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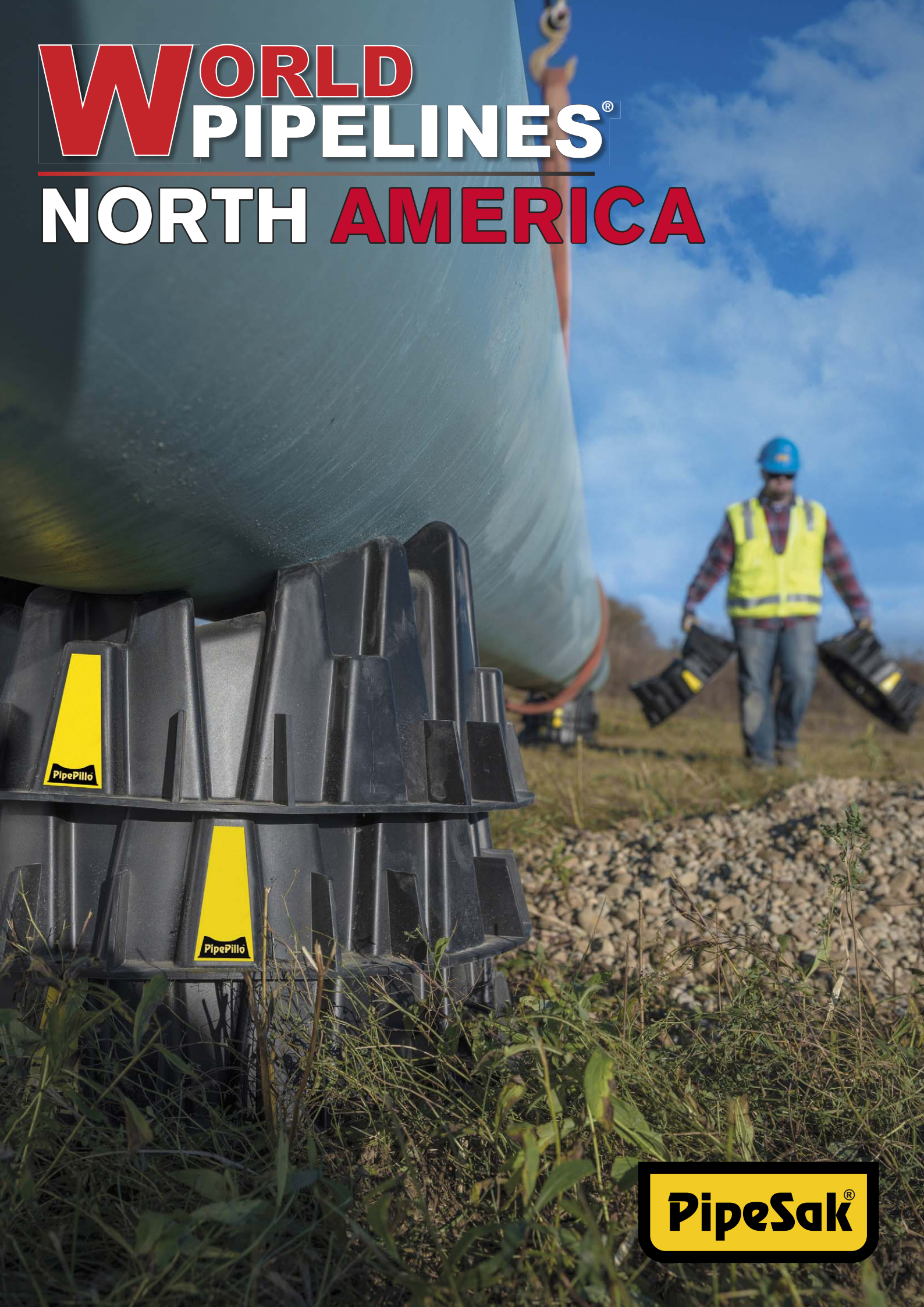

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WORLD PIPELINES

COMMENT

THE LAST OF THE WILD LANDS

The classification of land as 'wilderness' is reflective of an area's disturbance from human development, its remoteness to civilisation, and its inhabitants being only wild animals. Having spent a term at university studying this topic in great detail, it was explained how the sight of a wind turbine blade would instantly destroy the wildness of a location as it was a nod to human presence. However, an underground pipeline with perfect land reinstatement...well that's surely a different story.

The largest wilderness area in the US is, unsurprisingly, in Alaska. The Wrangell-Saint Elias Wilderness is 9 million acres of land in the south of the state, home to snow-capped mountains, deep valleys, and large, expanding glaciers. To the north of the state is the Arctic National Wildlife Refuge (ANWR), a vast natural area that should be associated with caribou, beluga whales, and grizzly bears, but is increasingly associated with the possibility of oil and gas operations.

The ANWR consists of 19.3 million acres, with 8 million acres dedicated to wilderness and 1.5 million acres designated as the Coastal Plain 1002 Area. In 1980, US Congress allocated the non-wilderness 1002 Area for a future of energy exploration, but only in 2017 was a small, 2000-acre portion passed for development. Years later, Trump's administration is making headway in establishing a leasing programme for the Coastal Plain of the ANWR, with the Bureau of Land Management (BLM) recently releasing the final Environmental Impact Statement (EIS). This has established that the lease programme would involve a minimum of two sales by 2024, with each sale covering at least 400 000 acres of the highest hydrocarbon potential lands within the Coastal Plain and including ROWs for pipeline crossings, roads, and other required access.[1]

> TRUMP'S ADMINISTRATION IS MAKING HEADWAY IN ESTABLISHING A LEASING PROGRAMME FOR THE COASTAL PLAIN OF THE ANWR

Whilst plans are in motion to open Alaska's ANWR up to oil drilling, the House of Representatives hopes to ban all drilling, with a 225-193 vote to protect the area occurring just hours prior to BLM's EIS release. However, it is unlikely the bill will be approved in the Republican-dominated Senate.

Offshore drilling has also been targeted by the House of Representatives, with two bills approved to ban new offshore oil and gas drilling off the Atlantic and Pacific coasts and the Gulf Coast of Florida. The intention of the bills is to protect US coasts from drilling activities that can damage and pollute important waters. However, the primary source of funding for the Land and Water Conservation Fund (LWCF) are the revenues generated from offshore oil and gas production. API has reported that the LWCF has provided more than US$4 billion for over 40 000 projects since 1965, and curtailing oil and gas exploration and development will directly limit future funding.

Change in the US oil and gas industry seems to be particularly prevalent in Alaska at the moment. BP, present in the state for 60 years, has sold all of its Alaska operations to Houston-based Hilcorp. The US$5.6 billion asset sale includes BP's 49% ownership in the Trans-Alaska Pipeline and its stake in the Prudhoe Bay oilfield.

The Trans-Alaska Pipeline is operating at approximately 500 000 bpd, considerably below its capacity to move 2.1 million bpd when at peak flow. Opening up Alaska's 1002 Area could provide new throughput to increase the pipeline's activity. However, in the EIA's Energy Outlook 2019, it was recognised that oil drilling in the ANWR will be of little value to US crude production until the 2030s, due to the lengthy process of finalising leases, undertaking exploration activities, and developing production infrastructure. Nevertheless, the long-term benefits include strengthening energy security, the creation of thousands of jobs for Alaskans and those further afield, and positive growth for the economy.

Whilst The Last Frontier may hold the largest proportion of the US's wild lands, it also holds the opportunity for the US to reduce its dependence on foreign energy and cultivate the land that has been awaiting exploration since it was assigned this status 39 years ago. WP

1. 'Coastal Plain Oil and Gas Leasing Program: Environmental Impact Statement', US Department of the Interior Bureau of Land Management.

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GUEST COMMENT

Toby Mack

President, Energy Equipment and Infrastructure Alliance

The astonishing growth of oil and gas production from shale has precipitated a major buildout of pipelines connecting new production areas with the market. But before a pipeline project can be built, the owner must navigate through a maze of federal, state and local permitting processes. Entire projects have been delayed or stopped when one permitting agency at any level denies a permit.

Interstate natural gas pipeline permitting starts with the Federal Energy Regulatory Commission (FERC) environmental reviews and market needs assessments, which if satisfactory result in issuance of the necessary certificates. The process next moves to the state level, where states may choose to accept federal delegation of permitting authority under the Clean Water Act (CWA), Section 401. This process allows the state to issue or deny permits based on whether it believes the project will meet federal water quality standards where it impacts state waterbodies. The Act specifies that the state must act on a project's application within one year of its submittal, or else the state is deemed to have waived its authority and permitting reverts to the federal level.

> ENTIRE PROJECTS HAVE BEEN DELAYED OR STOPPED WHEN ONE PERMITTING AGENCY AT ANY LEVEL DENIES A PERMIT

Some states, notably New York, New Jersey and Oregon, have exploited ambiguities in Section 401 language to delay or deny projects. A typical tactic has been to wait a substantial period of time after receipt of the application, only to deem the application incomplete and request the owner re-submit it with additional information, in some cases multiple times. The statute's ambiguity has allowed states to deem the one-year time clock to be restarted with each resubmission, resulting in indefinite delays. In one instance a state went far beyond the law's intent, denying certification not on water quality grounds, but on downstream greenhouse gas emissions.

Recognising this obvious state 'gaming' of the statute's intent by exploiting ambiguities in its language to block projects, in April 2019 the Administration – through a Presidential Executive Order (EO) – directed the Environmental Protection Agency (EPA), which is responsible for administering the CWA, first to issue 'guidance'. This is essentially a set of recommendations as to how the law should be administered by federal, state and tribal authorities. The second of the EO's directives to the EPA was to prepare a new Rule for implementation of Section 401, ensuring that it is consistent with statutory principles and purposes of the Section.

As opposed to a Guidance document's recommendations which can be issued administratively, a rule has the force of law, and its adoption is subject to a rigorous process. It begins with publication of a draft in the Federal Register, followed by a public comment period, then substantive consideration of input received, and finally official promulgation. The public comment process will remain open until late October. The EO specifies that the EPA must then finalise and issue the new rules by 10 May 2020.

The ball is now in the court of those who want to see the process reformed. Readers can submit comments on the Federal Government's regulations website, and more information about how to take action can be found on the Energy Equipment and Infrastructure Alliance's website.

Weighing in on this important opportunity is key to improving the permitting process. Your voice matters!

IT'S ALL IN THE CONTRACT

When forging contracts in the energy industry, buyers and sellers make an agreement rooted in uncertainty. Throughout a contract's lifetime, crude oil, natural gas and natural gas liquids prices rise and fall, benefitting producer and consumer in ebbs and flows. In a marketplace characterised by volatile commodity prices, when do contracting parties have grounds to terminate a contract, change the terms or renegotiate the fee structure? This question is the basis of energy disputes – both arbitrations and litigations – facing many corporations around the globe.

In today's environment, a large portion of disputes are concentrated in the midstream sector. Companies engaged in transporting, refining, processing and storing all forms of hydrocarbons find themselves at the centre of disputes for a number of reasons. Chief among them is the reality that US supply has, and is, continuing to increase exponentially, heightening demand for midstream services and placing stress on the nation's existing infrastructure.

In a June 2018 testimony to the US House of Representatives Committee on Transportation and Infrastructure, an American Petroleum Institute (API) director addressed the necessity of investing in the midstream to support increased production. "Ensuring we have a robust energy infrastructure system that keeps pace with growing production and demand is essential to helping provide American families and businesses with reliable access to affordable energy," Director Robin Rorick said. In his statement, Rorick also cited an API study forecasting a need for US$1.3 trillion in investments in US energy infrastructure until 2035.

The boom in hydrocarbon production for shale plays in the US, which has catapulted the country onto the map as a leading global energy supplier, has led to increased demand for infrastructure across all commodity types, including natural gas, crude oil and natural gas liquids. For example, Bloomberg reported that natural gas pipelines in the Permian Basin have surpassed their capacity, resulting in a controversial process known as flaring – the burning off of excess gas. Another visible impact of the lack of pipeline takeaway capacity has been Apache Corporation's delay in natural gas production in the Permian, a strategic decision resulting from the low market price and stranded gas, Oilprice.com reported.

At present, pipelines offer a capacity of 9.5 billion ft^3/d for transporting gas in the Permian region, which is insufficient for the 13 billion ft^3/d of gas that is pumped out daily. There has also been a recent uptick in drilled but uncompleted (DUC) wells. At the US Energy Information Agency's (EIA) last count, there were 4004 DUCs in the Permian Basin alone. While the bottleneck caused by a lack of takeaway capacity is expected to continue, predictions made by the International Energy Agency (IEA) had forecast the US competing with Saudi Arabia in the quantity of oil exports, overtaking Russia's production in the next five years. Early in April, Bloomberg and EnergyinDepth broke the story that the Permian Basin has already surpassed Saudi Arabia's Ghawar oilfield, and is

Bob Broxson and Clark Sackschewsky, BDO, USA, review the role of the US midstream sector in the increasing number of energy disputes.

now the highest producing oilfield in the world. The IEA believes that the ability of the US to increase natural gas production will lead to a 70% increase in global capacity until 2024, with production expected to average 91 billion ft^3/d in 2019.

Fees

As production volume increases and transportation capacity remains relatively fixed, many midstream energy companies are still charging fees set years ago – in contracts reached either before or during the downturn. This dichotomy forms the basis of many energy disputes. Majority infrastructure owners, investors, and private equity fund managers have contested that fees should increase as demand for midstream services intensifies prior to the construction of additional capacity.

Early 2019 saw the alleviation of some production pressures with the opening of two pipelines that assisted with gas takeaway constraints, though the EIA foresees growing production will bring back gas transportation pressures. Bloomberg predicts that 2020 will see the addition of 4 billion ft^3/d of pipeline capacity, which is expected to mitigate the quantity of flaring and support the increasing production levels.

US production continues to climb

US production of crude oil shows no signs of slowing. IHS Markit forecasts the Permian Basin – the unsurprising backdrop for many energy disputes – will account for 60% of the world's total oil production growth by 2023. In kind, oil and gas majors are adjusting their portfolios to capitalise on the rampant growth from these shale plays. Once dominated by independent players, the majors are playing an increasingly dominant role in the area. BP's US$10.5 billion acquisition of US shale properties from BHP Billiton in 2018 set the stage for the bidding war between Chevron and Occidental Petroleum over Anadarko this past April, from which Occidental emerged victorious. The deal adds 240 000 prime acres to Occidental's existing 2.7 million acres in the Permian Basin.

To maintain profitability and continue the growth of American shale, upstream organisations must focus on becoming lean machines: investing in new technology that improves operational efficiency – increasing production, while limiting expenditures – particularly in the face of major competition. But their success also hinges on the midstream, and the continued ability to transport crude oil and gas to the final consumer. This is likely to become more challenging for independents down the line as they look to compete for pipeline capacity with the ultramajors. With further consolidation expected in the Permian following Occidental Petroleum's acquisition of Anadarko, the area is likely to remain a hotbed for both deal activity and energy disputes.

LNG

Outside of the Permian, the next frontier of midstream energy disputes is the liquefied natural gas (LNG) industry. In the three years since the ban on LNG exports was lifted, the level of exports at LNG terminals has soared. The US exported 4.9 billion ft^3/d of LNG in 2018 – more than 2.5× the amount in 2017 – according to the EIA. To accommodate the outpouring of production, midstream players are eyeing opportunities to construct export facilities and terminals. A recent BDO prediction forecasts that by 2020, 30% of LNG export capacity will be built in the US. According to the EIA, there are currently 25 existing trains under construction between the Sabine Pass, Cove Point, Elba Island, Corpus Christi, Cameron, and Freeport. Seven more LNG export projects are expected to come online in the coming years.

As demand increases for LNG export facilities and the US becomes a larger exporter, it is likely that energy disputes around long-term terminal use agreements and purchase and sale agreements will increase. The complexity and changing nature of LNG contracts adds to the likelihood they will be subject to future disputes. In the past, the majority were long-term contracts, but that is starting to change. CNBC reported on the evolution of LNG contracts, noting that more buyers are demanding flexible contracts or 'spot deliveries' of LNG on an as-needed basis. Shell's 2019 LNG Outlook reported over 1400 spot cargo deliveries in 2018 globally, comprising 25% of global imports – a 5% increase from the year before – according to the International Group of Liquefied Natural Gas Importers (GIIGNL). Spot pricing benefits the buyer because they can adjust their purchases based on price fluctuations, and may increase the number of sellers pursuing contract renegotiations or disputes down the line.

Short-term LNG contracts are here to stay, and LNG spot indices are being pursued to support the changing model. The Singapore Exchange announced in early 2017 that it would be developing an index to monitor LNG prices and monetise shipping futures – an intention shared by the Baltic Exchange in mid-2018, which was taken over by the Singapore Exchange. These attempts at transparency have been delayed since their planned launch, though one index has gone live as of March 2019, and two more are planned for the year.

How are energy disputes solved?

