companies. We sought to understand what the industry needed, how they were currently managing inspection workforce needs, and what improvements they needed to see.

What we found was:

- Capacity, capabilities, and training are the biggest needs in the industry as it relates to inspection workforce (Figure 1);
- Companies are averaging 20 per cent replacement (Figure 2), and an increased need of 25 per cent (Figure 3) over the next two years, resulting in a total need of 45 per cent of their staffing volume over the next two years; and,
- The most common retention strategies include year-round work, OT, and PTO (Figure 4).

Figure 1. Capacity and capabilities were the top-ranked challenges with managing inspector workforce

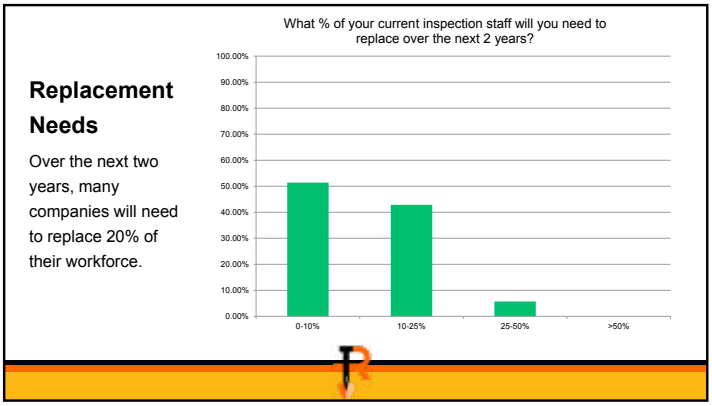

Figure 2. Utility companies need to replace an average of 20% of their inspection staff in two years

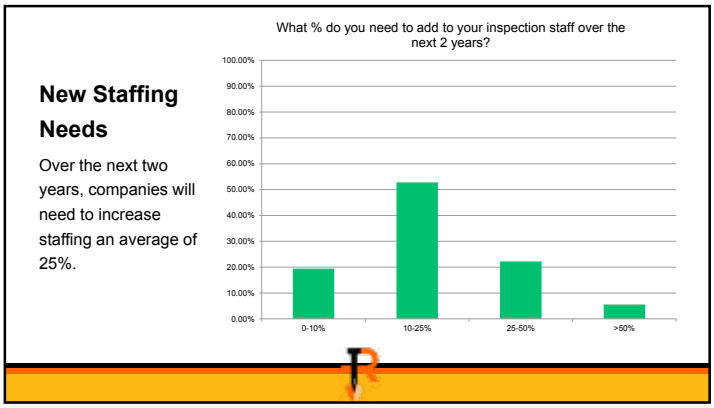

Figure 3. Utility companies will need to add new inspector staff equal to about 25% of their current workforce

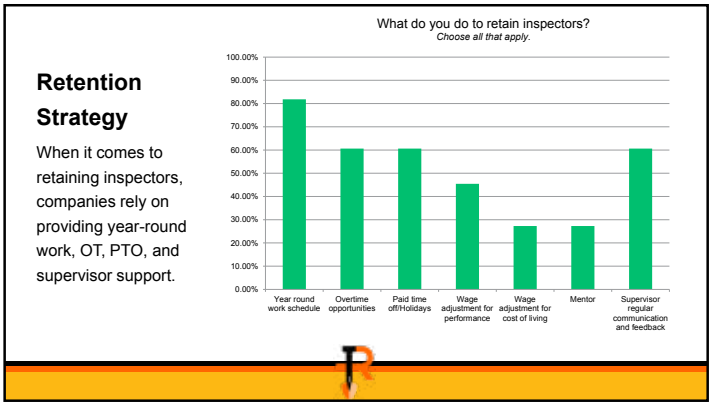

Figure 4. Most companies use year-round work, ot, pto, and supervisor relationships to encourage retention

THE COMMON MISCONCEPTION ABOUT PERFORMANCE

Typically, managers spend most of their time with" C" performers, trying to correct poor performance.

The chart (Figure 5) 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.

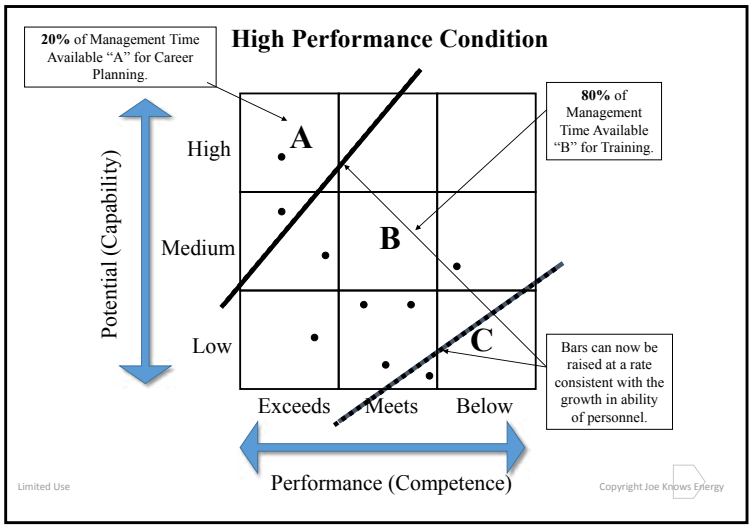

Figure 5. High Performance Condition

ELEVATE INSPECTOR PERFORMANCE: 5 STRATEGIES TO USE NOW

1. Benchmark Your Top Performers

What better way to raise performance than to study your high performers and replicate them?

Figure 6. When building high performance, priority is always people first

> *"The priority is always people first, followed by process and tools."*

The key to replicating your top performers is to understand how they think. How they think and process information ultimately drives their actions and the results produced.

Utilizing an assessment tool, along with an established benchmark of high performers and information collected during identification and selection allows us to replicate high performance.

This builds on the concept that, when building high performance, the priority is always **people first**, followed by process and tools.

The benchmark behaviors and information changes based on the role requirements. The inspector who is required to coach thinks differently from the one who focuses on record and report only.

2. Define Your Culture

Once you have defined what type of person is desired, then the next task is to define your culture, to ensure a good fit. We have discovered this is the primary driver of retention. There are many facets of a culture, here are several items to consider:

- What is it that makes your company unique?
- What roles do you require of this position?
- How are they supported?
- What are the work hours, what is the work season?
- What are the working conditions?
- What training and certifications are required?
- What is the compensation structure?
- What is the length of this opportunity?
- How do you measure success?

With information, selection criteria can be developed. We have found that the biggest driver is the type and amount of support that is provided.

Figure 7. What is it that makes your company unique?