In addition to an evolution of the types of energy disputes taking place, the nature of the proceedings themselves are changing as well. While most energy disputes have historically gone through litigation, very few cases make it to the court room today. Instead, arbitration has become more popular, typically because it allows parties to reach a resolution more quickly.

Micronomics, an economic research and consulting group, conducted an analysis to determine the efficiency and economic benefits of arbitration vs litigation. The study found that reaching a resolution through litigation took an average of one year longer than arbitration. Micronomics also quantified the financial impact of waiting for a litigation to go to trial. Over a four-year period, the direct losses associated with the additional time to trial required for litigation compared with arbitration resulted in losses of approximately US$10.9 billion to US$13.6 billion. With the intent of saving time and money, many energy companies include language in their contracts that dictates a dispute will be resolved through arbitration, if it arises.

Conclusion

Both energy dispute proceedings and energy market conditions are changing at a rapid pace, and the types of disputes will continue to evolve. With the future in view and further volatility on the horizon, the expansion and continued investment in energy infrastructure will be critical to the US's energy independence and prominence in the global market. One thing is for sure: the midstream will remain at the centre of it all.

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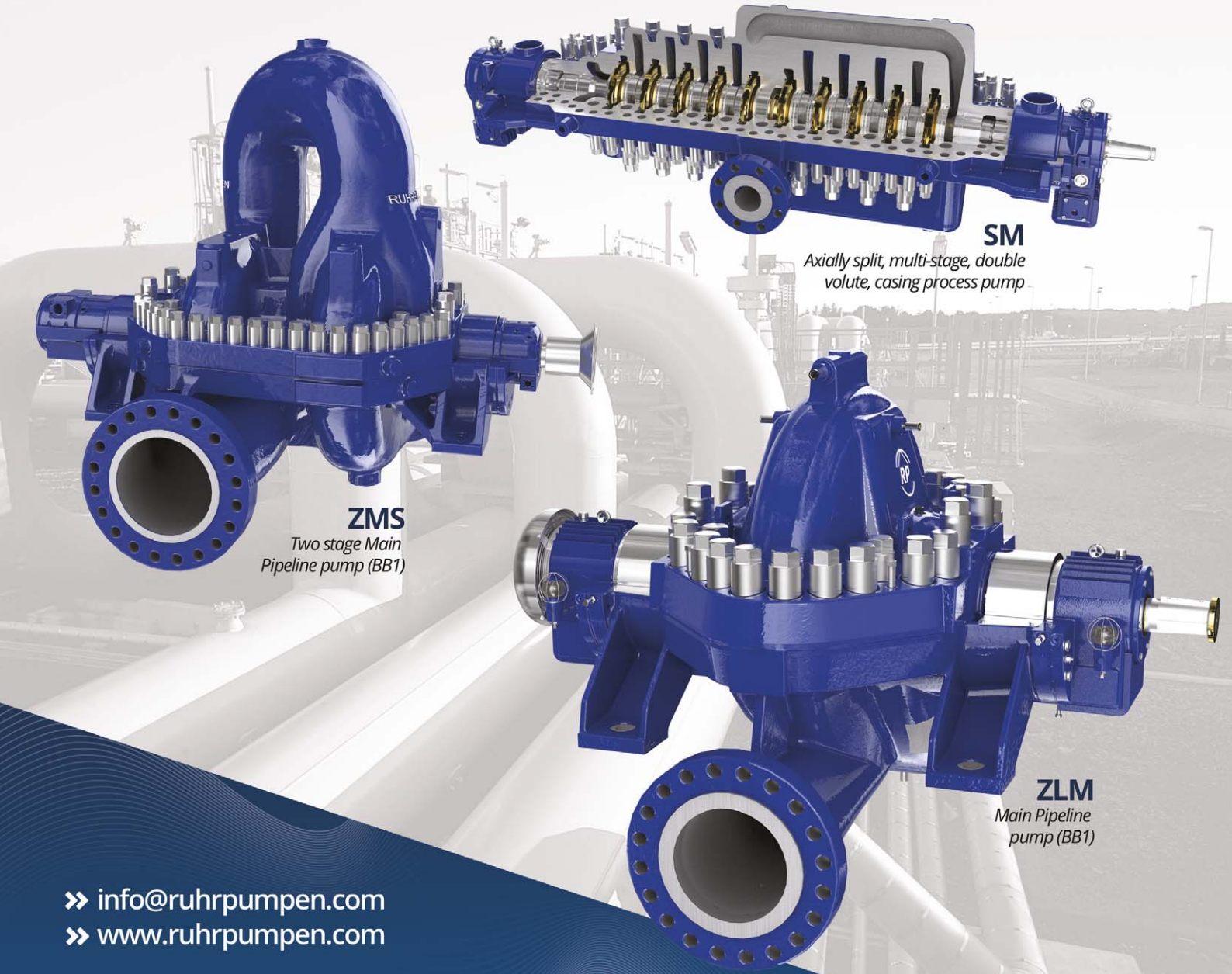

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FLIRTING WITH DISASTER

In a worrying development, individuals and organisations are increasingly attacking pipelines in North America. Gordon Cope explores the actions being taken to counteract them.

In times of civil insurrection, pipelines become a prime target; guerrillas can inflict serious economic damage by denying the ruling regime hundreds of millions of dollars in foreign currencies. Lines in Syria, Iraq, Libya and Colombia have been regularly attacked. Significant territory in Colombia, for instance, is still under nominal control by groups such as the Revolutionary Armed Forces of Colombia (FARC); the federal government reported 18 incidences of damage to pipelines in 2018 alone.

Home-grown trouble

While North America has historically been spared attacks on its energy network, a disturbing trend is emerging:

- In October 2016, in a co-ordinated assault, activists approached aboveground pipeline facilities in Minnesota, Montana, North Dakota and Washington State. They cut their way through fencing and padlocks and turned off aboveground valves to several major crude lines. The activists had informed operators of their impending actions, and all lines were safely shut down without disruption. Five people were arrested and charged in state courts.

- The Dakota Access Pipeline (DAPL) is a 1900 km pipeline designed to move up to 570 000 bpd of crude from North Dakota through Iowa to Illinois. It faced months of delays with court challenges and ROW protests by Sioux tribal nations and environmental groups. In early 2017, activists damaged the still-empty line by cutting through the pipe at valve shut-off points in South Dakota and Iowa.

- In Mexico, opposition arose during the building of Sempra Energy's 510 million ft^3/d Guaymas El Oro natural gas pipeline through traditional Yaqui territory on the Pacific coast. A battle in 2016 between pro and anti-pipeline factions left one dead. When a court order to stop construction was ignored, Yaqui members dug up a section of the pipe. The line was eventually completed in 2017, but start-up has been pushed back to 2019.

Why do they do it?

For those opposed to the use of fossil fuels, pipelines offer low-hanging fruit because they must go through a lengthy process in numerous jurisdictions in order to get approval for new-build and upgrades. Environmentalists have had significant success in Canada opposing pipelines by extending out the expensive approval process with legal challenges until proponents either cancel (TC Energy's Pipeline East), or throw up their hands in frustration and sell (Kinder Morgan's Trans Mountain Expansion Project).

But most pipelines, especially in the US, proceed ahead in spite of protests, political pressure and legal challenges. The defendants in the 2016 co-ordinated attack on crude pipeline valves believed that their actions were justified because the US government had failed to do anything about climate change. "This is the only way we get their attention," one defendant noted. "All other avenues have been exhausted."

Dr. Kelly Sundberg is an Associate Professor in the Department of Economics, Justice, and Policy Studies at Mount Royal University, Calgary. He has been researching and advising governments on border and infrastructure security for several decades. "Eco-terrorists believe that their actions will somehow bring awareness to the greater public," he notes. "Their number is extremely small, but there is a larger, significant minority who excuse their actions as relatively benign."

Necessity defence

Indeed, while the general public may see their exploits as stunts to attract media attention, the actions of the valve attackers were part of a much larger plan. Activists had been counting on their arrest and trial in order to introduce the 'necessity defence', a court manoeuvre that, if successful, would create a legal precedent and open up a much larger avenue for potentially aggressive opposition to fossil fuels.

Necessity defence is used in rare cases by a defendant to justify their illegal actions. Essentially, the accused argues that there was no other legal means short of civil disobedience to prevent a greater crime from occurring. In the case of the valve defendants, the potential for climate catastrophe justified their tampering with the pipeline.

When a judge granted the defendants arrested in Minnesota the right to mount a necessity defence, various environmental organisations began organising testimony, calling upon expert climate witnesses to convince a jury that the government had been so neglectful in reducing the use of fossil fuels that citizens were forced to physically intervene.

The burden of proof is hard to meet in a necessity defence. The defendant must prove that the harm that would have resulted from obeying the law far exceeds the harm caused by breaking it. They must show that there was no legal alternative to breaking the law, and that the defendant was in imminent danger of physical harm. Finally, there is a direct causal relationship in breaking the law in order to prevent the harm.

In October 2018, the judge in the Minnesota valve trial abruptly threw out the case against the defendants. County District Judge Robert Tiffany ruled that the prosecution failed to prove any damage had occurred from their actions. While some observers felt that the case had been dismissed on a technicality, others were relieved that the necessity defence had not been successfully sustained in court.

New legislation

The fact that many of the defendants in the 2016 valve attacks had been either dismissed or found guilty of minor charges, was not lost on legislators. Numerous initiatives have occurred on both state and federal levels.

The US Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) periodically updates pipeline safety regulations. In June 2019, Transportation Secretary Elaine Chao introduced proposals to the next reauthorisation that would extend criminal penalties to those who block the construction of a crude or natural gas pipeline. Current legislation places a maximum penalty of 20 years in prison for damaging or destroying an interstate pipeline; the proposed amendment would apply the same penalty to vandalism and 'disruption.' While opponents see it as a prevention of the right of lawful protesters to exercise their first amendment rights, the agency said it would consult with Congress to ensure final legislation protects their rights.

Texas legislators are intent on passing a law that would designate pipelines as 'critical infrastructure', raising civil disobedience against the projects to a third-degree felony, equivalent to attempted murder. Those convicted of violating the law could face 10 years in prison and be liable for damages.

In April 2019, North Dakota's Senate and House overwhelmingly approved an amendment to existing state law to make it a felony to damage or tamper with equipment,

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operations or construction of a critical infrastructure facility (which includes valve sites, pump stations, and locations designated or approved for the construction of such a facility). Organisations can also be fined up to US$100 000 for 'conspiring' with people who violate it. The bill was sponsored by Senator Janne Myrdal after one of the 2016 valve attackers shut off TC Energy's (formerly TransCanada) emergency valve in Walhalla, North Dakota.

The American Civil Liberties Union (ACLU) has denounced the law. "North Dakota's new law builds on a trend of anti-protest legislation that aims to chill protesters from using precisely those tactics that have proven most successful for getting their voices heard," said Heather Smith, Executive Director of the ACLU of North Dakota. "We'll be watching what happens with North Dakota's new law very closely."

Civil lawsuits challenging the new, stricter penalties are already entering the courts. In 2018, Louisiana passed a law expanding the definition of 'critical infrastructure' to include 125 000 miles of state pipelines, making trespassing on their ROW a felony rather than a misdemeanour, and carrying a penalty of up to five years in prison. In August 2018, activists entered the Atchafalaya Basin in Louisiana to protest the construction of the Bayou Bridge pipeline, setting up camp on a private landowner's property along the ROW. Over a dozen were arrested in subsequent weeks and charged with felonies under the new state law, but a judge recognised that the activists had been given permission by the landowner to occupy the land. In May 2019, civil liberty and environmental groups filed a lawsuit on behalf of landowners and activists seeking the federal court in Baton Rouge to declare the law unconstitutional. The lawsuit is likely to be the first to reach court, making it a litmus test for the 35 similar state laws either in effect or close to enactment.

The future

In the meantime, opponents remain undeterred. "Nothing has gotten better since we shut down the valves two years ago," said one of the 2016 valve attack defendants in a subsequent interview. "The political system has been even further foreclosed. What does that leave ordinary citizens to do? It doesn't mean stop trying legal means, but it does mean step up and put your body on the line too."

In February 2019, four activists, describing themselves as 'Catholic workers' broke into a shut-off valve area in north Minnesota and attempted to tamper with Enbridge's Line 4 pipeline. Itasca County Sheriff's deputies arrested the intruders. No damage was reported, but Enbridge immediately responded to the incident. "The actions taken to trespass on our facility and tamper with energy infrastructure were reckless and dangerous," Juli Kellner, a representative for Enbridge, wrote. "The people involved claimed to be protecting the environment, but they did the opposite. Their actions put themselves, first responders, neighbouring communities, and landowners at risk. While we respect the rights of individuals to safely express their views on the energy we all use, we take these matters very seriously and support the prosecution of all those involved."

More threats have been made against other existing lines. The Trans Mountain pipeline has been delivering 300 000 bpd of crude and fuel from Alberta to the Pacific Coast for six decades without major incidents. However, attempts to expand the network to 890 000 bpd have been stymied by environmental and First Nations opposition, as well as court challenges. The federal government ended up buying the pipeline from a frustrated Kinder Morgan and issued an order to proceed in mid-2019. Protestors have vowed to blockade expansion of the line and port facility.

Enbridge Line 3, a 760 000 bpd line moving crude from Alberta to Wisconsin, has been operating at half capacity for several years due to its advanced age. The company has been trying to modernise the line, but has also faced numerous court challenges. In July 2018, Minnesota regulators finally formally approved the replacement, angering opponents who vowed to mount Standing Rock-style protests to block it.

Enbridge, along with other pipeline operators, has taken steps to beef up security at remote locations and is working with Canadian and US law enforcement agencies to decrease the potential for further trespassing and tampering on new and existing lines.

The larger focus dealing with public sentiment toward eco-warriors needs to be addressed, however. Professor Sundberg has several recommendations. His first suggestion is to inform the courts and general public about the gravity of tampering. "There is an extreme danger with messing with an oil and gas pipeline, and prosecutors and judges need to be aware of that," he notes. "We should (also) educate the general public about the potential consequences of tampering. They need to understand the full gravity of the potential of loss of life, damage to the environment, and the loss of millions and millions of dollars to our infrastructure and economy."

Secondly, jurisdictions need to strengthen laws protecting infrastructure. "Canada has focused on making the penalties for corporations that cause environmental damage more severe; they should also make penalties against eco-terrorists who act against infrastructure more severe, because they have even greater potential for environmental damage," he notes. "Canada's federal government should consider putting specific laws in place that deal with interference to not only oil and gas infrastructure, but hydroelectric and other major infrastructures."

While pipelines will always be the most efficient and safest way of moving hydrocarbons over long distances, protestors will continue to focus their actions against midstream networks. A major crude pipeline typically runs for thousands of kilometres and carries several million barrels of crude. Pumping stations and valve shut-offs are generally located approximately every 100 km along the route in order to ensure safety. While controllers can react quickly in an emergency to shut off flow, each 100 km stretch of line can contain hundreds of thousands of barrels of crude; a serious breach committed by saboteurs directly upstream of a shut-off valve would make a large spill extremely difficult to control.

"Pipeline systems are incredibly complex networks that require people with the highest level of training to operate them," says Sundberg. "If a novice starts changing the system by closing valves, they have no idea what kind of problems they could create."


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HASTA LA VISTA FUEL THEFT

Ian Deacon, Fotech Solutions, UK, reviews the long-term feasibility of Mexico's approaches to pipeline fuel theft and outlines more sustainable preventative security measures.

In the first half of 2019, it was commonplace to see long lines of people waiting at petrol stations, jerrycans in hand, in Mexico City and across the rest of Mexico. This was just the latest culmination of a crisis that has gripped the country since 2017.

It is not necessarily a problem unique to Mexico. The US is home to some 2.7 million miles of pipelines – by far the biggest pipeline network in the world – yet falls short of the best and most recent practices on physical and cyber security. A host of other countries, such as Nigeria, have also experienced spikes in criminal activities on pipelines.

In Mexico, however, it has reached almost endemic levels. Fuel theft is a problem that has existed here for decades, largely perpetrated by local gangs. However, in the last few years it has escalated dramatically as the country's largest and most organised criminal groups have turned to pipeline theft in the face of a crackdown on drug-related businesses. These criminal gangs often target pipelines in remote areas and sell fuel on cheaply to rural communities.

Data reported by Reuters in January 2019 reveal the issue's staggering scale. In the first 10 months of 2018, Pemex reported more than 12 500 illegal taps on its pipeline network, and Reuters estimates that these taps are capable of siphoning off approximately 150 000 bpd of product.[1]

During an investigation into the crisis, a minister summarised the extensive scale of the illegal taps when he related that investigators simply "kept finding things and finding things". According to official numbers, the black market for stolen product was worth as much as US$3 billion/yr as of early 2019.