3. Support with Team Leader

High performance teams understand that it is critical to performance and retention to understand how well the inspector fits in the culture. Does he or she feel like they belong?

The team leader's job is to define performance and provide the tools and support to achieve it. The pressures that are on an inspector are unique, often in an environment where no one is happy with them.

The team leader understands these pressures and understands the whole person. They are available to address the concerns and support the inspector. They provide feedback on performance and help with development.

Figure 8. The team leader understands the whole person

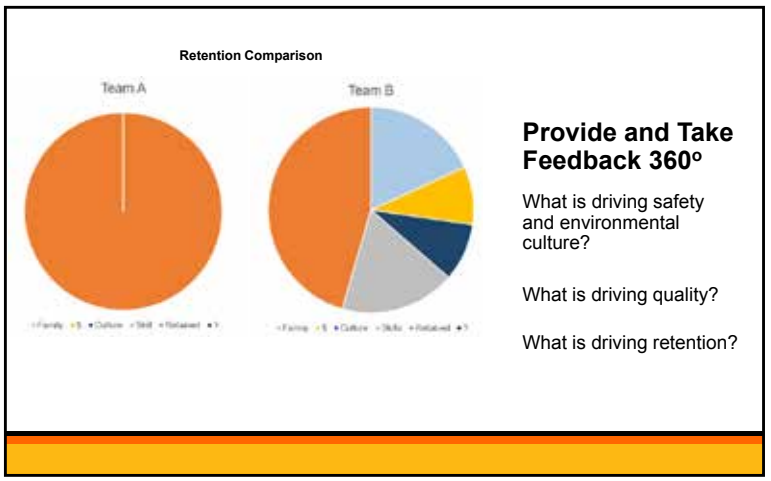

Figure 9. Retention Comparison

4. Provide Performance Feedback

Often, we find that inspectors do not receive feedback in regard to their performance. Why is this? In general, we believe it is because performance has not been defined and because there is limited supervisor presence. The contractor's opinion is often not deemed as credible due to the oversight nature of the relationship.

We have found that significant effort is required to develop clarity of expectations. Once it is developed, additional investment is required to actually provide timely and relevant feedback.

Several vendors have developed digital reports and dashboards that provide immediate feedback to inspectors and a summary management dashboard. We believe this feedback, coupled with and supportive team leader is key, because it provides support even when everyone gets busy, when the feedback in most valuable.

It is also critical that the information tracked aligns with the goals of the organization. Often only errors are tracked. The question becomes, over time, "are we making progress?" We need to be able to track the # of errors over a defined # of total observations.

5. Provide Feedback in Both Directions

Based on our experience, what our clients really want is to have their inspectors help elevate their safety, environmental and quality culture. To achieve this, a continuous improvement culture needs to exist, with feedback both ways, to the inspector and from the inspector.

There are 3 questions that we are trying to answer:

What can we do to elevate our safety and environmental culture?

What is being done well, what are our blind spots, where do we need to focus for improvement, what do we need to invest more in? Often times, the inspector, who is at the front line, can see reality when others don't.

What can we do to elevate our quality culture?

With these assets being designed to last 50+ years, ensuring that they are installed properly is critical. The same questions we asked for safety apply here. Taping into the inspector's knowledge is critical.

What can we do to drive retention of talented people?

We have found that by focusing on retention vs turnover, we look at the challenge differently. We seek to understand what is attractive to talented people, and then create that culture (Figure 9).

SUMMARY

The industry survey revealed that many are struggling to find the needed capacity, capabilities and training needed to deal with the 45% increase in inspector capacity over the next 2 years. They are seeking strategies to retain talent. We have discovered the following 5 solutions:

- Benchmark your Performers
- Define your Culture
- Support with Team Leaders
- Provide Performance Feedback
- Provide and Embrace Feedback both directions

ABOUT THE AUTHOR:

Dan Lorenz P.E. *has over 30 years leading construction, training and inspection services companies. At Joe Knows Energy he is the Founder and President. He is passionate about elevating safety and quality cultures with frontline professionals. JKE provides staffing, recruiting and consulting services to the utility and energy industries.*

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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Preventing Damage to Underground Infrastructure

By: Subsite Electronics

Constructing and repairing underground outside plant infrastructure are complex tasks that involve multiple factors. One of the most critical factors is how to safely avoid damaging existing buried pipes, conduits, and cables.

While the Common Ground Alliance (CGA) publishes a Best Practices Guide recognized as the most comprehensive guideline for preventing damage to underground facilities, and despite technological advancements made in preventing damage to buried infrastructure, accidental utility hits continue to happen on a daily basis.

These incidents can cause significant issues resulting in the disruption of essential services, property damage, costly delays in construction, and serious injuries—even death. Their aftermath often includes litigation with costly legal fees and, sometimes, judgments that can force a contractor out of business.

Identifying the presence of utilities on job sites during the planning stages is an important first step in preventing utility hits. Utilizing the One-Call locating service is the first step in locating and marking buried pipe and cable prior to excavation or boring. However, the crew that arrives on a utility construction site has no role in the One-Call notification and marking process. It is all arranged and executed by others. Therefore, the foreman or supervisor of a project must not blindly assume that paint and flags marking buried infrastructure are, in fact, accurate.

Supervisors and crew members must have what we call "underground awareness"—making themselves aware of what is underground and out of sight. Awareness of the underground means nothing can be taken for granted.

Locations of nearby utilities may be marked, but are the markings accurate? Are there utilities present that were not marked? Failure to consider these possibilities can have serious consequences. Inaccurate locates and markings continue to be a leading cause of accidental damage to utilities. There are times that the One-Call process fails, and marking is not done before a construction crew arrives.

Never begin excavating, trenching, boring, or drilling without knowing locations of existing utilities.

A careful visual inspection of the job site may reveal indications that other utilities are present. Gas meters, electrical boxes, and communications pedestals could mean there are buried lines.

Even when locations are confirmed, it often is necessary to pothole—physically digging a small hole to visibly confirm the exact location of a pipe or cable—when adjacent utilities parallel or cross the path of the new installation. Even if flag or paint markings are accurate, personnel must understand that all utility providers are not One-Call members and in many areas, water and sewer lines may not be marked.

Also, on-site personnel should be aware of tolerances required for depths of new installations and distances they should be away from existing facilities. Local codes and ordinances may be applicable. Depending on local requirements, new installations must be either 18 or 24 inches from a utility already in place. Locations of most utilities usually are measured from the outer edge, assuming the width is represented accurately by marks or the size of utility is provided and that single painted lines represent the center of the utility.

When a project is outside public right-of-way or the work location is on private property such as educational institutions, government complexes, or business parks, One-Call will not make locates and the responsibility falls on the property owner, primary contractor, and sometimes the utility contractor.

Regardless of who locates and marks buried facilities, many contractors have found it's worth the time and effort to confirm the locations with their own personnel and locating equipment.

When locating responsibilities fall on them, they must have the equipment to do the job or hire a locating specialist.

There are three basic locating options:

1. ELECTROMAGNETIC LOCATORS

Electromagnetic locators are the primary locating tool used by utilities, contract locators, and underground construction contractors. Electromagnetic locators are relatively easy to operate and when correctly used, are accurate. An electromagnetic system consists of a handheld receiver and small transmitter.

The operator walks above where utilities are expected to be, and the receiver locates underground pipe and cable by detecting magnetic fields created by electrical current passing through the lines. Information is displayed on a window at the top of the receiver.

For communications cable and metallic pipe, the small transmitter is connected to cable or pipe and sends current through the line to create a signal which is detected by the receiver. For plastic pipe with tracer wire, the wire is energized by the transmitter to provide a signal that the receiver can pick up.

Electromagnetic equipment has advanced significantly in the past several years. For example, the Subsite® UtiliGuard® 2 utilizes GPS positioning and has an Ambient Interference Measurement (AIM™) feature that scans the surrounding area for noise that could interfere with the locating signal and recommends the best frequencies to

Electromagnetic equipment has advanced significantly in the past several years

Contractors often use their own personnel to locate and mark buried facilities

make the fastest, most accurate locate. The system provides both horizontal location and depth of the line being located.

The primary shortcoming of electromagnetic locators is the necessity for the presence of current flow to make the locate.

2. GROUND PENETRATING RADAR (GPR) LOCATORS

Ground penetrating radar (GPR) utility locators avoid the need for electrical current to find buried utilities. The GPR locating component, mounted on a wheel platform, is pushed across the work area as electromagnetic impulses are generated downward into the earth. These signals bounce off buried objects, reflecting back to a receiving antenna, which the GPR unit converts to a graphic representation of the underground that is displayed on a screen mounted on the operator's handle. While GPR equipment can perform in situations that are beyond the capabilities of conventional electromagnetic locators, they also find rocks, chunks of concrete, other debris, and tree roots, making interpretation of the screen sometimes challenging.

The most significant limitation to GPR locators is they don't work in dense, highly compacted soils. Since their effectiveness is directly linked to soil conditions, that has limited their use for utility locating. However, recent models are addressing that issue.

3. POTHOLING

The best way to be absolutely certain of the location of a buried utility is to actually see it. Uncovering buried lines is nothing new, and for years it was done with a backhoe, compact locator, or by hand with shovels. However, mechanical methods run the risk of damaging the utilities they seek to protect.

Vacuum excavators have changed the "potholing" process. Using "soft" excavation technology employing either high-pressure water or air, a vacuum excavator can dig a one-foot square, five-foot deep pothole in about 20 minutes without the risk of damaging the pipe or cable being located. As easements become more crowded with buried utilities, many project owners, primary contractors, and regulatory agencies mandate potholing any time a new installation crosses or closely parallels an existing utility.

Most vacuum excavators on utility projects are compact trailer models, although truck-mounted models also are available.

In addition to potholing, dual-purpose vacuum excavators are all-purpose vacuums and have become the primary method for keeping directional drilling work sites clear of drilling fluids escaping the bore hole.

The first step in preventing accidental underground strikes is education. Following the guidelines put forth in the CGS's Best Practices Guide (available online at www.commongroundalliance.com) is key. This will not only reduce the risk of damaging utility infrastructure, it will reduce the risk of injury to construction personnel and the general public. Avoiding shortcuts and reliance on others is the next step in ensuring a safer job site. There is no substitute for gaining accurate underground awareness for yourself.

> *"Supervisors and crew members must have "underground awareness"*

For additional safety information such as the color codes for marked utilities, safety bulletins and brochure, visit www.subsite.com/safety.

ABOUT SUBSITE ELECTRONICS:

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***Subsite® Electronics** provides underground construction professionals a comprehensive suite of electronic products, including utility locators, Horizontal Directional Drilling (HDD) guidance equipment, utility inspection systems, and equipment machine controls. Subsite has established itself as a premier source of electronic technology supporting the installation, maintenance and inspection of underground pipe and cable.*

Henderson Municipal Gas Installs PA12 6-inch Pipe with HDD

First Project Completed under New USDOT/ PHMSA Mega Rule for Plastic Pipe

By: Doug Weishaar, Evonik Industries

A recent change to the national standards regulating the use of plastic pipe materials in natural gas distribution networks created a great opportunity for Henderson Municipal Gas (HMG), saving the utility both time and money on a major project to relocate over half a mile of 6-inch steel main along Ohio Drive in the Henderson industrial park. Completed in August 2019, this project was the first installation of Polyamide 12 (PA12) gas pipe under the updated standard, which provides a new pipe material option for natural gas operators.

Effective January 2019 the Pipeline and Hazardous Materials Safety Administration's (PHMSA) introduced a Mega Rule approving the use of plastic pipe in a wider range of high-pressure gas applications(update of 49 C.F.R. Part 192). The new Mega Rule was intended to enhance public safety and enable greater use of plastic pipe in natural gas distribution networks. It included updated standards governing the use of gas pipe made from polyamide 11 and 12 (PA11 & PA12) thermoplastic materials.

The new Mega Rule was perfect timing for Henderson Municipal Gas (HMG), which serves over 10,000 residential, commercial and industrial customers in Henderson KY and surrounding area. Operating a distribution system comprised of approximately 260 miles of mains and 130 miles of service lines, HMG had been working hard over the previous two years evaluating different factors in the design and detailed planning of a project to relocate a 2,800 foot 6-inch high-pressure epoxy coated steel main, and a dozen connected high-pressure gas services.

> *"The welding required to join steel pipe sections on this project would have required additional manpower, a longer time-frame, and frequent traffic interruptions."*

Relocation of the 6-inch main was prompted by a road widening project upgrading a three-quarter mile stretch of Ohio Drive in the Henderson industrial park area. For HMG, the two most important planning criteria for the relocation was the paramount necessity to avoid any disruption to the heavy employee traffic serving several industrial enterprises located along Ohio Drive, and the need for a pipe material rated for at least a maximum allowable operating pressure (MAOP) of 200 psig.