Cracking down on the fuel thieves

The fact that fuel thieves have grown so prolific and their siphoning methods so sophisticated, has created a backlash from the Mexican government. Spurred on by a particularly damaging attack in December 2018, when 1.5 million gal. of gasoline were extracted through a single illegal tap, and an explosion on a punctured pipeline in January 2019 killed more than 130 people, the authorities declared an all-out assault on the fuel thieves.

In early 2019, the Mexican government began to divert product to tanker trucks under armed guard. Federal security forces were deployed to protect pipelines and refineries. Suspected thieves and corrupt employees at Pemex were arrested and their bank accounts frozen. Officials even went as far as shutting down some of the biggest and most heavily targeted pipelines, which caused the fuel shortages playing out at fuel pumps across Mexico.

In May 2019, less than four months after initiating the offensive, the Mexican president claimed that fuel theft had been slashed by 95%. While this was an impressive achievement, local and international observers are unconvinced by the sustainability of the crackdown. Many believe that the fuel thieves are merely 'waiting out' the government and will come back in full force once attention and security measures are shifted back to other priorities and problems.

The need for long-term strategies

Indeed, although the efforts of the Mexican government have had an impressive short-term impact, it is hard to believe that they are a sustainable long-term strategy. Given the scale of pipeline networks, which traverse huge distances, often in rugged and remote environments, it is simply not viable to keep security forces in place as any sort of permanent defence. Equally, can the economy sustain the crippling shortages that result from closing pipelines?

The costs and harm that result from these heavy-handed approaches could end up causing as much harm as the thievery they are intended to prevent.

Instead, combatting the product-theft epidemic in Mexico requires smarter solutions. Fortunately, technology exists that can effectively detect, locate and prevent third-party intrusion (TPI) events. This technology can provide a real-time and in-depth view of pipeline security – delivering reliable and actionable information that allows for real-time decision making and a rapid rate of response, to stop thieves at the source and meet the security challenges posed by criminal gangs.

Strengthening security through technology

Pipeline intrusion detection systems (PIDS) are fast becoming critical to global pipeline security strategies. The growth in deployments of these systems is driven by the protection they can give to pipelines that are deployed in harsh environments, densely populated areas, and remote locations that have often proved difficult to monitor and secure through traditional methods.

Indeed, traditional security technologies such as aerial surveillance, closed circuit television (CCTV), and ground radars, although still useful as part of a multi-layered security solution, have significant limitations. Most notably, each technology is limited in range and it is not commercially viable to deploy enough sensors or cameras to monitor the entire length of the pipeline. In the case of cameras and other 'point' solutions, systems are visible and easily circumvented by well-funded, sophisticated and determined criminals.

In the case of mass balance sensors, which can detect changes in the weight of the product in pipelines as a potential indication of a tapping incident, they may only be able to pinpoint an incident to a section of pipeline several kilometres in length. This makes it impractical as an information source when rapid responses are required.

In contrast, distributed acoustic sensing (DAS) deployed at the heart of new PIDS infrastructure gives pipeline operators significantly enhanced capabilities when it comes to monitoring pipelines.

DAS-based PIDS utilise fibre optic cables that run alongside a pipeline. By harnessing cutting-edge photonics, advanced artificial intelligence and edge computing, DAS converts these cables into an ecosystem of highly-sensitive, individual vibrational sensors, enabling the successful detection, classification and alerting on a range of threat events and activities. DAS can identify, with clarity and confidence, the different types of disturbances that might impact a pipeline and provide operatives with specific alarms to accelerate the decision making process.

Fully-integrated DAS PIDS can cover the entire length of pipelines – providing a complete real-time view over potentially hundreds of kilometres of pipeline, and giving operators access to unique insights that can inform and speed up decisions.

Realising operational efficiencies and security gains

The capabilities of DAS mean that operators can significantly strengthen their security monitoring. With PIDS in place, they have access to invaluable intelligence and key insights into both the location and nature of a potential threat. When it comes to preparing a response – whether it is a criminal gang attempting to tap a pipe, tunnelling in from afar, or an unexpected excavation activity taking place around the pipeline – operators can react with confidence.

Crucially, the insights and alerts that DAS can deliver can be monitored from one central control facility, enabling clear and controlled decision making in high-pressure security scenarios. This means operators can optimise how they direct their incident responses and maximise the efficiency of how they use their other security resources.

For an example of how this technology can benefit authorities in Mexico, look at India, a country that also experiences high rates of pipeline theft.

In a deployment involving Fotech, 26 separate hot tapping incidents were detected on one single pipeline in a six month period. The majority of these tapping attempts were prevented before the potential thieves could reach the pipeline, as digging in the proximity of the pipeline was detected and an alarm was raised that subsequently provided timely, actionable information for the operators. This information enabled the security teams to direct their responses more effectively, resulting in several arrests. The DAS data has also been made available as evidence in support of prosecutions.

In one particularly sophisticated case, DAS was able to identify and locate sporadic and quiet digging activity over several nights. This was ultimately identified as a tunnel that had been dug from a building approximately 20 m from the buried pipeline for the installation and operation of a valve for a bleed-off pipeline. However, directed by the DAS data, the tunnel was successfully discovered, the hot tap removed, and evidence collected for law enforcement agencies – which would not have been possible without DAS in place.

Conclusion

The exponential rise of pipeline theft in Mexico provides an object lesson in just how difficult it can be to maintain the security of pipelines. While the frequency of incidents has subsided in Mexico for now, operators and authorities cannot afford to be complacent. As the threats to pipelines and refineries intensify, the climate for operators has never been so challenging and smart technologies are becoming a necessity.

The operational, commercial and environmental responsibilities of pipeline operators mean that sending in troops or cutting off pipelines are not long-term solutions. Instead, the industry requires responsive technology designed to meet evolving security threats. Even in the face of determined criminal activity, DAS can provide a significant boost to pipeline protection efforts and should be an essential element of security strategies. WP

References

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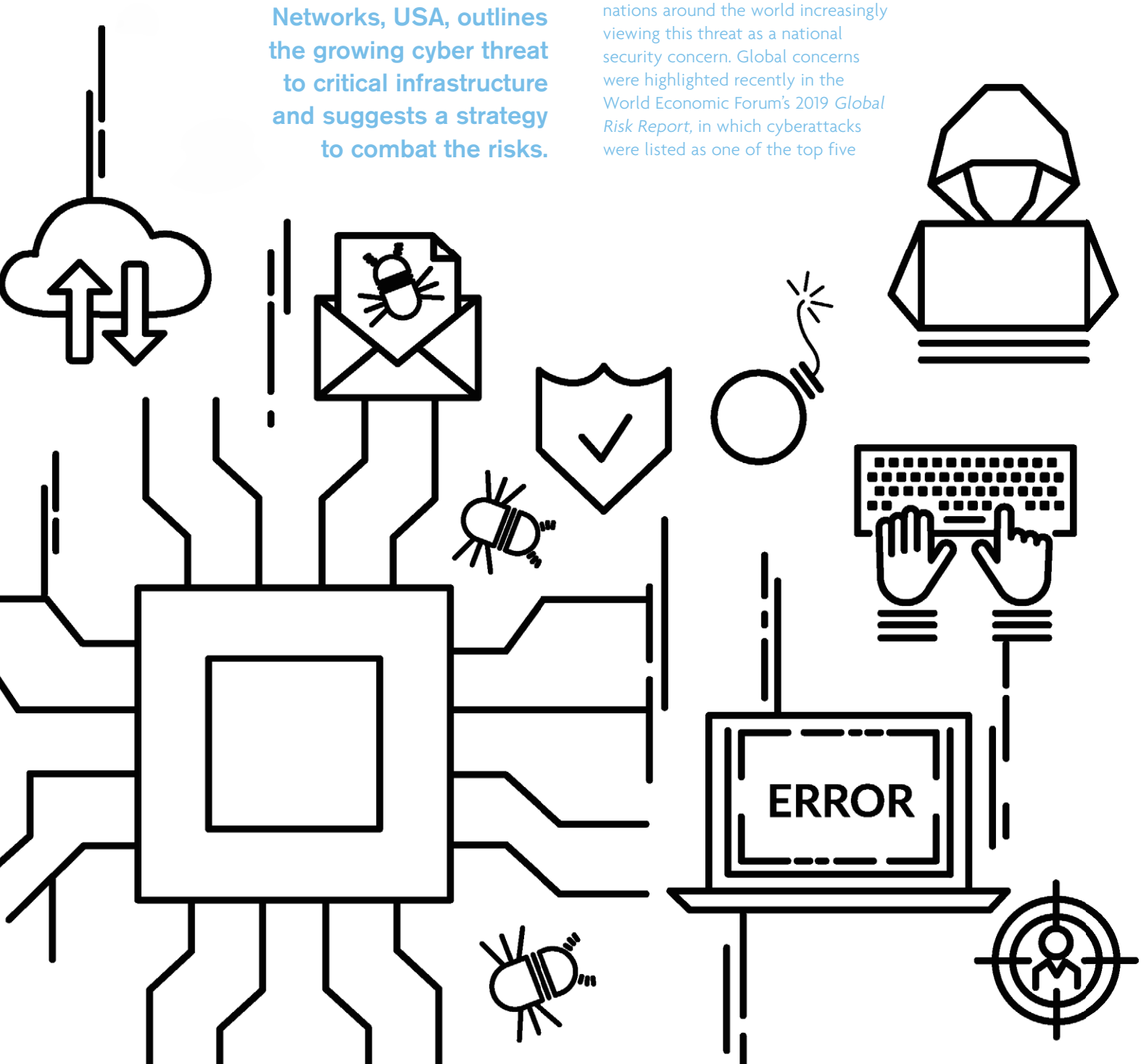
CRITICAL NATIONAL INFRASTRUCTURE UNDER THREAT

Andrea Carcano, Chief Product Officer and Co-Founder at Nozomi Networks, USA, outlines the growing cyber threat to critical infrastructure and suggests a strategy to combat the risks.

There are growing global concerns about attacks against critical national infrastructure (CNI), with nations around the world increasingly viewing this threat as a national security concern. Global concerns were highlighted recently in the World Economic Forum's 2019 *Global Risk Report*, in which cyberattacks were listed as one of the top five



global threats, consolidating their position in the global risk landscape as a high impact and high likelihood threat. Furthermore, the report stated that cyberattacks and critical infrastructure breakdown was the second most cited interconnected risk.

A nation's essential services, which include energy, transportation, communications and emergency services, are classified as critical infrastructure. In the US there are 16 critical infrastructure sectors and in the UK there are 13 listed. If any of these infrastructures were to be compromised, there would be widespread disruption and potential danger to life.

Cyberattacks against critical infrastructure have never been easier, and the myth that CNI systems are impenetrable has been truly discredited by devastating cyberattacks such as the Stuxnet virus, Wannacry and NotPeyta.

The challenges of critical national infrastructure cyber security

Within CNI organisations it has traditionally been IT teams that have been tasked with protecting critical business applications from associated cyber security threats, whereas engineering and operational teams have taken care of managing operational technology (OT). However, as OT within industrial plants has grown increasingly connected, this has resulted in the convergence of two traditionally siloed departments.

OT systems have historically been designed without cyber security in mind. Security concerns have previously focused on preventing physical access. However, modern industrial plants regularly connect machines, devices, sensors, and people to the internet. The use of Industrial Internet of Things (IIoT), which involves connecting smart devices and using the data collected to increase efficiency in production and cost, has eliminated the security blanket of a fully air-gapped OT environment. The expansion of smart technologies and widespread digitalisation within critical infrastructure has brought the worlds of IT and OT together. The increased connectedness and convergence of IT/OT has multiplied the number of entry points hackers can use to compromise these environments, and opened up a world of new attack techniques.

To benefit from increased connectivity within CNI, all connected devices and networks must be secure. The strength of this security will determine how vulnerable CNI is to a cyberattack.

Malicious tactics: an easier playing field

As a result of the proliferation of online tools, the knowledge that threat actors need to carry out sophisticated and potentially catastrophic cyberattacks on CNI has decreased. Attacks on industrial infrastructure can be achieved through smart use of open source software (OSS), application of ICS malware frameworks, and the intent to do harm. DragonFly 2.0 is just one recent example of attackers using OSS tools to attack ICS.

Today we are also more frequently witnessing devastating attacks that are carried out by straightforward and low-level techniques such as phishing, however attackers are still seeing significant success.

For instance, in 2015, cyber criminals used sophisticated malware to disrupt the electricity supplies of 230 000 people in Ukraine. Three energy distributors were targeted by spear phishing emails which, when clicked on, downloaded the malware onto the systems. The attack was attributed to the advanced persistent threat (APT) group BlackEnergy and is considered one of the first cyberattacks on CNI. Following this, in October 2018, a new piece of malware believed to be a successor of BlackEnergy was discovered by ESET researchers. This malware was named GreyEnergy, and it had been targeting industrial systems in Ukraine and Poland for the past three years. The malware, similar to the methods of BlackEnergy, used phishing attacks against employees to gain access to company networks. An attack starts when an employee is emailed a malicious word document. If a user clicks on enable content, then the GreyEnergy malware is downloaded. Once inside the systems, the malware avoids detection because of its cleverly constructed code, which utilises anti-forensic techniques.

The convergence of IT/OT means that the protection against these types of attacks – previously offered by air-gapped ICS systems – is now obsolete. The increasing connectivity of ICS and SCADA systems has opened CNI to cyberattacks that would have previously been isolated to IT systems. Both BlackEnergy and GreyEnergy highlight how phishing attacks are an essential tactic in an attacker's arsenal. As a result, practising good cyber security hygiene and educating staff can help prevent future attacks.

So, how are specific CNI sectors affected by these cyber security threats?

The cyber challenges facing the midstream oil and gas industry

The US midstream oil and gas industry is experiencing rapid digitalisation, resulting in increased connectivity and improvements in efficiency and reliability. In the industry, operators are focused on keeping product flowing securely and safely through pipelines. To mitigate any cyber security or operational issues that could result in outages, full visibility of the network is required. However, operators face a range of challenges in implementing a strategy for achieving full operational visibility of pipelines. These include:

- The vast length of pipelines, which leaves them vulnerable to physical and cyberattacks.
- Limited visibility of the components that make up the pipeline system.
- Inadequate capacity to detect developing operational problems.
- Multiple customers on the pipeline, each with different security levels, as well as a reliance on customers to implement a good security practice.

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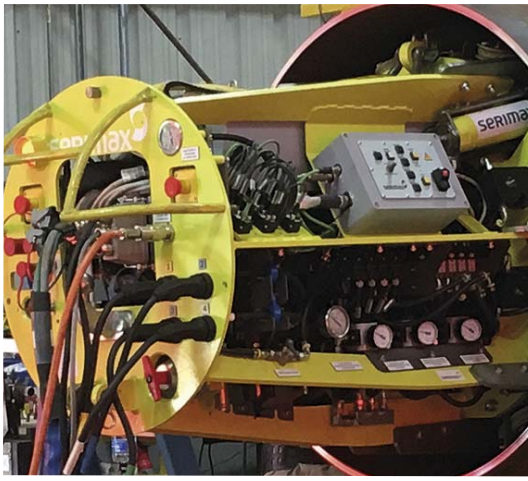

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- Impractical nature of manual audits.

To solve these issues and prevent cyber security or operational issues, network and asset visibility is essential. Automated monitoring of industrial networks is the solution to preventing unplanned downtime.

The electricity grid under attack

Electric utilities are also becoming increasingly interconnected in a bid to improve operational efficiencies and reduce carbon footprint. However, this is establishing a new and wider attack vector for bad actors and raising concerns about cyber security. The growth in attacks targeting energy infrastructure has increased the focus of governments around the world on critical infrastructure cyber security.

In the US, over 3000 utility companies work together to deliver power through 200 000 miles of high voltage transmission lines. Millions of homes and businesses are powered by 55 000 electrical substations and 5.5 million miles of distribution lines. An attack on any of these grids would leave millions of people without power – causing widespread disruption and potential loss of life.

In March 2018, the US Department of Homeland Security (DHS) issued a report describing Russian cyberattacks targeting US critical infrastructure. The identification of the threat actor was a rare occurrence, and with this the DHS also revealed the attacker's strategic intent, a timeline of the attack, indicators of compromise (IOCs), and detection and prevention measures. On 15 March 2018, US-CERT released an advisory describing the Russian cyberattacks. The key details were:

- A key tactic used in the campaign was to infiltrate third-party supply chain vendors using spear phishing and altered trade publications and websites.
- The credentials required to carry out an effective spear phishing campaign were gathered from publicly available information.
- The malware established multiple local administrator accounts.
- User credentials were collected and stored by tools that had been downloaded onto the network from a remote server.
- Information on industrial networks and network processes was collected.
- The threat attacks cleared logs and removed malware applications, registry keys, and screen captures to avoid detection.

Whilst these attacks did not result in widespread disruption of the US electric grid, it does appear that in this instance it may only have been fear of the consequences holding the attacker back.