Hard smooth coated surface of PA 12 helps pullback

Due to its smaller surface footprint, horizontal directional drilling (HDD) is particularly advantageous in congested urban settings and in industrial areas like Ohio Drive. Therefore HDD was selected as the best approach to install the majority of the new 2,800 foot length of pipe, with two separate 700-foot HDD bores under driveways and parking lots, and a smaller bore of 172 feet crossing directly under Ohio Drive. Two shorter excavations accounted for the remaining length in the less heavily trafficked areas.

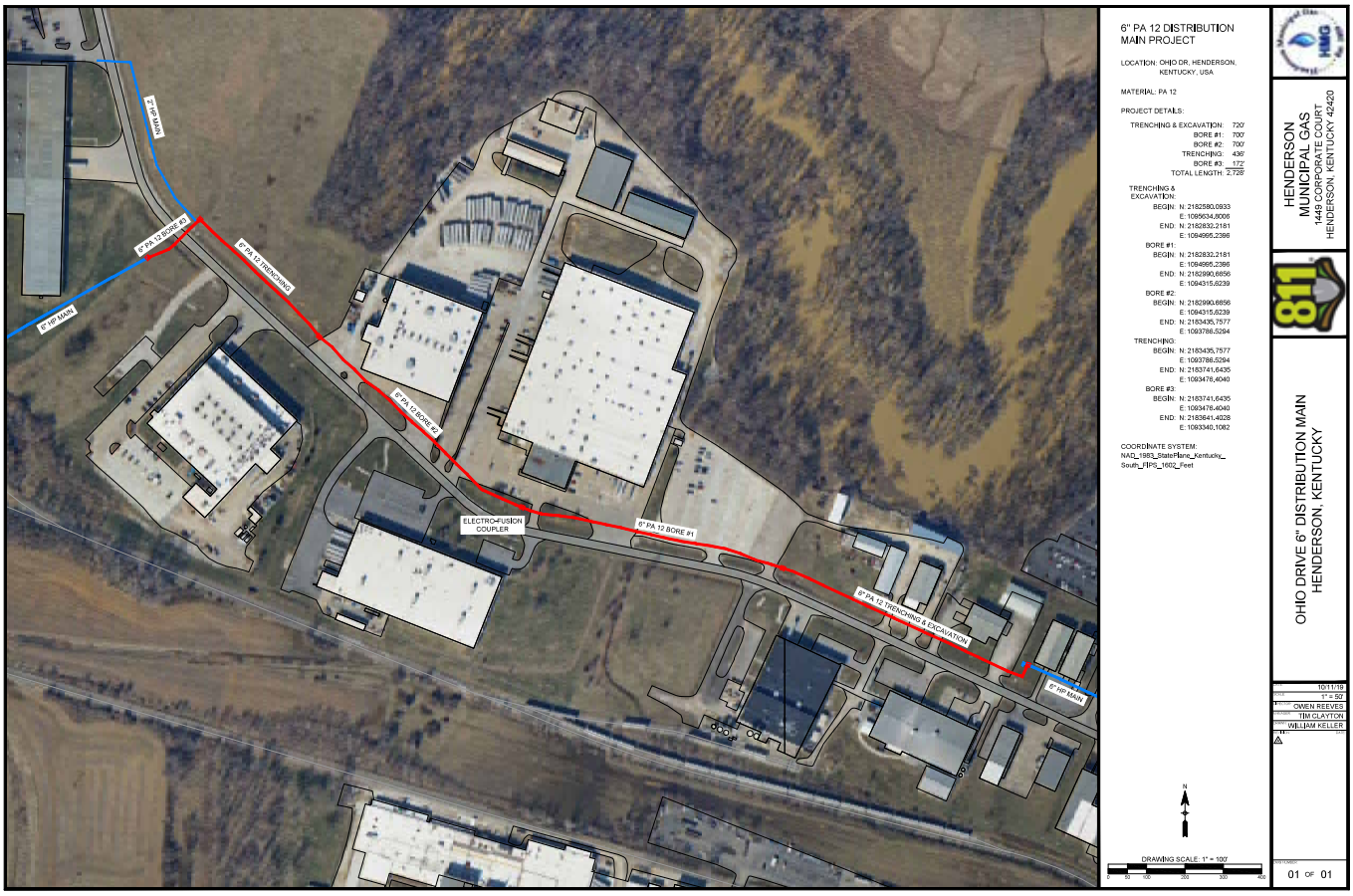
Long used as the primary trenchless option for installing new gas distribution pipelines, HDD has found increasing acceptance largely because of the reduced social and environmental impacts during construction. HDD is an environmentally friendly application when compared to open cut methods, with minimal surface damage and reduced carbon output. Directional drilling offers many social benefits in terms of construction times and costs, licensing procedures, soil displacement, surface restoration, and minimal disruptions to nearby traffic, residents and businesses. HDD is the best, and often the only viable method, for crossings under bodies of water and under other sensitive environments, such as wetlands and wildlife protected areas.

Steel and plastic pipe have long been installed using HDD, and both materials were evaluated for the Ohio Drive project. Included were the PA11 and PA12 options, newly available for use on the project because of recent approval under the new plastic pipe Mega Rule. Several years before Dennis Jarnecke of the Gas Technology Institute had shared technical information on PA11 and PA12 with HMG, and when the project was confirmed he referred HMG to Evonik Industries, who were the original developers of the PA12 material in the Vestamid NRG pipe product (see sidebar). PA11 was ruled out as an option because there is no manufacturer currently producing 6-inch PA11 pipe.

Although HMG had extensive prior construction experience with 6-inch steel pipe, and PA12 had never been used, PA12 was ultimately selected for the project primarily because of the clear advantages over steel in staging and joining the pipe segments onsite for this project. Similar to PE, yet with a high MAOP rating of

More ductile and lighter than steel pipe, PA 12 is easy to install

250 psig, PA12 can be delivered in straight pipe sections or installed from coils, supporting even longer HDD bores and much less joining work. Welding the steel pipe sections on this project would have been far more costly and time consuming, resulting in frequent disruptions to the employee traffic along Ohio Drive. Instead, the butt fusion and electrofusion methods for joining PA12 pipe, are much easier and



HDD bores minimized disruption to traffic along Ohio Drive

faster, in the end saving HMG significant time and labor costs.

As HMG gas system Director Owen Reeves, P.E. relates, "The process for fusing PA12 pipe is nearly identical to the process for fusing traditional PE pipe." HMG had a lot of previous experience installing 4-inch PE, and smaller diameters, however had not installed 6-inch plastic pipe. For the project, HMG purchased a new manual butt fusion unit from McElroy that could work with 6-inch plastic pipe, either traditional PE or the new PA12, and a new electro-fusion instrument by Nupi Americas. McElroy provided a one-day training session onsite at HMG to ensure all crews were properly trained on the new butt fusion machine. All of the fusions, welding, and tie-in work on the Ohio Drive job were completed by HMG crew. This "saved us a lot of money", Reeves said, "Our employees deserve recognition for their dedication in getting this project completed on time and well under budget."

Lack of corrosion concerns dramatically reduces ongoing maintenance

The heating process takes a little over 11 minutes for joints to fuse, yielding a single low-profile bead, unlike the two separate rolled beads with fused PE. It was necessary to use a brace for precise alignment on the electrofusion joints. Crews were able to complete a joint in an electro-fusion joint in little over an hour

Joining PA 12 pipe is easy and fast, saving time and money

before moving to the next joint, and this would have taken even less time except for the cool down requirement. This made the Ohio Drive gas main relocation, "A perfect job", observed Reeves, "No valves, and only one butt fusion to complete."

More ductile and much lighter than steel, PA12 made the HDD installation much easier. Utility construction contractor Electricom LLC, based in Paoli IN, was brought in to make the two longer bores of approximately 700 feet each, and the shorter 172-foot crossing under Ohio Drive. A surprising lesson learned during the HDD installation was how well the PA12 material withstands the pulling loads. It is actually less ductile in comparison with traditional PE, and has a much harder and smoother surface, which was helpful during pullback, showing the strength of the PA12 coating technology. "Pulling of the pipe was very easy, easier than a steel pipe," Reeves observed, "The uniqueness of the material was its hard smooth surface and it being less ductile than PE pipe. Our pipe supplier Teel Plastics was very helpful in designing the weak links we used for the pullback."

An added benefit of using PA12 pipe is the elimination of corrosion concerns, which dramatically reduces ongoing maintenance costs. Reeves notes with PA 12, "you don't have to worry about cathodic protection … you put this in the ground and you're done with it, and so it's great in that regard."

It remains to be seen whether more LDCs will turn to using PA12 gas pipe under the new PHMSA Mega Rule, however ease of installation, high psi rating, and resistance to corrosion, present many advantages that make it a simple and reliable technology worth considering, with enormous potential for savings.

HMG, Reeves concludes, "Couldn't have hoped for it to go any better. We learned a lot about PA12 pipe during this project. It has a small window of application, yet it's pretty tough to beat within that window. A great alternative, for sure."

For more information on the PHMSA Mega Rule announcement, please visit: https://www.phmsa.dot.gov/news/us-dot-announces-final-rule-enhance-public-safety-expanding-natural-gas-transportation-plastic

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Evonik is one of the world leaders in specialty chemicals. The company is active in more than 100 countries around the world and generated sales of €13.1 billion and an operating profit (adjusted EBITDA) of €2.15 billion in 2019. Evonik goes far beyond chemistry to create innovative, profitable and sustainable solutions for customers. More than 32,000 employees work together for a common purpose: We wantto improve life, day by day.

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Steel had no competition until the arrival of VESTAMID® NRG, a polyamide 12 (PA 12) product. This material withstands operating pressures of up to 16 bar, making it suitable for distribution lines and industrial connections. Fittings and end caps are made of the same material.

Compared with medium and high density polyethylene (MDPE, HDPE) in use for low pressure gas supply, "long chain" polyamides like PA 12 (and PA 11) provide "naturally" superior performance due to their described chemical structure.

Like PE, VESTAMID® NRG 2101 piping systems offer a superior range of economic benefits for gas utility companies as compared to metal piping. PA12 piping systems feature well-known advantages during installation, maintenance, and operation. The following have made the investment worthwhile for a number of gas companies:

- VESTAMID® NRG pipe is lightweight and easier to handle and transport.
- Given their inherent flexibility, VESTAMID® NRG pipes can be delivered in coils, thereby reducing the number of joints to create in the field, increasing productivity, and reducing installation costs.
- Pipes and fittings can be joined by butt fusion and electrofusion, thus reducing installation time and cost.

VESTAMID® NRG pipes can be used with an array of low-cost, trenchless rehabilitation techniques, including horizontal directional drilling, slip lining, pipe bursting, etc:

- Using these techniques more pipes can be installed in a shorter period than using conventional installation methods.
- VESTAMID NRG piping systems do not require expensive active or passive corrosion protection, thus significantly reducing investment and maintenance costs.
- VESTAMID® NRG retains its chemical, physical, and mechanical stability over its design life and does not experience premature oxidative degradation, circumferential expansion, or loss of long-term strength.

For information, please contact:
doug.weishaar@evonik.com

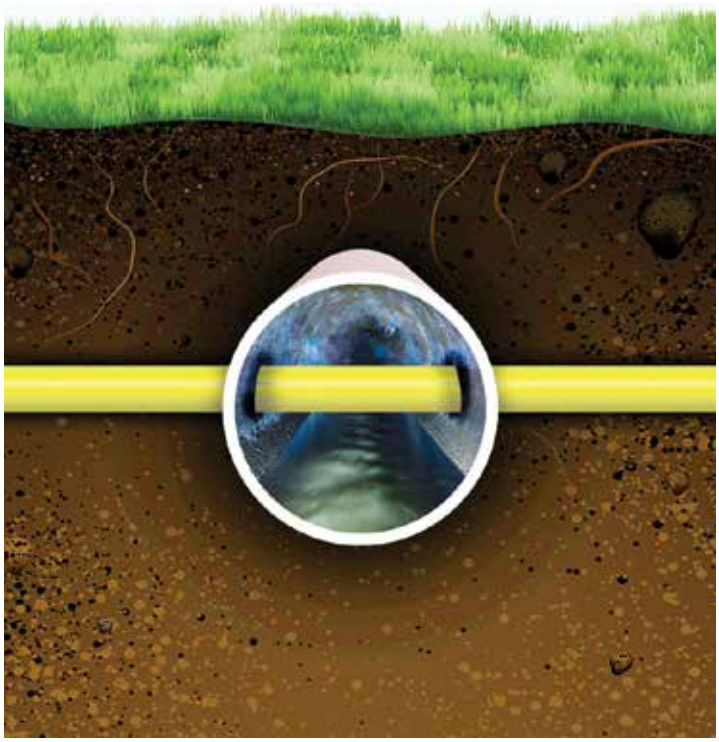
Trenchless Pipe Extraction Technology Offers New Solution for Replacing Steel Services

By: Alan Goodman, HammerHead Trenchless

Steel gas services were installed extensively in the 1960s prior to the advent of plastic pipes and the establishment of federal regulations. Today, many bare steel services continue to operate although may be nearing the end of their useful life as the lack of a protective coating subjects the pipe to corrosion affecting its integrity. In 2018, the U.S. Department of Transportation reported that more than 1.5 million bare steel services are still in operation.