Concerns about the threat of cyberattacks against CNI have since re-emerged at the forefront of discussion in boardrooms and on the plant floors of US utilities and their suppliers. What happened during these cyberattack campaigns offers utility companies the opportunity to learn how to better protect themselves in the future.

Protecting critical national infrastructure: the next steps

Connected industrial networks offer a range of benefits, but cyber security needs to be prioritised. The technology to provide visibility for large, heterogeneous, high availability industrial systems did not exist five years ago. In 2019 it is a different story, and these types of technologies need to take centre stage, providing industrial infrastructure organisations with real-time visibility of cyberattacks, risks and incidents. Operators should endeavour to have real-time visibility of their networks, allowing them to rapidly detect anomalies using machine learning and artificial intelligence. These technologies can passively monitor network activity and traffic to identify suspicious activity and stop attacks quickly.

In addition, companies should identify all the devices connected to their network, ensuring that all are secure. A vulnerability management programme can aid organisations in identifying vulnerabilities that need to be patched or mitigated. This will allow operators to access their cyber risk and take appropriate action to secure CNI. It is crucial that any vulnerabilities that are detected are patched or mitigated quickly to avoid unauthorised access to industrial systems.

Phishing attacks have emerged as a common tactic that bad actors use to gain access to industrial systems. This is good news. Companies can prevent attacks through educating staff on the dangers of email phishing campaigns, being taught to identify malicious emails, and learning the importance of reporting any suspicious activity to the appropriate security teams. People can often be the weakest link within an organisation's security strategy, so teaching staff to 'think before they click' can contribute massively to protecting CNI.

The convergence of IT/OT requires organisations to adopt a converged IT/OT cyber security strategy that includes centralised oversight. IT and OT cyber security will still require different sets of tools, but organisations need to ensure compatibility and integration in areas such as asset management, endpoint and network protection, security monitoring and reporting, and secure remote access. This can require formal organisational changes that bring together teams of people that work in IT, OT and security operation centres (SOC).

Co-ordination and intelligence sharing between government and private enterprise will be crucial for effective navigation of an increasingly complex and sophisticated threat landscape. The sharing of information on evolving threats will help organisations implement the necessary strategies for securing critical infrastructure from the inside out.

Today's attackers, whether they are cyber criminals or nation states, do not appear to be slowing down. However, the more we learn and understand about the attackers' playbook, the greater chance we have of putting ourselves a step ahead of the bad guys.

TRANSPORT FOR ALL TERRAINS

Erica LoPresti, on behalf of Terramac, USA, explores how rubber track crawler carriers can be used for a variety of tasks during operations.

The very nature of pipeline construction demands versatility, ease of operation, and reliability from the equipment that is being used. A pipeline right-of-way (ROW) extends across various types of terrain, causing ground pressure and traction to be major concerns throughout the process. The rubber track crawler carrier is engineered to tackle the various tasks of a pipeline project.

Standard wheeled trucks and steel track carriers have traditionally been the preferred solution for most material transport applications, but pipeline contractors found that productivity suffered when these heavy haulers became stuck in wet ground conditions. In addition, the footprint of these machines often caused enough soil damage in transit to require remedial repair work, resulting in project cost overruns.

Figure 1. The Terramac RT9 crawler carrier with two tac welding units working on a 10 in. and 12 in. pipeline.

"Rubber track crawler carriers are designed for the type of terrain chassis trucks and other vehicles can't handle due to ground conditions, steep grade or working angles," says Mike Crimaldi, CEO of Terramac, a manufacturer of rubber track crawler carriers. "One important benefit of the rubber tracks is that the vehicle exerts minimum ground pressure at full capacity. This leaves a minimal footprint for less soil disturbance and provides reduced slippage for the toughest weather and terrain conditions. In addition, with the ability to manoeuvre in all types of terrain, crawler carriers can easily haul material when necessary on asphalt access roads without damaging the surface."

"The multi-purpose carrier is built with a frame that easily accommodates customisations," adds Crimaldi. "It can support various types of specialised pipeline equipment for the job at hand. Anything seen on the back of a truck can be outfitted onto a carrier."

"The capabilities of the crawler carrier are unlimited," says Chris Holomon, Purchasing and Procurement Professional at Enviro Services. "These machines are so versatile that they can be used from start to finish on a pipeline project. Interchangeability between attachments is a main drawing point for utilising crawler carriers on pipeline projects. In the beginning phases, crawler carriers can haul and transport material or personnel down the ROW. They can be used for various tasks, such as welding and sandblasting during the middle phases, as well as during the final phase for reclamation."

The result is the ability to take workers, equipment, and raw materials to any job location to complete the pipeline on time and on budget. These tasks include the following:

Figure 2. Rotating functionality enables the Terramac RT14R to haul and dump materials in confined spaces.

Figure 3. Configured with a personnel carrier, Terramac units transport crews to remote pipeline jobsites.

Clearing and potholing

The pipeline ROW is cleared of vegetation in order to establish a path for the pipeline, as well as for the transport of equipment and material during the construction process.

"Crawler carriers are used to remove the brush and mulch from the ROW, which is often repurposed during the reclamation process," says Jesse Whittaker, Director of Business Development at Terramac.

Potholing to identify existing utility lines before trenching and laying pipe is also a critical early step. This process has been improved with the use of vacuum excavators, also known as pothole rigs, mounted onto rubber track crawler carriers.

"The crawler carriers equipped with pothole rigs provide contractors a safer, faster, and more cost-efficient exposure of the pipelines," says Holomon. "Crawler carriers are widely used for this application for their nimble movement on all terrain types, unlike wheeled semi-trucks that were previously used."

Hauling and transport

Flatbed crawler carriers lead the way on pipeline jobsites by hauling mats in preparation for heavier equipment to come through, while dump bed carriers haul out debris and bring in rock, sand bags and other materials. "More than 35 years ago we used to haul material along the ROW with sleds pulled by dozers. Sometimes two pieces of heavy equipment needed to be used," explains DJ Craven, Vice President of Pipeline Systems Inc. "Crawler carriers allow us to combine these tasks but at a lesser cost, because they can be operated by one trained crew member. This results in our crews being much more self-sufficient."

"We need to be able to transport material in between the access points along the ROW," says Craven. "There can be thousands of feet between each point, and the terrain can be extremely hilly or muddy. Because of their lighter footprint, the crawler carriers are able to effortlessly transport sand bags and dirt to the remote areas in which the crews are located, regardless of ground conditions."

Breakthroughs in conquering various terrain types have led to other developments for crawler carriers. "We developed the Terramac RT14R unit that features a 360° rotating upper frame," says Crimaldi. "The unit's unique rotational functionality allows materials to be offloaded faster and the driver can head right back out. This solution has dramatically saved time by eliminating the need for the driver to navigate the truck into a dumping position through a series of start and stop manoeuvres. Instead, a simple touch of the switch rotates the bed into the desired position to deliver the material to the exact location, without any adjustment of track positioning."

Contractors are provided with a solution to tackle a range of applications while improving efficiency and saving costs. The amount of time saved adds up quickly when the number of loads being hauled on a daily basis is factored in.

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An additional application for rotating crawler carriers is evident when padding the pipeline; sand bags, cribbing or other material can be dumped directly into the trench, rather than left on the side. Also, mat hauling on steep inclines with a rotating unit provides less wear on the undercarriage and increases the life of the machine.

Personnel transport

Personnel carriers make the transport of crew members to and from a jobsite a safe, easy, and efficient task. Personnel carriers are utilised throughout the entire pipeline project – from the clearing crews to the final reclamation crews – for their ability to transport the maximum number of workers with one vehicle while minimising trips over rough, soft, and steep ground conditions.

"One personnel carrier can take up to 25 crew members plus all of their tools and meals safely out to the jobsite and back," says Whittaker. "No need for multiple vehicles that get in the way or get stuck trying to get through. The cabins can also be enclosed and equipped with heaters to protect crews from the worksite elements, which makes a big difference."

Pipeline stringing

Transporting pipe along the ROW requires the utmost strength and attention to detail. Crawler carriers equipped with a specialised fifth wheel attachment simplify the pipeline stringing process by pulling the stringing trailer. These specialised carrier units allow the stringing crew to efficiently string the pipe from end-to-end along the ROW, eliminating the need for using heavy haulers that cause soil damage or become stuck in adverse ground conditions while in transit. Flatbed carriers can also be utilised during this process to haul pipe to the jobsite.

In addition, crawler carriers with fuel tanks provide fuel for the entire fleet of equipment while working along the ROW; this increases productivity as machinery does not need to travel from the remote jobsite to a main road or equipment yard for refuelling.

Pipe welding and coating

Crawler carriers are often used as all-terrain welding systems. After the stringing and bending are complete, the pipe sections are aligned to be welded together in preparation for placement into the trench.

Figure 4. Crawler carriers tackle environmentally sensitive jobs with a variety of restoration equipment, including hydroseeding units.

"There is no easy way to get the welding trucks with rigs out to certain areas, especially when working in the hills of West Virginia, Pennsylvania, and parts of Ohio," says Craven. "The hills are not the terrain for a pick-up or heavy-duty truck. However, with the low ground pressure and off-road capability of a rubber track carrier, our crews are able to tackle the challenging ground conditions, reach the worksite while carrying the welding system, and finish the job."

Crawler carriers can also be configured with a crane to help the welding crew pick up and hold a line clamp whilst tac welding the pipe into place. The crane is also useful for holding up a canopy to provide the crew with shade during the welding process, which is important for keeping sun glare out of their welding hoods.

"The Terramac RT9 with tac welder unit has become highly useful on our customers' pipeline jobsites," says Whittaker. "It's able to deliver power for up to four welders at one time while also providing the shaded canopy necessary for teams to perfect their welds."

In addition, crawler carriers can be equipped with sandblasting rigs, air compressors, and sandblast pots to make cleaning and coating a simple process for maintaining a pipeline over time. These specialised carrier units allow crews to sandblast the welds and remove any of the initial coating that could have been damaged during the welding process.

Reclamation

Restoring land to its original state is the last part of a job, and reaching jobsites in need of environmental reclamation has a reputation for being problematic. However, this important step can be made easier with rubber track crawler carriers equipped with specialised restoration equipment, such as hydroseeding units.

"After the pipeline construction is complete, we use the Terramac RT14 to haul and replace the topsoil along the ROW and then follow up with the RT14 equipped with a hydroseeding unit to seed, fertilize and mulch the land in one simple process," says Roger Zacher, Co-Owner at Absolute Reclamation Services.

Crawler carriers with water tanks can be used to supply the hydroseeding crew with a steady supply of water to increase production. Other restoration attachment options include bark blowers and straw blowers.

Crawler carriers are also utilised for the installation, maintenance and removal of erosion and sedimentation (E&S) control devices along the ROW.

"Due to the flotation from the rubber tracks, we are able to safely maintain the E&S devices with minimal environmental damage and disturbance to the soil. Once we achieve 70% growth on the ROW, we are able to go back in and remove all of the E&S devices," says Zacher. "At this stage, land owners may also want the wood chips removed from their fields and pastures located along the ROW. We utilise the crawler carrier to haul all of that material back out so the crews finish the job with little evidence they were ever there working."

Wave goodbye to water

Lindsey Mattson, ROWD, USA, outlines the recent advancements in dewatering structures for pipeline construction.

Developed out of frustration from dealing with straw bale structures, the concept of a new way to dewater was invented in the field with safety, environment, and efficiency in mind. ROWD provides the pipeline construction industry a versatile dewatering structure that can hold either straw bales or filter sock between the rectangular internal and external frames. Key features include heavy-duty steel construction for durability and functionality; large frame member design that allows levelling on any surface; skid mount design for mobility; and dewatering capability that meets and maintains strict environmental compliance.

A structure for any terrain

The ROWD sled made its debut on a project with mountainous terrain, limited access and limited working space, cutting dewatering costs by 80% and earning its place on the project as it was put to the test day after day.

Making it easy to dewater, the sled was a much-needed solution for this challenging pipeline construction project. “The ROWD sled has proven its value on our project,” said Kris Evanto, Project Director at Precision Pipeline, LLC. “We started with one ROWD sled to see how it would perform on a project with difficult terrain, and we soon realised we needed to increase their use on this highly scrutinised East Coast project to comply with strict environmental regulations, in order to complete dewatering on time and within budget. We couldn’t have done it without ROWD.” Starting with just one ROWD sled, the tie-in crew carried it with them for their dewatering needs, and by the first week this single sled had replaced five conventional structures and reduced the amount of discharge hose the crew had to use.

Figure 1. Locking the filter material between external and internal steel frames, the ROWD sled is assembled and moved from one location to the next without filter material shifting.

Figure 2. The ROWD sled is assembled off-site in a convenient location and hauled to the dewatering site ready to use.

ROWD utilises inner and outer steel interlocking frames on a movable base to transport easily and maintain efficiency after multiple uses. The steel structure is designed for hauling with trucks and moving with equipment, while the solid base helps facilitate levelling in any location. After pushing, pulling or carrying into the dewatering site, levelling is completed by placing material under the solid base to lift the edges and create an efficient dewatering structure. The ability to quickly level the ROWD was especially helpful in the mountainous terrain of the project, where conventional structures would have been transported in pieces and built on imperfect ground. The tie-in crew on this project hauled one ROWD sled with them for the length of the right-of-way, dewatered as necessary, and simply replaced filter material when needed. If conventionally built dewatering structures had been used, the crew would have made multiple trips to bring the necessary filtering materials to each location prior to dewatering, spent many hours pounding wooden stakes into the rocky ground, and then abandoned the used structure until environmental crews came to clean-up afterwards. The mobile ROWD sled eliminates the waste of conventional structures by allowing filter material and filter bags to be used until they are completely spent. Filter material and filter bags remain in the ROWD sled and are moved to the next site. A piping inlet and valve secured to the filter bag traps sediment-laden water during transport, so the filter bag can be completely used before replacing. Once completely used, the filter bag is easily replaced with the help of a filter bag remover to lift out the heavy bag while leaving the straw bales in place. Crews can easily attach a new filter bag into the centre of the ROWD sled and dewatering is ready to resume. The sustainability of ROWD eliminates partially used structures, reduces filter material waste left for clean-up, and minimises excess fuel used for transportation; saving time and money for the project, as well as allowing the environmental crew to focus on other tasks.

Technical specs

Dewatering regulations typically create new challenges in pipeline construction. ROWD uses the idea of straw bale (or filter sock) filtration but places it in a sturdy steel frame, so the amount of water that can be run through without failure is increased while maintaining the mobility of the sled. By locking the filter material between concentric rectangles, the ROWD sled also becomes a safer dewatering structure as heavy, water-logged straw bales are prevented from shifting and collapsing, such as in conventional structures.

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Constructed off-site and easily transported for assembly, a ROWD sled is designed to ensure proper function with every use. The steel structure is built to hold either straw bales or an 18 in. filter sock, and has a filter bag in the centre. Having the ability to assemble off-site allows the crew to set up the structure completely before the sled arrives on site ready for use. "The best part about ROWD sleds is that they arrive already constructed," states Evanto. "Our crew simply adds the filter material to the steel frame, brings the sled to the dewatering location, and lets it pump until dewatering is complete. Even in tight working spaces and difficult terrain, we were able to manoeuvre a ROWD into place, level it, and quickly complete dewatering."

With ease of mobility and versatile filter options, one ROWD sled is capable of reducing manpower, material, and disposal cost. This was proved as the cost and time savings increased exponentially when more ROWD sleds were added to the project. "We used multiple units on all of our spreads," stated Evanto. "The cost savings combined with environmental compliance in every location makes the ROWD sled a must-have whenever dewatering is necessary."

Upon completion of dewatering, the ROWD sled is quickly moved to allow other construction activities to continue. This allows for more efficient filtration from site to site with less disposal of partially used filter material and filter bags, minimising the downtime across the entire spread. The ability to relocate one ROWD sled to a new dewatering location eliminates repetitive build and teardown throughout a project to save valuable time.

"While dewatering at a pipeline construction site was the inspiration for ROWD, we see it being applied in numerous other dewatering situations," says Steven Grice, representative of ROWD. "We continue to improve on the functionality and ease of use as we consider how this unique dewatering tool may be used in other applications." In the most recent flow test, ROWD performed effectively on both a 2° and 5° slope. The ROWD sled holds a maximum of 1816 gal. of water, which is 32 in. of water inside the centre of the sled. The flow test concluded that with a 6 in. pump operating at full throttle, even at a 5° slope, the dewatering sled never reached capacity and could have handled an even faster flowrate or steeper slope.

A safety study of the ROWD sled analysed the loading condition of the structure completely full of water. Each structural component met the allowable stresses for A36 steel using ASD design methodology under the loading condition. The results indicated a minimum factor of safety equal to 1.5, proving the ROWD sled is safe to operate under conditions that are less than or equal to extreme loading, regardless of ambient conditions to which the sled is exposed.

While the filtering concept ROWD is designed around is not new, the way it is assembled refines straw bale or filter sock dewatering to create a structure that can perform in adverse conditions and locations. During live demonstrations for FERC, ROWD sled received positive reviews and approval. It was stated that ROWD sled removed risks from jobsite dewatering, which is the number one violated task during pipeline construction.

Designed to be versatile, economical and efficient, ROWD can be effective on even the most difficult pipeline construction projects, with the ability to help bring a project to completion on time and within budget, all while maintaining safety and environmental compliance.

Note

ROWD™ patents pending.

HANDLE WITH CARE

Todd Razor, Vacuworx, USA, explains the advantage of preparation to meet the pipe handling demands of the midstream market.

An important measure of success for pipe handling and transportation projects is the ability to overcome logistical challenges that could threaten to endanger schedules, budgets and the well-being of construction workers.

In North America, according to a study produced by global consulting services company ICF and the INGAA Foundation,

Figure 1. American Pipe Handlers utilises a Vacuworx lifting system, coupled with a John Deere excavator, to handle 80 ft lengths of 20 in. OD oil pipe in Arkansas.

some 41 000 miles of pipeline will be installed across the US and Canada from 2018 to 2035, as the investment in new oil and gas infrastructure is projected to average US$44 billion/yr.

In the US alone, according to a review of Bureau of Labor Statistics data, overall employment of construction equipment operators is projected to grow 12% from 2016 to 2026, outpacing the average for all occupations. Demand for labourers and helpers, also projected to grow 12%, should mirror the level of overall construction activity.

That adds up to hundreds of thousands of future skilled personnel who will play a part in loading, offloading and transporting pipe to and from ports, pipe mills, storage yards, and staging points in the coming years.

Moving miles of pipe

Headquartered in Port Allen, Louisiana, American Pipe Handlers is one US-based pipe logistics services company working to stay on top of current demand in the market while gearing up for a prolonged stream of new business, both domestically and internationally. American Pipe Handlers offers a full range of storage and transportation services, including co-ordination with domestic and international manufacturers from the port to the construction site.

Established in 2015, American Pipe Handlers employs 36 people and relies heavily on its fleet of owned equipment to meet the needs of a customer base comprised largely of pipeline contractors, US-based steel mills and offshore manufacturers. Using heavy duty excavators, front end loaders, drayage vehicles, pole trailers and material handling equipment, the company's specialty is dealing with large quantities of oil and gas pipe arriving or departing by truck, rail, ocean vessel or barge.

Curt Gauthé, Owner and President of American Pipe Handlers and its non-asset management company, American International Maritime Company, is in charge of analysing the constantly moving parts of an operation that, in the past five years alone, has manoeuvred more than 4000 miles of pipe. The organisation is presently involved with simultaneous pipe handling jobs that stretch from Arkansas to Alabama, East Texas and Washington.

Figure 2. **80 ft lengths of 20 in. OD oil pipe in Arkansas being handled by American Pipe Handlers.**

Recently, American Pipe Handlers wrapped up a multi-month job that involved manoeuvring approximately 167 t of material ultimately slated for use in construction of the Keystone XL pipeline. Starting in December 2018, the contractor began transporting 80 ft lengths of 36 in. (914 mm) OD pipe that had been stored in a laydown yard at Wellspun Corporation's Little Rock, Arkansas location.

Utilising a Vacuworx RC Series vacuum lifting system, work crews loaded a total of 23 000 pipe lengths onto over-the-road trucks bound for a 700 mile journey by barge to be stripped and recoated by Bayou Companies in New Iberia, Louisiana.

Another large diameter project currently underway, which required the construction of a 26 acre pipe yard in Odessa, Texas, and a 10 acre pipe yard in Cleveland, Texas, will keep American Pipe Handlers engaged through the end of 2019. For this job, Vacuworx lifters are being utilised to offload approximately 225 miles of 36 in. (914 mm) OD pipe from rail cars to the prime rack for portions of the Wink to Webster pipeline.

Preparation is key

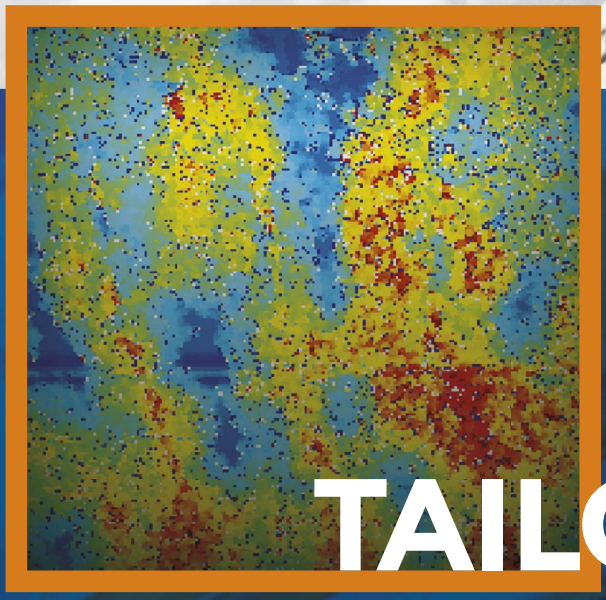
A former stevedore with decades of international logistical experience, Gauthé emphasises the importance of being prepared to help avoid interruptions in the event of any potential last minute changes in project requirements.

When operating on multiple projects, Gauthé says the first priority is making the best use of available resources, while always taking into consideration the issue of safety in the field.

For example, American Pipe Handlers owns approximately a dozen Vacuworx vacuum lifting systems, including RC 16 and RC 20 models with respective lifting capacities of 32 000 lb (16 t) and 44 000 lb (20 t). Although the majority of projects can be handled easily using the lower capacity lifter, the contractor deploys at least one of each lifter on applicable jobsites in an effort to be prepared for all contingencies.

According to Gauthé, employing both is a precaution that has paid off in the past. "I've got pipe moving right now that is 8000 lb (3629 kg) to 10 000 lb (4536 kg) per joint," he said. "The stuff I've got coming up is 22 000 lb (9979 kg). Things change. We've had situations where the dynamics of a project could change. Sometimes we have product in the field that comes close to capacity lines. When an audible is called, it's best to be safe than it is sorry, and to not be slowed down."

Compatible with a wide range of host equipment such as American Pipe Handlers' John Deere 350 and 470 excavators, Vacuworx RC Series lifters feature 360° rotation that allows for the precise placement of



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materials. The systems, operated by wireless remote, create a powerful positive engagement of the load and reduce or eliminate the need for tag line operators on the ground.

Comparing vacuum lifting technology with conventional hooks and slings, which can shift or come loose and require personnel to work in close proximity to the load, Gauthé said that vacuum lifting presents a definite advantage. This is especially true in field environments where actual jobsites and geographies can change daily.

"In the stevedoring industry, it was always about how quick," Gauthé said. "Out here, in the midstream environment, it's a completely different culture that revolves around maintaining a high level of consistency, in terms of how safely we can move the product.

"You've always got to be mindful of your surroundings. That's why Vacuworx is one of the best products to use in the field. It gets the job done safely, which is our number one priority. There is less exposure to people in the active work zone."

Many projects are in the pipeline

TC Energy, formerly known as TransCanada Corporation, has recommenced some preconstruction activities along the 1180 mile Keystone XL route, anticipating mainline construction on the Gulf Coast expansion project to begin in 2020. Over 9000 skilled labourers will be required to build the estimated US$8 billion project, with an approximate two-year construction schedule and the potential for tens of thousands of jobs to be created through its supply chain.

When complete, Keystone XL will have the capacity to deliver up to 830 000 bpd of crude from western Canadian oilfields to the Gulf Coast refineries.

The nearly 700 mile Wink to Webster pipeline, with the capacity to transport more than 1 million bpd of Permian Basin crude oil and condensate, is expected to become operational by the first half of 2021. The project has the potential to generate more than 3100 construction jobs.

The ICF and INGAA study notes that the US oil stream is becoming more highly comprised of light sweet crudes from regions like the Permian Basin, with expectations of greater US refinery blending of the Canadian heavy oil with the lighter crudes in the future.

"We base our core abilities to service a couple of big projects [at a time]," Gauthé said. "When we have the labour and equipment available, we will also work smaller projects in between.

"We have some really good vendors that we trust, and use subcontractors to keep everything moving. We will also rent machines when it makes sense, when it suits the timeframe and our proximity to a given project. The production will be there. If we have access to the people and equipment, to do it safely, then we can get it done."

SOWING THE ENERGY SEEDS

Giuseppe Ratti and Francesco Petrelli, Bonatti Mexico, discuss the development of an integrated approach to a variety of energy projects in the country.

Over the past seven years, Bonatti has completed several pipeline projects in Mexico, with over 1500 km of structures which are already in operation. The company consolidated its role in the country through the construction of facilities, such as compression, measurement and distribution, and pressure reduction stations.

It has built three compression stations, with a total of nine solar machines and 150 MW of installed power in Mexico. Added to these were 12 metering stations of varying capacities, pressure reduction stations and other facilities – all engineering, procurement and construction (EPC) based.

In Mexico, the interlocutors were the major distribution players of the area, namely IEnova and TC Energy (formerly TransCanada) through their subsidiaries Gasoducto del Noroeste, Gasoducto de Chiuaha, Infraestructura Marina del Golfo and Transportadora de Gas Natural de la Huasteca, with companies like Howard Energy and end customers such as CFE and Pemex.

Figure 1. Safety toolbox.

Figure 2. The Cañada Rica compressor station.

Figure 3. Construction of the petroleum terminal.

In addition to the compression stations of Los Ramones and Camargo that established a gas flow between the US and the centre of Mexico in 2017, the main completed projects include the compression stations of Cañada Rica and Tula within the Tuxpan-Tula project, completed in 2018, and the construction of the entire Sur de Texas system with gas-in starting at the beginning of 2019.

The Sur de Texas system was the result of work carried out by a project team that developed the engineering and procurement of two important measurement and distribution stations and a pressure reduction station, in addition to constructing 64 km of 36 in. and 42 in. lines. This was achieved entirely in-house in less than one year.

The project experienced changes in progress which suggested the use of horizontal directional drilling (HDD) on seven sites to mitigate the effects of some unexpected technical, environmental and right-of-way (ROW) issues. Permit problems were also solved, allowing gas input within the originally planned timeline for the important node which connects the 680+ km long sealine from Brownsville (US) to the networks of the Tuxpan-Tula, Tamazunchale and Cactus San Fernando systems, in addition to various other utilities.

Speed and innovative solutions, but also versatility – as in the case of the Tula-Villa de Reyes project (currently in progress), in which the customer requirement was to identify a company capable of modulating resources following daily changes of context (community, authorities, permits, ROW, engineering, etc.) – were needed, in cost-saving policy perspectives that were constantly shared with the customer.

The context

From the operational point of view, some of the difficulties encountered by Bonatti were tackled using a tailor-made approach adapted with works in progress, together with the customer, to handle specialised vendor management directly. This eliminated authorisation and formal steps, providing an advantage in time. A task force was created with end customers such as Pemex, CFE, etc. to eliminate extra steps in paperwork while operating in maximum transparency conditions. Finally, full-time work teams were created for specific tasks to finalise EPC contracts for compression stations in 11 months, from contract signing to gas input.

Pinpointing the inherent critical issues of operational areas in addition to those arising from customer needs is crucial. Examples include security – which is a priority particularly in states such as Tamaulipas, Nuevo Leon, Hidalgo, Veracruz and Sinaloa – and logistics. The latter is interesting because although proximity to the US is an advantage, issues arise from the sheer vastness of the area associated with the need to undertake construction works at sites in which basic infrastructure and services are not always available.

In order to address these needs, Bonatti has developed strengths which can be considered strategic in projects of

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this type. Worth underlining is the presence of a specialised in-house engineering team, which can be supplemented, if necessary, by the services provided by selected partners and the creation of interest groups on the territory able to provide all services in operation areas (long-term partnerships). A consolidated vendor list is used to ensure the speed and quality required by the high standards of customers, with whom working procedures and specifications are shared in advance.

A new challenge

Management that is capable of giving priority to safety and quality, without neglecting the business needs of stakeholders by exploiting operational flexibility in EPC perspective at the highest levels, has been met with approval. Such management has allowed Bonatti to approach a new potential market that is experiencing strong recovery in Mexico, namely the construction of storage facilities for petroleum products.

A new regulatory framework which envisages increasing safety stocks in the main urban areas and the needs of the storage tank construction sector in the near future, is expected to match well with the expertise gained over the years by Bonatti in providing integrated management and EPC services, developed both in-house and availing of consolidated partnerships.

In the medium and long-term, this development is expected to generate the necessity to implement interconnections between the new distribution hubs, by means of new lines dedicated to conveying different products – called 'poliductos' – to replace the current transport system on rail or road.

Accordingly, Bonatti is currently building the petroleum terminals of Puebla and Valle de Mexico. Once again, the target is to complete the installations – which will handle more than 1.2 million bbls of product – in record time (less than one year). For these projects, collaboration with the customer is even more important so that engineering development and material purchase can take place harmoniously, in view of all the possible optimisations achievable by adopting a 'one team' approach.

Key operating factors

To achieve the objectives of speed and market flexibility, internal processes have been streamlined to reduce the normal verification and approval cycles typical of different stages of EPC project development, by means of interdisciplinary engineering verification sessions with the involvement of the construction team from day one. This considerably reduces the gaps between engineering and construction that are typical of projects of this type.

Training local personnel to operate in multitasking mode was fundamental. According to a project's size, this consists of employing construction supervisors in quality tasks and involving technical office personnel in planning, in line with skills and project requirements. In this way, the entire staff can obtain an all-encompassing view of the work, allowing for the flexible use of each person in moments of market evolution, without dispersing the know-how acquired during the projects.

Strong collaboration, integration and the exchange of roles has, in practical terms, led to the identification of operational solutions such as off-site prefabrication of civil works, standardisation and prefabrication of steel structures. Examples include the pipe racks, which can be fitted in a bidirectional manner, or the construction of prefabricated superstructures with pre-installed cable tracks and utilities. These made customers appreciate the development of projects using an operational approach from the earliest stages, which gave a strong construction-oriented identity to Bonatti in the scope of EPC projects.

A window to Latin America

The challenging plans and the need to cut manufacturing and construction times has led Bonatti to develop a logistics hub located in San Miguel De Allende (Bajío Region). In addition to being the maintenance centre of the entire fleet of vehicles and the central warehouse, the hub was equipped with the prefabricated workshop and a sandblasting and painting area.

As a result, Bonatti was also able to establish itself as a manufacturer of medium and high-pressure vessels and light structures, and to prefabricate both lower and higher piping directly, reducing the risks and cutting the times of the normal production chain. The strategic position and the continuous growth and development of services and structure make the San Miguel hub a logistical and operational point of reference, and a window that looks out onto South America as a whole.

Conclusion

Whilst the projects described in this article were developed, Bonatti found favourable ground in terms of availability of resources, strategic geographical location (consequent to the proximity with the US) for specialist supplies and, more generally, for incentives granted to foreign companies interested in investing in Mexico.

It is likely that these positive impressions are shared by all foreign companies that approached this market. The economic liveliness in the various industrial sectors has allowed the investments of major players and their allied industries. The latter followed their main customers or perceived the business opportunities generated by the strong economic development.

Clearly, it is necessary to adapt to the local market to access the opportunities. One of the processes developed by Bonatti, for instance, was to focus on human resources and training to reach employment rates of local manpower close to 100%.

Recognising the value of people, combined with the 'tropicalisation' of business methods to fully adapt to the Mexican market, enables foreign companies to facilitate synergies with local businesses, creating real partnerships.

The application of all the processes mentioned have led to a very positive outcome on the Mexican market. This was only possible by working together with customers, and the results are tangible. The projects completed have led to the construction of major infrastructures which are already fully operational: over 150 MW of installed power, over 1500 km of operational pipeline, 14 HDD sites, tanks for more than 1 million bbls (currently underway), three compression stations and 12 metering stations.

Figure 1. PipePillos® used to stockpile 40 ft joints of 0.888 WT NPS42 pipe for the Mountain Valley Pipeline project in West Virginia, US.

STACK, STORE, SUPPORT

Meghan Connors, President of PipeSak Incorporated, Canada, describes the use of structured pipeline supports for all stages of pipeline construction.

Structured pipeline pillows (SPPs) are engineered pipeline supports developed to address the pipeline integrity concerns posed by traditional types of in-trench support for rocky areas, such as compacted sand and foam pipe pillows. PipePillos® are light enough to be handled manually, yet dense enough to resist flotation. Unlike other support methods, SPPs provide a full 90° of support, reducing the risk of ovality and denting. The patented, dual frustoconical design gives the SPP excellent compressive strength while keeping the weight low and manageable.

In addition to in-trench use, SPPs have proven to be an ideal support during all stages of pipeline construction, including pipe transportation, storage, fabrication, stringing and welding. The SPP is engineered to provide secure, standardised and permanent support.