Operators have been diligent in identifying and addressing pipelines in need of replacement, and some have realized the benefits of trenchless technologies within their pipeline rehabilitation and replacement programs. Reduced excavation is often more economical and less disruptive to utility customers, and utilizing the existing conduit greatly reduces the risks associated with relocating the line.

HammerHead® Trenchless recently introduced a new trenchless replacement method within its line of Same Path™ Technology: the SLX1300 pipe extraction system for small diameter steel pipes.



A cross bore is an example of damage to third party utilities with the risk of compromising the integrity of either or both underground structures

The trenchless pipe extraction process can offer operators a simple, cost effective way to replace steel services with minimal excavation and equipment requirements.

Trenchless technologies including HDD and horizontal boring with pneumatic earth piercing tools are widely accepted methods for installing new services and are often more cost effective than traditional 'dig-and-replace'. However, any new installation poses potential risks and additional expense. Such risks include the possibility of damage to third party utilities. Further, leaving an abandoned line in the ground could cause locating errors during any future construction, especially when the new line is installed in close proximity to the abandoned one.

While HDD and pneumatic piercing tools both offer some benefits of trenchless methods, HDD operations may not provide cost savings due to the large equipment requirements and need of highly qualified crews. Piercing tools are often more economical yet do not address the concerns of leaving the abandoned line in the ground.

While these existing technologies have proven effective, certain site conditions make their use costly, inefficient or infeasible, presenting a need for innovative alternative solutions.

Trenchless pipe slitting is a proven method for replacement of plastic pipes that utilizes the same location as the existing line

One such solution is trenchless pipe slitting, a process that has been developed to replace plastic pipes utilizing the same path as the existing line by using a constant-tension cable winch to draw specialized tooling through the pipe, splitting it in place, while simultaneously pulling in new pipe.

This method has proven to be especially effective for the replacement of legacy materials such as Aldyl-A, but the slitting process is not as well suited to replacing steel services, as it requires a cable of sufficient width to be fed through the pipe in order to pull back tooling with enough force to burst or split the material. A cable wide enough to withstand the amount of force required to burst steel is often too large to pass through small-diameter services. So, while it may sometimes be possible to split or burst steel pipes, the equipment requirements generally make it less economical or even infeasible for replacing service lines.

Bare steel (or uncoated) pipes, are often priority candidates for replacement. Bare steel was installed extensively in the U.S. until the 1960s and it was not until the 1980s that the use of coated steel and plastic pipe became widely accepted and preferred where federal regulations mandated pipeline coatings. While many bare steel lines have been taken out of service, many still operate and pose a higher risk than modern materials. The lack of an outer coating subjects the steel to faster corrosion from its surrounding environment so planning and careful inspection are necessary. Cathodic protection helps prevent corrosion, yet small, localized areas of corrosions are difficult to identify and can lead to pipeline integrity issues. Often as a result of an integrity management program, many operators have made bare steel a focus of their rehabilitation and replacement efforts.

Given the disadvantages of existing technologies, HammerHead Trenchless developed a new trenchless method specifically to address steel pipes. Working closely with crews in the field, HammerHead created the SLX1300 pipe extraction system. The SLX1300 is a hydraulically powered static pulling machine that generates up to 13.3 tons of force to extract the pipe from the ground while simultaneously pulling new HDPE or MDPE into the existing location.

The SLX1300 pipe extraction system was designed to be compact to minimize excavation requirements and to make it simple to transport, set up and operate. It requires an excavated machine pit as small as 30 by 27 inches, and it is capable of extracting up to 100 feet of 0.5- to 1.25-inch diameter steel pipe.

Utilization of the existing location of the service was the primary objective of the product design because it addresses some of the most significant concerns of existing technologies: it eliminates the need to rent new easement or pay rent on an abandoned line

The hydraulically powered extraction machine generates up to 13.3 tons of pulling force and is operated from outside the machine pit

The pipe extractor requires a small excavation to access the pipe to be replaced. Minimum machine pit size is approx. 30 x 27 inches

PE product pipe is pulled into place simultaneously as the existing pipe is extracted

The SLX1300 features onboard pipe shears allowing extracted material to be cut into manageable segments for easy disposal

within the ground, and the use of a proven conduit eliminates risk to surrounding utilities and is safer for crews than other construction methods.

PIPE EXTRACTION PROCESS

The pipe extraction process requires two access points: a machine pit located where the service connects to the main, and an access point opposite the machine from which to pull in the new pipe. The unit is lowered into the machine pit and connected to a hydraulic power pack at the surface from which it is operated.

A cable is fed from the machine through the pipe and attached to the new pipe at the other end. The machine's jaws clamp the steel pipe and the cable within it, and the machine is then engaged to pull the pipe from the ground. The jaws release and the machine cycles forward to clamp and pull another segment. Depending on ground conditions, the process may not require the use of a cable in which case the product pipe is connected directly to the steel pipe opposite the extractor unit.

One significant design consideration for any technology with which pipe is fully removed from the ground is what to do with the extracted material. The SLX1300 offers a unique solution in is its onboard pipe shear located behind the machine's clamping jaw. The pipe shear can be engaged at the operator's discretion to segment the extracted pipe in any length as space allows. The segment-cutting design makes it easier to manage the extracted material. Crews can simply collect the sticks of steel from the extractor pit and throw them in the back of a truck for disposal or recycling. By cutting the extracted pipe into short segments, pit sizes can be reduced and "no work zones" around the live gas main may also be observed. Since the operator has the option of when to shear the pipe segments, the speed of the extraction can be optimized to the pit size and main location.

The SLX1300 pipe extractor was designed specifically to provide gas utilities with the cost-savings of 'low-dig' construction methods, the advantages of Same Path Technology, and the efficiency to address multiple services in a specified time frame. Same Path Technology utilizes the path of an existing service which may sometimes reduce the requirements of multiple locates and "daylighting" which can reduce the overall cost and duration of a traditional service line replacement.

Some attributes of the final design were decided upon to allow crews the ability to work in sequence on replacement of multiple services, somewhat like an assembly line. One team could utilize an excavator to create the access pits for the first service and then move on to prepare the next location since the SLX1300 does not require an excavator arm to operate. A second team could perform extraction operations and a third team could then complete the connections after extraction is complete as the second team moves on to the next location prepared by the first team. During field testing, this approach proved to be an efficient way to replace multiple services a day.