Case one: In-trench pipeline support

Usage:
PipePillos were used in place of polyurethane foam and sand bags as in-trench pipeline supports to permanently elevate the pipeline from the rocky trench bottom.

Project:
The North Montney Mainline (NMML) project is a 206 km (128 mile), 1067 mm (42 in.) diameter pipeline in northern British

Columbia, Canada. This pipeline connects the liquid rich Montney formation, west of the Alaska highway, to the existing NOVA Gas Transmission Ltd (NGTL) infrastructure. PipePillos were used on Spread One of the project, located on a challenging section of terrain.

Problem:

The pipeline trench of Spread One was blasted through a shale formation, which resulted in an extremely rough trench bottom. The pipeline required supports to suspend the pipeline from the trench bottom, protecting it from damage and allowing sand padding to surround the pipe. Traditionally, foam pillows or sand bags would have been used in this situation. The remoteness of this site, coupled with the steepness of the trench, made sand bag supports an expensive and cumbersome option. In addition, sand bag supports would have compacted under the weight of the heavy pipe, creating a potential risk for denting and ovality. The foam used for in-trench pipeline support is a lightweight expanding foam similar to what is used for building insulation. For pipeline applications, foam is either sprayed directly into the trench or is preformed into blocks. However, foam is not engineered for compression strength and little testing has been carried out on its effectiveness in protecting pipelines from rock damage. Foam has also been proven to restrict cathodic protection (CP) systems. As most know, foam is an excellent insulator – this does not bode well with buried pipelines. For these reasons, the owning company did not approve the use of polyurethane foam due to the risk of CP shielding and its questionable long-term integrity.

Figure 2. **PipePillo SPP being tied to 1067 mm (42 in.) OD pipe outside of the trench and prior to installation on the North Montney Mainline project in Alberta, Canada.**

Figure 3. **1067 mm (42 in.) OD pipe being installed in a trench, utilising side booms with PipePillo SPP tied to the pipe. This was on the North Montney Mainline project in Alberta.**

Solution:

The owning company approved the use of PipePillo SPPs on Spread One to provide permanent support while ensuring the integrity of the CP system. Third-party testing had confirmed that the PipePillo SPP has negligible cathodic shielding effects when compared to foam. SPPs are incredibly lightweight – the SPP48 used on this project weighs only 19.5 kg (43 lb), light enough to be handled by a single labourer, and has an ultimate load-bearing capacity of 38 400 kg (84 658 lb) per SPP. The SPPs used maintained permanent contact with the pipe, helping to decrease the risk of pipeline ovality by up to 50%.

Outcome:

Workers were able to tie the PipePillos to the pipe using standard 0.25 in. rope, achieving the desired spacing as calculated by PipeSak (Figure 2). During installation, all PipePillo preparation work was undertaken out of the trench and completed within a few hours. The side booms lowered the pipeline sections into the trench with the PipePillos already installed, allowing a full 90° of support and 203 mm (8 in.) of elevation above the rocky trench (Figure 3).

Case two: Pipe storage and fabrication

Usage:

PipePillo structured pipeline pillows were used in the pipe yard in place of wooden cribbing for pipe storage, and to support the pipeline during fabrication and welding in both single and stacked configurations.

Project:

The Mountain Valley Pipeline (MVP) project is a 1067 mm (42 in.) OD natural gas pipeline scheduled to go into operation mid-2020. The pipeline route spans approximately 473 km (294 miles) through 16 counties in the states of West Virginia and Virginia. With a capacity of 2 billion ft^3/d of natural gas, MVP will play an essential role in providing natural gas to markets in the Mid and South Atlantic regions of the US. The MVP has utilised over 45 000 PipePillo SPPs to date, in place of foam pillows and sand bags, to support the pipeline in the trench. In addition to in-trench use, PipePillos are also being utilised by contractors outside of the trench to aid with pipe storage, fabrication, and welding.

Problem:

Standard practice is to use stacked wood cribbing in the pipe fabrication yard to store the pipe and to support it during

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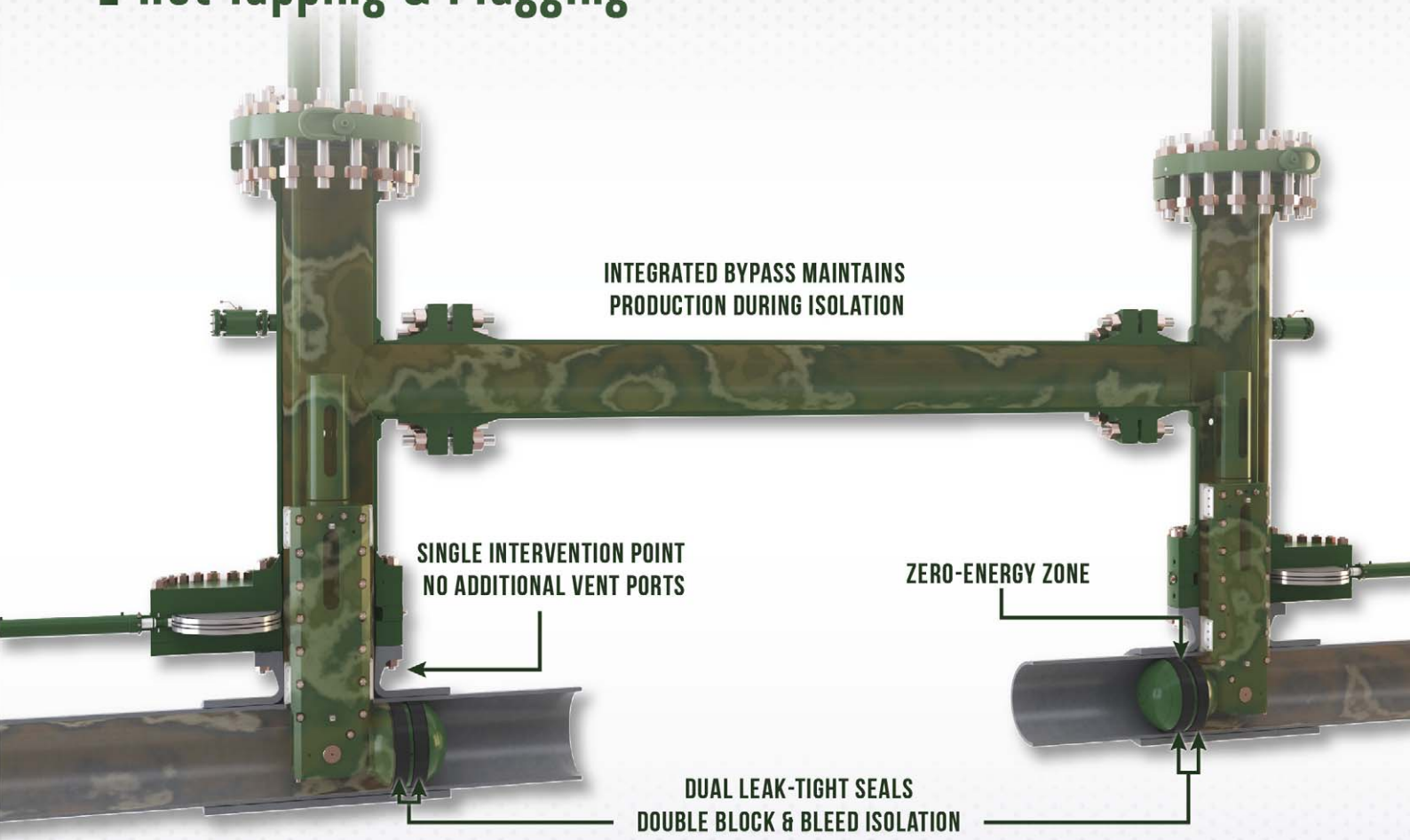

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Figure 4. **PipePillos supporting pipe while a welder backwelds a fitting on the Mountain Valley Pipeline project in West Virginia, US.**

fabrication and welding. Stacking wooden skids is a cumbersome and labour-intensive process that poses a significant safety concern in the yard. The pipeline contractor wanted a lower cost solution that provided reliable and uniform support with multiple height configurations.

Solution:

PipePillos were an ideal support for all stages of the project's construction. When used outside the trench, PipePillos supported the pipe in both a single and multi-stacked configuration, giving the contractor the freedom to easily adjust the height as required. Each PipePillo has two levels – one being the shipping level which adds 77 mm (3 in.) to the height. The other is the extended level which adds 115 - 152 mm (4.5 - 6 in.) to the height of each PipePillo. To achieve the extended level, the second PipePillo was rotated approximately one-eighth turn or 22.5° off centre. Spacing was typically two towers per joint of pipe – much like current wooden skids. The patented, dual frustoconical design gave the SPP good compressive strength and it was used repeatedly in the fabrication yard without compromising durability or strength. They offered 90° of support, ensuring the integrity of the pipe was maintained at all times.

Outcome:

PipePillo SPPs were successfully used in the fabrication yard for pipe storage (Figure 1), inspection, fabrication and welding (Figure 4). Contractors were impressed with the durability of the PipePillos and were able to reuse them over and over in the yard. Ray Steig, one of the contractors from Trinity Energy Services, said that "PipePillos [had] replaced skids for all of [their] pipe supports. The ease and stackability made it quick and easy to secure large bends. The durability of PipePillos [was] amazing – [they] reuse the same 24 for [their] daily bending."

Case three: Pipe stringing and welding

Usage:

PipePillo structured pipeline supports were used for low-level stringing of the pipe along the right-of-way in place of wooden cribbing.

Project:

The Brantford to Kirkwall pipeline expansion project was a 1219 mm (48 in.) OD, 14 km (8.7 mile) expansion to an existing line in southwestern Ontario, Canada. The expansion, beginning in Brantford and terminating at the Kirkwall Valve Site, was part of the Dawn Hub and Dawn Parkway. The Dawn Hub is the largest integrated underground natural gas storage facility in Canada, and the second most physically traded hub in North America. The Dawn Hub is strategically located in southwestern Ontario, only 300 km (186 miles) from the Marcellus and Utica shale basins of the US, which are expected to supply over 40% of the natural gas to the Dawn Hub by 2023. To service the Dawn Hub, the Dawn Parkway System consists of 225 km (140 miles) of parallel 660 mm (26 in.), 864 mm (34 in.), 1067 mm (42 in.) and 1219 mm (48 in.) OD pipelines as well as four mainline compressor stations: Dawn, Lobo, Bright and Parkway.

Problem:

Wooden cribbing is still widely used in North America for temporary pipeline support during stringing and welding. There is no uniform standard for wood cribbing and poorly supported pipe strings can cause serious injuries or even fatalities. Studies have found that the thermal gradient between the two sides of the pipe can cause longitudinal and transversal movements that can lead to pipe instability on wooden cribbing. The owning company wanted to trial a simpler and safer solution for low-level stringing and welding for the large 1219 mm (48 in.) OD pipe.

Solution:

PipePillo was selected for a number of reasons, primarily its ability to offer a full 90° of support, ensuring stability and safety for the pipeline and the pipeline workers. Furthermore, the patented, dual frustoconical design gives the SPP compressive strength while ensuring the pipe is securely supported during slight movements caused by thermal contraction and expansion. Finally, PipePillos are manufactured using high-strength polypropylene resins treated with UV inhibitors to ensure durability and longevity from the elements.

Outcome:

PipePillo SPPs were used to provide controlled and uniform pipeline support along the ROW during stringing and welding. The contractor was able to stack the PipePillos to achieve additional clearance in 76 mm, 152 mm and 203 mm (3 in., 6 in., and 8 in. respectively) increments. Stacking the SPP supports provided a safe and cost-effective alternative to using wooden skids to support the pipe stringing and welding process (Figure 5).

Case four: Integrity and rehabilitation projects

Usage:

PipePillo SPPs were stacked approximately 3 m (10 ft) high to support an exposed 1219 mm (48 in.) OD pipeline crossover and valve assembly during an integrity dig.

Project:

The Enbridge Dawn compressor station in southwestern Ontario is a critical component of the Dawn Hub, one of North

America's largest natural gas trading hubs. Natural gas, while being transported through a gas pipeline, needs to be constantly pressurised. A compressor station is a type of 'pit stop' for natural gas every 80 - 160 km (50 - 100 miles) that compresses the gas (increasing pressure) using a turbine or engine, and provides a boost to keep the gas moving along. The Dawn compressor station is one of four mainline compressor stations in the 225 km (140 mile) Dawn Parkway pipeline system, and is a critical component to keeping natural gas moving.

Problem:

A below ground tee and small section of pipe needed to be replaced with an elbow at the Dawn compressor station. A 1219 mm (48 in.) OD above ground cross over and valve assembly, weighing approximately 13 600 kg (30 000 lb), needed to be supported approximately 3 m (10 ft) above ground during the replacement work. The support method used needed to remain in place for several weeks until the replacement work was completed and backfilled. The initial plan was to support the above ground header using a crane until a custom manufactured support comprised of metal I-beams was put into place. Prior to designing such an expensive and time-consuming solution, the project engineers contacted PipeSak Incorporated to determine if PipePillo structured pipeline supports would be an option for this application.

Solution:

PipePillo SPPs can be stacked to achieve any height requirement. The stacked PipePillos can be easily slid under the pipe, making them beneficial for integrity digs. The PipePillo design incorporates a dual frustoconical shape which is able to transfer extreme loads effectively through to consolidated or virgin soil beneath. PipePillos are engineered to last up to 25 years above ground, making it an optimal solution for this above ground application. In addition to the strength and ease of use, PipePillos have several cavities that allow water to drain, reducing any risk of corrosion from water pooling.

Outcome:

PipeSak engineers designed a solution utilising 19 PipePillo SPPs to support the 1219 mm (48 in.) OD pipe. The SPP48 PipePillos were stacked up from virgin ground approximately 3 m (10 ft) (Figure 6). Two additional SPP48s were used to support the buried pipeline during tie-ins. Following completion of the welding, the replaced section was backfilled to grade – leaving the 19 stacked PipePillos in place until permanent concrete supports were installed.

Conclusion

PipePillo SPPs are an engineered, uniform solution for pipeline support – both in and out of the trench. PipePillo SPPs provide 90° of support to limit ovality, and their many cavities support CP systems.

Outside the trench, PipePillo is well-suited for use during transportation, storage, fabrication, stringing and welding as single or multi-stacked supports. PipePillo SPPs can also be used as an effective means to support exposed pipelines during and following integrity digs. Additional height can be achieved by stacking multiple PipePillos, limiting the requirement for compacted soil beneath the pipe. PipePillos are manufactured from high-strength polypropylene resins which are environmentally inert, yet softer than pipeline coatings.

With five sizes currently available, PipePillo SPPs can accommodate a wide range of pipe diameters from 60.3 mm (2.375 in.) to 1219 mm (48 in.).

Figure 5. PipePillos supporting 1219 mm (48 in.) OD pipes outside the trench for the Brantford to Kirkwall section of the Dawn Parkway expansion project in Ontario, Canada.

Figure 6. Stacked PipePillos supporting 1219 mm (48 in.) OD header pipe 3 m (10 ft) above ground at the Dawn compressor station in Ontario.

EVERYTHING'S CONNECTED

Figure 1. Pipeline under construction. PLTB aids in design, construction, operations, and integrity to maintain pipelines in a prudent manner. Image courtesy of Mears Group, Inc. HDD/DP Division.

Drew Lafleur, Technical Toolboxes, USA, examines how digital integration is helping operators to optimise safety and asset integrity management.

Digital transformation is now a global buzzword, regardless of the industry in which it is applied. In the oil and gas industry, the term is sometimes used interchangeably with 'integrated operations' or 'integrated oilfield.' Whichever terminology is chosen to describe the movement, the key concept revolves around the effort to increase profitability by creating paths of communication between people, processes, multiple data sources, databases and software applications, which have never 'talked' to each other before. Technical Toolboxes is a global provider of desktop and cloud-based pipeline engineering software, and has observed in many case studies how improved communication helps operators gain added insights into the status of equipment and operations, which may have previously been overlooked if close attention was not being paid to the data.

Changing formats

Digital transformation involves taking paper records and making them into databases, which can be used to extract individual data fields to load into calculations. It has been some time now since the industry-wide move was

made from paper to PDF formats (Figure 2). However, a PDF is not useful for operators attempting to feed that into an algorithm for a calculation. This type of data is required to be in a much more leverageable form. This is a key challenge that all industries face when they go through digital transformation, and is a large part of the challenge that the oil and gas industry is facing right now. One growing solution to this challenge is 'next-gen' data capture and immediate, pain-free, automated integration into analysis applications.

Easing the human workload

Once a certain amount of data and information is gathered around a given problem, it can be enhanced and made more user-friendly with the help of automated workflow routines that take a lot of the day-to-day, time-consuming tasks out of the job remit for engineers and operations personnel. These days, a computer can perform many essential tasks if the time is taken to tell the computer to do it. Commands can be based around looking out for certain triggers, for example, 'to survey the entire pipeline and alert the operator if any one sensor goes out of its trend range by 10%,' or, 'alert the operator if any one sensor goes beyond 12 000 psi,' or, 'alert the operator if flowrate goes below a certain amount.' This type of digital automation is known as surveillance by exception, and it eliminates the need for a person to laboriously check all the data sources to find out if any one of them has met any of those triggers.

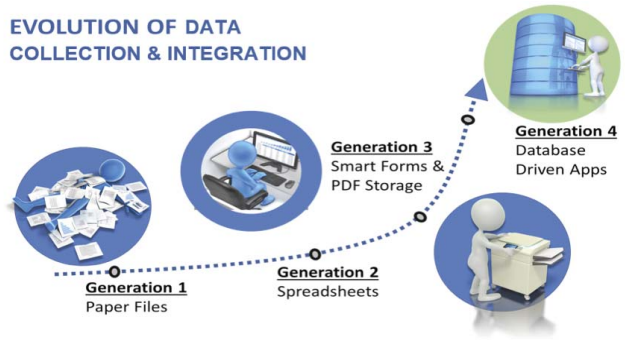

Figure 2. Paper records have undergone a digital transformation to have critical data captured as leverageable digital databases, in real-time.

Figure 3. MIC corrosion at girth weld. With suitable data analysis, costly pipeline digs can be reduced by 30 - 50%.

Supporting the move from reactive to proactive

Once the basics of digital transformation are in place, more complex, sophisticated algorithms can be employed. Key performance indicators can be combined with contextual data about the operating environment and pattern recognition, to produce a more reliable automated interpretation of events such as RPM and discharge temperature variations in compressors and pumps, etc. The time of a company's workforce is then freed up substantially. Operators no longer need to spend time sourcing data, inputting it into a tool that can analyse the data, then seeking out exceptions and deciphering what they mean. Essentially, a reactive mode of operating is replaced with a proactive mode.

For example, a particular cylinder on a machine in a remote location might be suddenly identified with an unusual data signature. With experience, the signature can be observed to indicate a high likelihood of machine failure in the subsequent 60 days. With this foresight, an engineer can be dispatched to the location in plenty of time, and can perform pre-emptive repairs before a failure occurs. In this way, the disruption to the system can be controlled before it fails and puts the operator into a reactive or more problematic situation.

Trusting the change

The oil and gas pipeline industry is characteristically resistant to, or sceptical of, changes to entrenched processes and technology. Therefore, change management is the most difficult aspect of conducting a successful digital transformation within a pipeline company. Encouraging operators and engineers to trust the process and believe in the quality of the data that is feeding these calculations actively contributes to the continuous improvement of the process. Put simply, if the software users do not trust it, they will not use it. In a situation of poor trust, the user will return to their previous solution and digital transformation initiatives will falter.

The cost of corrosion

One of the costlier activities for a pipeline operator is to dig up a pipeline to see if a repair is needed, or to actually carry out a repair (Figure 3). Smart pigs are run through the lines to gather data about defects and abnormalities that may not have been present at the time of construction. With this large data set in hand, the operator faces the task of identifying the problem areas within the pipeline. The common problem that needs to be solved is deciding whether the pipeline needs to be dug up and a whole section repaired, or if it is possible to focus on just a few spots or one short piece within that section. If this problem is addressed correctly, the number of locations that are targeted for digging can be reduced by 30 - 50%, saving the pipeline company time and money and again freeing up the workforce to focus on preventing failures in other parts of the business.

One of Technical Toolboxes' software products, PRCI RSTRENG+, is particularly suited to this activity and works to identify the specific areas of the pipe within long stands of corrosion that would actually cause a pipeline failure at a given operating pressure. The RSTRENG+ software is offered as desktop or cloud-based, allowing for both report and case sharing, enabling

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SPX PIPELAYER

MODEL	SPX-260	SPX-460	SPX-670	SPX-903	SPX-960SV
Max lifting capacity (lb)	57,320	101,415	145,505	202,825	213,850
Operating weight (lb)	44,095	68,345	90,390	121,255	138,890
Net flyweel power (hp)	202	250	350	400	440
Speed travel (mi/h)	5.6	5.4	5.1	5.6	5.6

All models comply with engine EPA CARB Tire 4 final (or Tier 3 on request)

SPD PADDING MACHINE

MODEL	SPD-150	Restyling SPD-160 EVO	Restyling SPD-250 EVO	Restyling SPD-350 EHD	Restyling SPD-450 EVO
Screening area (ft^2)	25	56	30	61	86
Operating weight (lb)	26,455	55,115	66,140	85,980	119,050
Net flyweel power (hp)	142	225	250	350	440

All models comply with engine EPA CARB Tire 4 final (or Tier 3 on request)

SRT-SFT CRAWLER TRACTOR

MODEL	SRT -155	SRT-180	SFT-155	SFT-180	New SRT-155RD	New SRT-180RD
Payload (lb)	13,230	22,050	13,230	22,050	13,230	22,050
Operating weight (lb)	20,945	27,650	19,620	26,455	25,355	33,070
Net flyweel power (hp)	202	225	202	225	202	225
Speed travel (km/h)	4.6	5.0	3.7	3.7	4.6	5.0
Type	Rubber tracks	Rubber tracks	Steel tracks	Steel tracks	Rotating dumper Rubber tracks	Rotating dumper Rubber tracks

All models comply with engine EPA CARB Tire 4 final (or Tier 3 on request)

SPB PIPE BENDING MACHINE

MODEL	SPB-6.20	SPB -16.30	SPB-22.36	SPB-32.42	SPB-36.48	Restyling SPB-48.60 SL
Operating weight (lb)	13,225	40,785	59,525	95,900	149,900	182,985
Net flyweel power (hp)	62	142	142	225	225	225

All models comply with engine EPA CARB Tire 4 final (or Tier 3 on request)

CPX HYDRAULIC WINCHES KIT

MODEL	CPX-61	CPX-71	CPX-72	CPX-83	CPX-94
Max lifting capacity (lb)	40,785	59,525	88,185	138,890	202,825
Basic machine	Cat 561	Cat 571	Cat 572	Cat 583	Cat 594

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users to collaborate prior to a report's generation. Through the software's import/export capability, cases can be sent directly to collaborating team members, allowing data to be input by both parties to build an inclusive report.

Eat or be eaten

In today's active pipeline fields, the cathodic protection (CP) catchphrase is 'eat or be eaten.' If a pipeline operator does not apply CP to their pipe, it essentially becomes a sacrificial anode to someone else's pipe. In other areas, operators face the CP challenges of natural earth chemistry. In locations with overhead power lines, the electromagnetic field that those power lines generate can cancel out an operator's CP measures. On Technical Toolboxes' integrated software platform, analyses using the PRCI AC mitigation application are enhanced and automated in a way that saves weeks of analysis and deals specifically with this phenomenon. Using the information gathered from the software, engineers and technicians can create models to mitigate or modify the design of pipeline CP systems enabling the reduction of AC density effects, helping users meet the criteria specified either by a client or the National Association of Corrosion Engineers (NACE) standard. Because of its intuitive nature, mitigation scenarios can be generated in minutes to reduce the effects of overhead AC power lines on buried pipelines.

Managing protection at surface

General earth-level construction that involves a large amount of heavy, moving equipment can also pose a problem for pipeline operators. Every time an element of heavy industry crosses a pipeline, someone needs to consider the risk of the weight deforming, cracking or collapsing the pipeline beneath it. Questions to be asked include, 'Are rig mats required?' or 'Do bridges need to be constructed which will take the vehicle off the ground and away from the pipeline?' Several major North American pipeline operators use Technical Toolboxes' Pipeline Toolbox (PLTB) software in order to solve these challenges. PLTB contains engineering calculations needed to quickly solve daily challenges across the pipeline lifecycle. More than 230 different pipeline-specific oil and gas applications and calculations are integrated into a complete, industry-validated software application, which has become the industry standard over the past 20 years.

Case study of a major North American pipeline operator

Overview

To accommodate activity happening on the land surface, heavy equipment needed to cross pipelines. At the same time, due diligence needed to be performed to protect the pipelines. Technical Toolboxes' PLTB software has been employed for more than a decade to help the company analyse individual crossing requests for external loading potential, confirming compliance with specifications in a timely manner.

Background problem

Before using PLTB software for wheel load and track load analysis, a home-written program was deployed using the Spangler method. This solution proved to be relatively slow, inefficient and cumbersome to use in practice. The biggest pain point was the long time required to respond to internal customers. For example, if two analyses were to be run, each needed to be completed separately. This meant that all the data for one analysis needed to be input, run, then all data fields re-input a second time to perform an additional analysis.

Example in practice

A field operative raised a call to managers and explained that there was a cement truck approaching. The cement truck was making a delivery for a house construction project. Initial questions raised were, 'Can he go across the line?' 'What measures need to be taken to safeguard the pipe?' With PLTB, engineers could quickly perform an external analysis and tell them how much ground cover was needed over the pipeline to support the load without damage to the pipe. Field operatives could then identify a spot that had the depth of cover required, or deduce that there was no location with adequate depth of cover and inform the cement truck that they could not cross. Essentially, it was better to block the cement truck and let a load of cement go to waste than damage a pipeline at a cost of millions of dollars. The advantage of using PLTB in this process was the timing, as a rapid analysis was performed at short notice.

Benefits observed with the software

In the past, this team had six or seven staff that regularly used the previous method. Now, only one member of staff is required for the same activity level using the PLTB (85% reduction), freeing up 240 hours per week of engineering time to focus on other activities. Training on PLTB for wheel load and track load analysis is quick and easy; staff can become competent in a relatively short period of time. This means it can accommodate the business today, in which people move more frequently, internally and externally, and younger recruits take the place of retired staff.

Future outlook

In order to move in step with pipeline operators' needs, Technical Toolboxes has released the Pipeline HUB (HUB^{PL}) to integrate pipeline data and facilitate customers' technical work. This new platform paves the way for automating integration and analyses to reveal advanced insights into design and operational fitness of infrastructure. The HUB^{PL} connects engineering standards and tools to users' data across the pipeline lifecycle. Integrated maps provide for visual reconnaissance of existing databases and allow automation of geospatial analyses. The HUB^{PL} continues to support core software products (such as PLTB) while integrating the IP of partners to create a more holistic midstream platform, paired with automation to improve the user experience in engineering workflows.

Conclusion

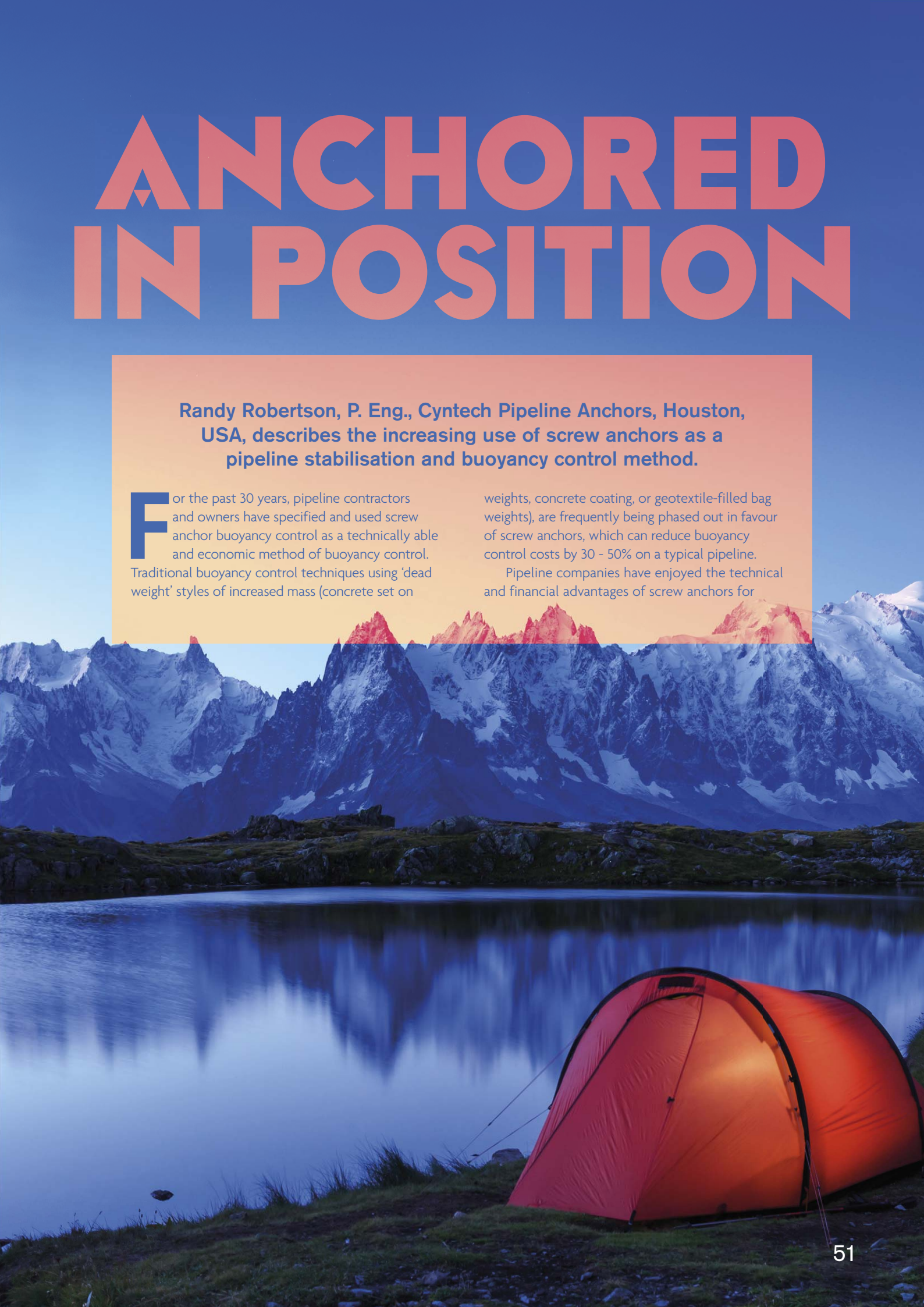
As the industry continues in its digital transformation, sophisticated, integrated holistic analysis tools will become the norm. The HUB^{PL}, for example, has been engineered to integrate solutions for design, construction, operations and integrity. This will enable users to make more efficient and accurate decisions to ensure pipeline safety, and improve their management of asset integrity.

ANCHORED IN POSITION

Randy Robertson, P. Eng., Cyntech Pipeline Anchors, Houston, USA, describes the increasing use of screw anchors as a pipeline stabilisation and buoyancy control method.

For the past 30 years, pipeline contractors and owners have specified and used screw anchor buoyancy control as a technically able and economic method of buoyancy control. Traditional buoyancy control techniques using 'dead weight' styles of increased mass (concrete set on weights, concrete coating, or geotextile-filled bag weights), are frequently being phased out in favour of screw anchors, which can reduce buoyancy control costs by 30 - 50% on a typical pipeline.

Pipeline companies have enjoyed the technical and financial advantages of screw anchors for



buoyancy control, and as a result several engineers and operators have started using them to provide additional stabilisation and deflection control in seismic areas and at overbends where large thermal stresses and strains are present.

Technical specs of the anchor

The anchor shaft is manufactured from solid, high-strength steel bar with one or more helix plates welded onto it. The anchor shafts are literally 'screwed' into the soil, below the bottom of the ditch, to a depth where they will encounter soil of sufficient strength to resist the tensile loads imparted by the pipeline. Typical depths are 15 - 35 ft (4.6 - 10.7 m).

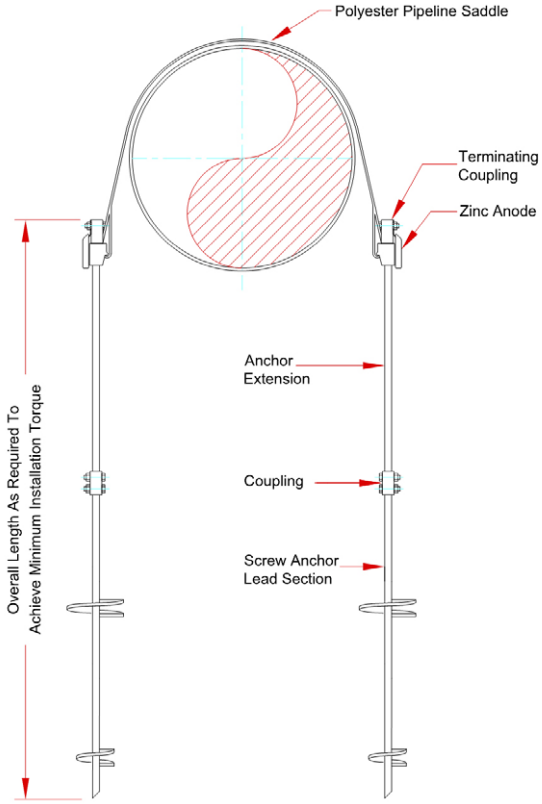


Figure 1. Typical pipeline anchor buoyancy control system.