The product's design has thus far been focused on the unique requirements of steel natural gas services and has been proven effective for bare-, coated- and wrapped-steel lines. Field testing on additional materials is underway and is expected to progress throughout 2020 to collect sufficient data supporting the use of the extraction process for alternative applications.

The rehabilitation and replacement of dated natural gas pipeline materials is a high priority and with the volume of services in need of replacement, a need exists for innovative solutions. Trenchless technologies have gained acceptance in the gas industry as proven methods to reduce the costs and risks of open-cut replacement. However, there is opportunity to find additional innovative solutions for the challenges unique to the gas industry with safety being a critical factor.

Having realized the advantages of trenchless replacement methods utilizing the existing location of a service, HammerHead Trenchless has developed a new solution that facilitates rapid replacement of at-risk steel gas services. Based on initial feedback from operators actively using the technology, pipe extraction is an efficient and more economical solution for replacing bare steel natural gas services.

ABOUT HAMMERHEAD TRENCHLESS:

*Founded in 1989, **HammerHead Trenchless** provides the industry with the most comprehensive suite of precision-manufactured trenchless equipment and consumables for the installation, repair and replacement of pipes used in fiber, communication, water, sewer and gas underground infrastructure. HammerHead is part of The Charles Machine Works' Family of Companies, the Underground Authority. Each CMW company shares in its overall commitment to solving today's infrastructure challenges, offering solutions in all areas of underground construction.*

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Large Diameter, Full Pressure, Polyethylene Tapping Tee

By: Julie Maupin, Peoples Gas
Steve Gauthier, Energy Experts International

BACKGROUND

Peoples Gas is the first and oldest utility in the city of Chicago and delivers natural gas to about 870,000 customers within the city limits through 4,500 miles of gas mains and 500,000 services. Since 2011, Peoples Gas has been pursuing an aggressive system modernization program. This includes the replacement of 2,000 miles of cast iron and ductile iron mains operating at 7 inches water column with modern polyethylene operating at 22 psi. This program also includes relocating regulators and meters outside and installing excess flow valves in service lines and shut-off valves in readily accessible locations. At the end of 2019, the program had retired 550 miles of main, installed 1,036 miles of distribution main, 21 miles of high pressure main, 78,000 services and moved 170,000 customer meters.

The total cost of large scale infrastructure projects is dominated by labor and restoration expenses. Reductions in either of these areas can result in significant savings over the duration of the program and early adoption can create a compounding effect. Peoples Gas (PGL) looks to reduce costs through adjustments in construction methods and adoption of tooling and technological advancements. Potential solutions are evaluated for applicability and suitability before moving to field trials. Field trials are the true litmus test where practicality is explored, field employee interest is gauged, and the range of applications is discovered.

SUPRAFLOW

One advancement that PGL has evaluated is the large diameter, full port, full pressure, polyethylene (PE) tapping tee developed by Torre Gas called Supraflow (Figure 1). Supraflow was developed in Europe as an alternative to squeezing pipe in order to install inline tees on larger diameter mains. It has been tested and qualified to relevant ASTM standards and each one is individually factory tested to 225 psi, 150 per cent of maximum operating pressure. Supraflow tees have been installed over 10,000 times in Europe and Latin America over the last decade.

Figure 1 – Supraflow Tapping Tee

The fitting is available with outlet sizes of 3-, 4-, 6-, and 8-inch diameters. The diameter of the main it can be installed on is only limited by the commercial availability of branch saddles. Once installed on the main, the tapping operation is carried out under live conditions and in less than 15 minutes. The fitting has been tested and rated for operation up to 150 psi. The design of the fitting allows for the use of a single small excavation by eliminating a double squeeze and vent movers for back fed mains. It has lower associated risks than shutdown operations.


Figure 2 - Supraflow Excavation Pit

PGL typically butt fuses the Supraflow to an electrofusion branch saddle then installs the saddle on the main. It is possible to fuse the branch saddle, then electrofuse the Supraflow to the branch, if the crew has an electrofusion clamp that can be adjusted to clamp just outside of the coupling. Typically the new pipe segment is joined to the Supraflow and pressure tested prior to tapping. One feature of the combination of a branch saddle and the Supraflow tee is the ability to install it 360 degrees around the main or the axis of the tee. (Figure 3).


Figure 3 – Multiple Orientation Options

The tapping cutter inside the Supraflow is factory assembled inside a traditional butt fusion PE tee. Much like a service tapping tee, the cutter is housed in the top of the fitting (Figure 4) and is driven down to perforate the active pipe, then withdrawn back into the tower. The coupon is fully retained in the cutter and the shavings from a 4-inch tap could fit on a quarter.

Figure 4 – Cutter Tapping PE Main Under Pressure

A squeeze off operation on larger diameter main requires a distribution crew, equipment operator, two fusers, and a large excavation. The tapping of the Supraflow tee can be completed by one person in a significantly smaller opening. PGL is able to use the compact Supraflow tapping tool with a max pressure of 30 psi. (Figure 5). This is especially useful in crowded underground areas with poor horizontal separation from other utilities. Although the tool is manual, operation takes less than 15 minutes and removes the need for a compressor.

FIELD TRIALS

Peoples Gas conducted four field trials on mains ranging from 6 to 12 inches. All installations were to connect new services with large loads although the Supraflow lends itself to system expansion and branch connections missed during the design phase. Energy Experts International (EEI), the US technical representative of Supraflow, was on site for installations and provided table top reviews and training of the procedure prior to any tapping. The avoided costs for labor, excavation, and restoration were around $30k.

Figure 5 - Compact Installation Tool Design

> *"Tapping time for all four trials was under 15 minutes."*

Figure 6 – Table Top Demonstration of Operation

Site 1- 12- x 4-inch installation (Figure 7)

- Limited horizontal clearance for traditional hot tap which requires 7 feet.
- Eliminated two squeeze points and air movers, the need for a distribution crew and equipment operator, and a 16-foot opening.
- Less work performed to cut out the old 24-inch cast iron main the 12-inch PE was inserted in.

Figure 7 – Site 1: New Service for Large Residential Development

Figure 8 – Site 2: Main Extension for New Service

Site 2 – 6- x 4-inch Installation (Figure 8)

- 5- by 8-foot excavation was sufficient with Supraflow.
- Performing a traditional tie in would have resulted in extending the opening an additional 10 feet in order to get the specified squeezing distance from joints and fittings. This would have also resulted in the loss of a large industrial customer.

Figure 9 – Site 3: Horizontal Service Installed on an Inclined Main

Site 3 – 12- x 6-inch Installation (Figure 9)

- Installation took place on a very busy one-way street.
- Supraflow installed in a 6- X 5-foot excavation instead of a 16- X 6-foot trench for a double squeeze off with loss of a customer.
- No requirements for a formalized shut down procedure, distribution crew or equipment operator.
- Small rotation of the Supraflow tee made it seamless to install the service horizontal from a main on an incline.

Figure 10 – Site 4: New Service to a Famous Landmark

Site 4 – 8- x 4-inch Installation (Figure 10)

- Trench width only needed to be 5 feet, rather than 12 feet for a double squeeze.
- No requirements for a formalized shut down procedure, distribution crew or equipment operator.
- High visibility project requiring a new gas service

CONCLUSIONS

1. Peoples Gas conducted four successful field trials of the Supraflow Large Diameter High Pressure Live PE Tapping Tee with support from EEI.
2. Tapping time for all four trials was under 15 minutes.
3. Each trial allowed for the use of a reduced size excavation.
   a. Decreased costs for small excavation and restoration.
   b. Increased safety and reduced disruption to the public
4. Simplified gassing-in operation from needing a large crew performing a shut down to one fuser performing a simplified tie-in.
5. Reduced need for heavy equipment and elimination of pipe squeeze tools.
6. Supraflow is approved for standard operation at Peoples Gas.

ABOUT ENERGY EXPERTS INTERNATIONAL:

Steve Gauthier *is the Vice President & General Manager of the Energy Experts International Midwest Region. He oversees the business interests in the Midwest including clients in the southeastern and southwestern states. Steve has served the Natural Gas Industry for over 30 years. He is a licensed Professional Engineer in the state of Illinois and a graduate of Stevens Institute of Technology with a BS in Mechanical Engineering. He earned his MBA from the University of Illinois.*

ABOUT PEOPLES GAS:

Julie Maupin *started her career at the Gas Technology Institute in 2003 where she enjoyed working on a wide range of subject matters related to the transportation of natural gas. In her later years with GTI, she became heavily involved in plastic piping systems including associated risks and failures. In 2010, Julie joined Peoples Gas. She has held multiple positions within the organization including Compliance, Vision and Technology, Materials, and Capital Construction. Her current role is Engineering Manager where she oversees the evaluation of emerging technologies, material standardization initiatives and development of testing protocols for new materials.*

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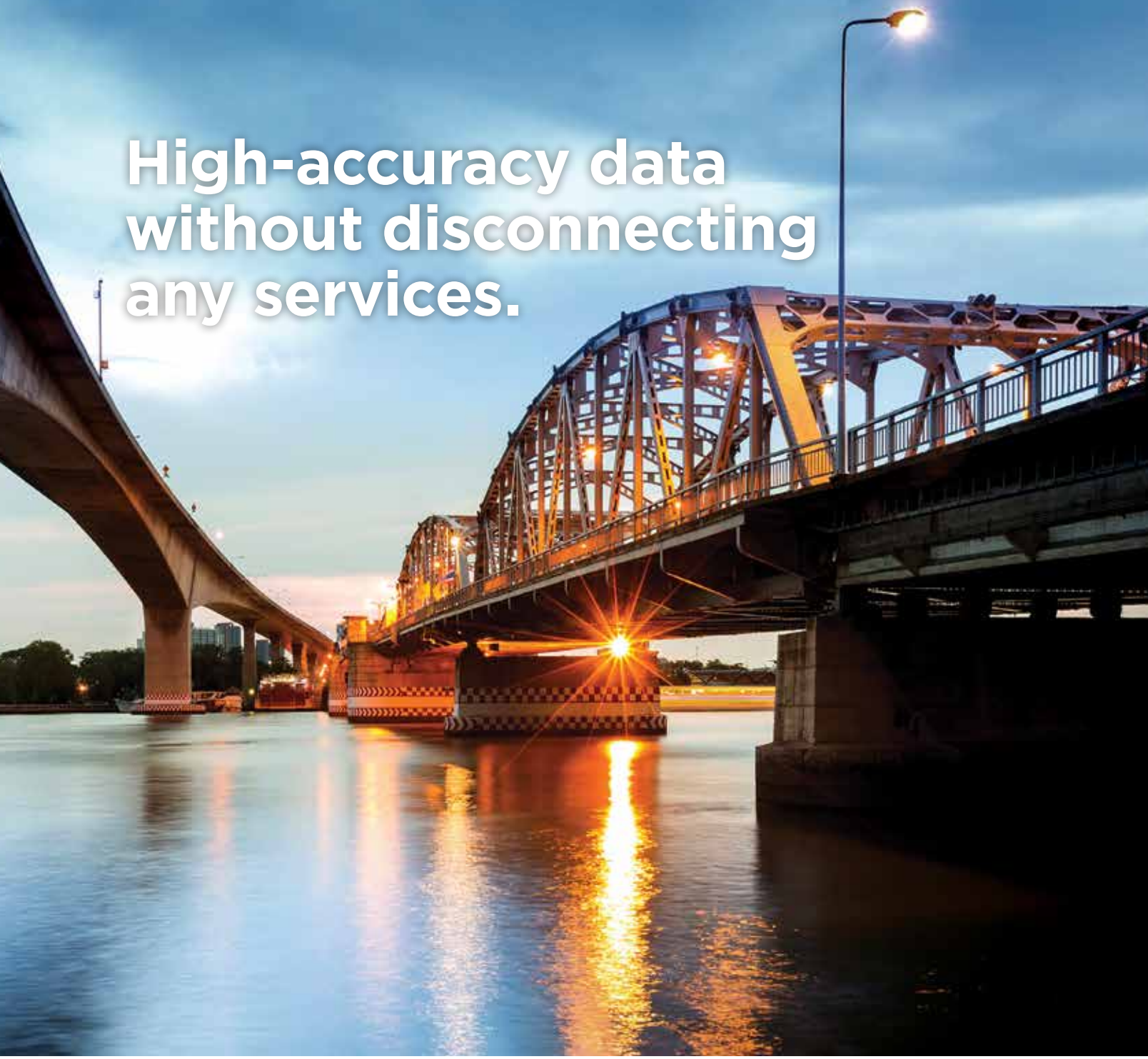

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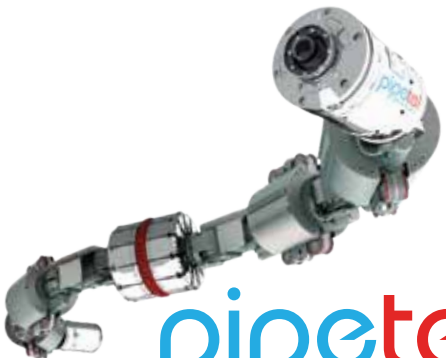

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