Figure 2. Pipeline anchor system for overbend stress mitigation.

Anchor sets are spaced along the pipeline through the area that requires buoyancy control or stabilisation. This is to provide stability to the section of pipeline where a high water table, or other external forces, may be present.

A typical pipeline anchor buoyancy control system is depicted in Figure 1.

An added benefit of screw anchors is that because there is no increased mass or dead weight placed on the pipeline, there are no additional external stresses on the pipeline; pipeline anchors simply resist the vertical movement of the pipeline when it is subject to buoyant or other external forces. This 'passive' load resistance greatly reduces external stresses exerted on to the pipeline itself, which is of even more benefit on liquid pipelines, where buoyancy forces are only present during construction and maintenance. In general, liquid pipelines are negatively buoyant when they are filled and in operation.

Since the buoyancy force on a pipeline increases with the square of the diameter (D^2), the forces required to be resisted on larger diameter pipelines (NPS 30 and larger) can be several hundred lb/ft (or several hundred kg/m). This increase carries through to an exponential increase in the mass of dead weight required to resist. Adding to the deteriorating economics is the fact that traditional dead weight style buoyancy control techniques are themselves subject to buoyancy. The effective weight of submerged concrete is only slightly over 50% of its dry weight, while sand and gravel are even lower at less than 40% of their dry weight. This means that almost 2 lb (0.9 kg) of concrete or 3 lb (1.4 kg) of gravel is needed to resist 1 lb (0.45 kg) of buoyant force – increasing the inefficiency of these styles of buoyancy control.

Savvy pipeline owners, contractors and engineers have discovered this and have looked for more efficient and economic solutions to this problem.

The screw anchor buoyancy control system is also relatively small and lightweight (a typical anchor set weighs less than 500 lb/225 kg), and therefore is not subject to the inefficiencies of self-buoyancy and will provide the required resistance to hold down forces in a much more economic manner.

Anchor installation in action

Building on these technical advantages and increased cost savings, pipeline engineers have used pipeline anchors to solve other problems and situations that have arisen.

In 2015, Cyntech was contacted by an international pipeline engineering company to investigate the use of screw anchors for a pipeline traversing an area susceptible to seismic activity and potential soil liquefaction. Seismic liquefaction momentarily increases the density of the saturated sands, causing it to behave like a fluid, and results in a significant increase in the net buoyant force. Buoyant force is directly proportional to the density of the fluid the pipeline is sitting in. These forces are quite large, and any traditional buoyancy control technique would also be subject to the same liquefaction forces – thus screw anchors were chosen to stabilise the pipeline in these areas. With the calculated depth of liquefaction ranging from 3 - 13 ft (1 - 4 m) below ground

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level, the anchors were installed below the liquefiable layer, resulting in significant cost savings and a superior technical solution. Increasing the size and weight of the dead weight style buoyancy control would have induced large contact and bearing stresses on the pipeline through normal operations.

More recently, a major North American pipeline operator was evaluating stress concentration and deflections at overbends. The operator discovered that in some pipeline geometries, the combined stresses of thermal expansion and field bends could cause excessive deflections in the pipeline. Because the magnitude of these stresses and resulting strains were large, screw anchors were investigated as a passive means to resist the deflections, while still allowing some movement and flexibility in the pipeline. The rationale was that the operator did not want too rigid of an anchor point (thrust block, or similar) that would resist all pipeline movement and

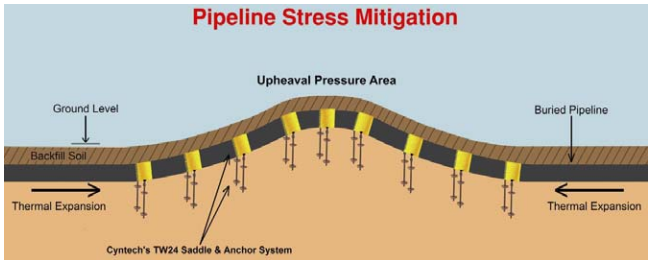

Figure 3. Diagram of overbend stress mitigation.

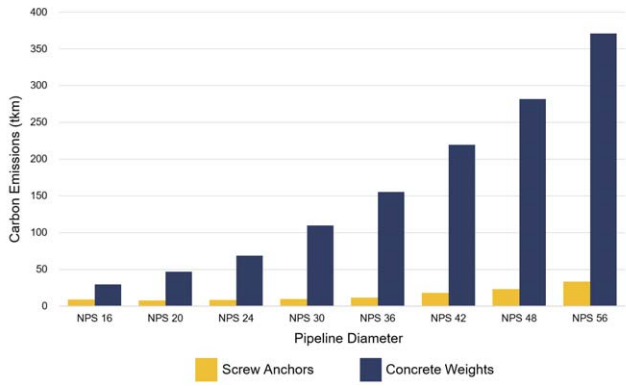

Figure 4. Social cost comparison, pipeline anchors vs concrete weights.

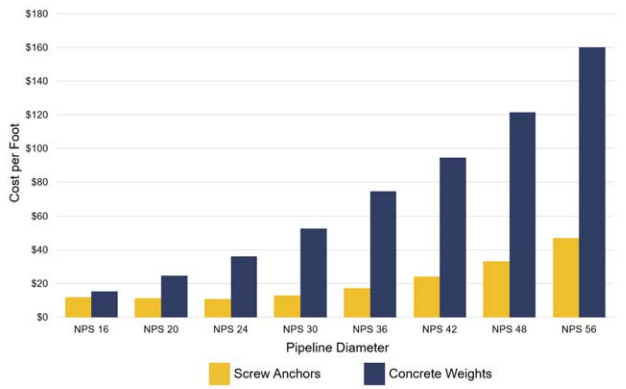

Figure 5. Buoyancy control cost comparison, pipeline anchors vs concrete weights.

could inadvertently impart its own stress concentrations on the pipelines in these areas.

The operator was well versed in the use and applications of pipeline anchors for buoyancy control, having used them for over 25 years; however this was a new problem and new application for them. Building on the long-standing relationship between the pipeline owner and Cyntech, the pipeline owner approached the company to work together to solve this problem.

Cyntech had previously developed a larger pipeline saddle to counter buoyancy on insulated pipelines. The relatively fragile exterior insulation pipeline coating could be more easily damaged by dead weight type buoyancy control devices, and even the standard sized pipeline anchor saddle would not adequately protect the insulation. A modification of the typical pipeline anchor system was needed, with a wider saddle required to increase the contact area between the saddle and the pipeline insulation. This would reduce the contact stress and compressive stress on the insulation, to ensure it was not crushed or otherwise damaged by the buoyant force of the insulated pipeline.

Although the pipeline being investigated for overbend anchorage was not insulated, the same rationale was employed to reduce the contact stresses. These stress mitigation anchors were installed and successfully stabilised the pipeline to prevent buckling. Additionally, a closer spacing between anchor points was used to distribute the pipeline stresses over a larger area, to reduce point loading or stress concentrations on the pipeline.

Figures 2 and 3 show the configuration of the pipeline anchor at the overbend. Important to note is the 24 in. (600 mm) wide saddles which have been installed at a closer spacing than normally used.

Pipeline anchor system

Today, several major pipeline operators use Cyntech's stress mitigation anchors on all overbends, and the acceptance and use of pipeline anchor systems continues to grow. Cyntech recently supplied its 100 000th pipeline anchor set to a client in Thailand. The company's system has been used by pipeline contractors in projects spanning North America, South America, Europe, Asia, Africa and Australia.

Contractors are benefitting from the simple and safe equipment and installation, with smaller, lighter components for installation. Meanwhile, pipeline owners and operators are benefitting from the significant cost savings and lower carbon footprint and social costs, as illustrated in Figures 4 and 5.

As the pipeline industry continues to expand and infrastructure development becomes more challenging due to competition, economics, commodity pricing and social issues relating to permitting, owners and contractors are learning to adapt and evolve to safer and more intelligent processes and techniques. Smarter, safer, and less carbon intensive options are becoming more commonplace. Pipeline anchor stabilisation, although relatively new to some engineers and owners, is now a common practice in many parts of the world. Doing things 'as they have always been done' is no longer an acceptable practice; the market, and society, is requiring change.

TRACKED FROM START TO FINISH

Layne Tucker, CEO of EchoRFID, Steve Louis, CE Consultants, and Steve Slusarenko, ProStar Geocorp, USA, detail how digitalisation and tracking of materials are advancing from onshore pipelines to offshore projects.

RFID technologies are quickly gaining acceptance in the onshore oil and gas industry, as midstream companies are able to prevent costly delays and interruptions through enhanced tracking of pipeline materials from manufacturing to construction. Through this 'lean production process', as discussed in Lloyds Register's 'Pipeline Construction: A Virtual Process' paper, oil and gas project managers are relying on low-cost RFID and barcode technologies to provide enhanced visibility of major materials, including where they are in the supply chain.

Additionally, low-cost GPS transponders are being used to track shipments and provide detailed information on their location at a given point in time. Companies like Q&D Construction (based in Nevada, US) have entered into a pilot project for tracking pipeline components both above and below ground, with the goal of optimising the company's turnkey construction schedules for its clients.

Additional savings post-construction have been identified by using RFID tags during periodic maintenance inspections. Utilising a cloud-enabled mobile software solution, RFIDs provide real-time capture and transmission of the inspector's data for electronic submission and approval. This eliminates the entire manual, paper-based process and subsequently all associated issues – delays, unnecessary costs, and human error.

Figure 1. **RFID tags provide material and personnel data.**

Figure 2. **RFID and GPS transponders track shipments and individual items.**

Industry experts expect other companies to follow suit as RFIDs advance along the innovation adoption curve, not only because of the material management benefits but also due to new regulations. The 2019 'Protecting our Infrastructure of Pipelines and Enhancing Safety' (PIPES) Act from the US Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), will require facility owners to provide evidence of a reliable, traceable, verifiable and complete record keeping system. This in itself may convince late adopters to utilise RFIDs as a way of improving materials logistics and documentation, as well as ensuring that regulatory requirements are met.

It is not just companies who are benefitting from this technology. In Canada, the First Nations partners whose lands provide access for pipeline routes have turned to RFIDs to access reliable and real-time pipeline information stored and shared in the cloud. This allows them to participate on an equal footing with all other stakeholders as pipeline projects become sanctioned and placed into service.

Layne Tucker, founder of EchoRFID and native Tahltan, advises regulatory agencies as an RFID Subject Matter Expert (SME) on the future of this technology. Based on his 25 years of experience in oil and gas pipelines, he has witnessed the benefits of forming alliances with the First Nations – including Tahltan Nation Chief Rick McLean and his company Bear Claw Industries – to promote pipeline safety and environmental protection for the long-term sustainability of all developmental pipeline projects.

Because of the increased RFID usage and benefits realised in onshore applications, integrated exploration and production companies are beginning to take this same RFID technology to the approximately 3200 active offshore platforms in the Gulf of Mexico (GoM).

Each of these platforms consist of miles of piping as well as hundreds of flanges, valves, hoses, pumps, generators and tanks. Every day, offshore personnel test, inspect, repair, and maintain these systems by working from piping and instrumentation diagrams (P&IDs) which may not always be readily available or up to date, requiring the staff to rely on experience, namely memory and intuition.

Onshore and offshore: similar challenges

The complexity of an offshore platform is not unlike the challenges faced by onshore pipeline systems.

The logistics for sending personnel and equipment to an onshore location in the Permian for instance, require a great deal of pre-planning and cost considerations, given the long distances from airports and equipment suppliers which may be hundreds or even thousands of miles away.

Connectivity for cloud-based networks has historically been an issue both onshore and offshore, although it has improved over the last five years due to advancements in satellite communications and 4G

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technology. Companies such as Globalstar can provide satellite Wi-Fi hotspots using its Sat-Fi2 system that offers 72 kbps for email, talk, text, web, file sharing and SOS communication. Regardless of whether a pipeline is in an uninhabited region in Canada or an offshore platform in the middle of the GoM, information can now be accessed and transmitted without restriction.

RFID for inspections and maintenance

To demonstrate, let us discuss a typical inspection process irrespective of whether it is for an onshore pipeline or onboard an offshore platform. In order for a unit to be properly inspected, a paper-based work permit must be created and a paper-based job safety analysis (JSA) must be prepared and conducted on site. The permit is granted by the ultimate work authority (UWA) who must physically trace the given pipeline/piping route to ensure that all the valves are open or closed, the proper flanges are removed or blinded off, the pressure is bled down, and all areas have been barred off.

This attention to detail is critical, because an uncontrolled release of hydrocarbons or unexpected burst of high pressure in the line could cause a massive incident to people, property and the environment.

To avoid these undesirable events, personnel can put RFIDs on sections of the pipe using straps, high grade adhesives, or brazing. One example of a tag provided by Omni-ID can be applied to almost any surface and resist cyclical loading and high temperatures of up to 235°C (455°F).

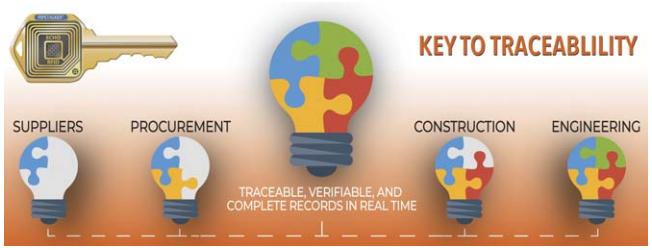


Figure 3. Portal for digital material and construction data for full traceability.

Figure 4. Incorporating digital with RFID and tracking transponders for offshore.

These RFID 'tags' have a unique identifier which corresponds to a site on a cloud server. On this virtual site, a data entry specialist uses a tablet to upload the pipe details – diameter, wall thickness, material, weld type, heat numbers, pressure ratings, direction of flow, which pipe is next in the series, when the last inspection was conducted, and essentially any data associated with that pipe which is valuable.

During an inspection or test, the inspector can 'read' the tag using a tablet or RFID handheld reader to instantly identify the pipe and log that the section has been verified before starting the test. Zebra Technologies has integrated these tools, offering tablets with built-in barcode and RFID readers as well as standard cameras which seamlessly document the inspection process.

The UWA and anyone else who the operator has granted access to (anywhere in the world that has a connection) can verify in real-time that the pipe matches the permit and that inspection has been completed. The need to handwrite data logs to be scanned in, sent, and filed away into a file cabinet has been virtually eliminated. The potential for inadvertently skipping a section or misreading a faded-out stencil is now a thing of the past.

A major risk to platform safety and operations is during the lock-out/tag-out process of a unit that is temporarily out of service during repair or maintenance. The equipment is literally 'locked and tagged' and the associated paper-based permit is sent off to be signed by the UWA. The issue arises when another team may not be aware that a particular piece of equipment is down on maintenance, and is able to restart the machinery or operation that then causes a serious incident.

By installing RFID tags at each site, the maintenance worker and the operations worker would both receive alerts when they scan the RFID tag with their reader. They would also automatically receive notification that the repair has been completed and is safe to proceed. The UWA would also know how long the machinery was down for maintenance, who repaired it, and when it is scheduled to be checked again.

RFID for material management

Material management can make or break any project regardless of the industry. A recent survey of project managers highlighted that one of the largest unanticipated cost overruns on a project was from needing to pay expedited shipping fees for items which could have been identified and shipped off the critical path.

Additionally, an inordinate amount of resources is often required to find a misplaced item on the premises, whether it be at an onshore or offshore location.

In order to mitigate both types of issues, project managers now use RFIDs to track consumables not just from the manufacturer to the job site, but throughout the useful life of the item.

Small tags are attached to the material once the item arrives on site. As the consumable makes its way to the

various project locations and is depleted, the item can be tracked continually for where it is located and how much is left.

Similarly, for materials such as technician's tools or equipment (pumps, compressors, drills, winches, gas monitors, etc.) each item must be 'checked out' prior to and after use. If the item does not match what is on the electronic permit, then the reader will alert the worker that this is the wrong tool for the job. Once the item is checked back in, the platform will have an automatic log of how long it was used for and how many times in a specific time period, notifying the manager back on land that it is time to recertify the piece of equipment.

Even at the end of the construction period, surplus materials can be quickly and easily categorised and allocated to the spares inventory or to the next project.

RFID for personnel management

Real-time tracking of the onshore or offshore crew is extremely important, especially during an alarm which requires personnel to muster at their dedicated location. For an offshore platform, if the crew all have RFIDs clipped to their coveralls, their exact location can be determined electronically using gate readers placed on the platform. No more roll calls or sending a colleague into harm's way to search for a missing employee.

From a productivity standpoint, project managers are able to more effectively allocate resources to the area with the largest need by receiving real-time data on where the employees are working and for how long they have been performing a particular task. More accurate schedules and cost estimates are created through the use of RFIDs, enabling management to maintain budgets and achieve milestones objectives.

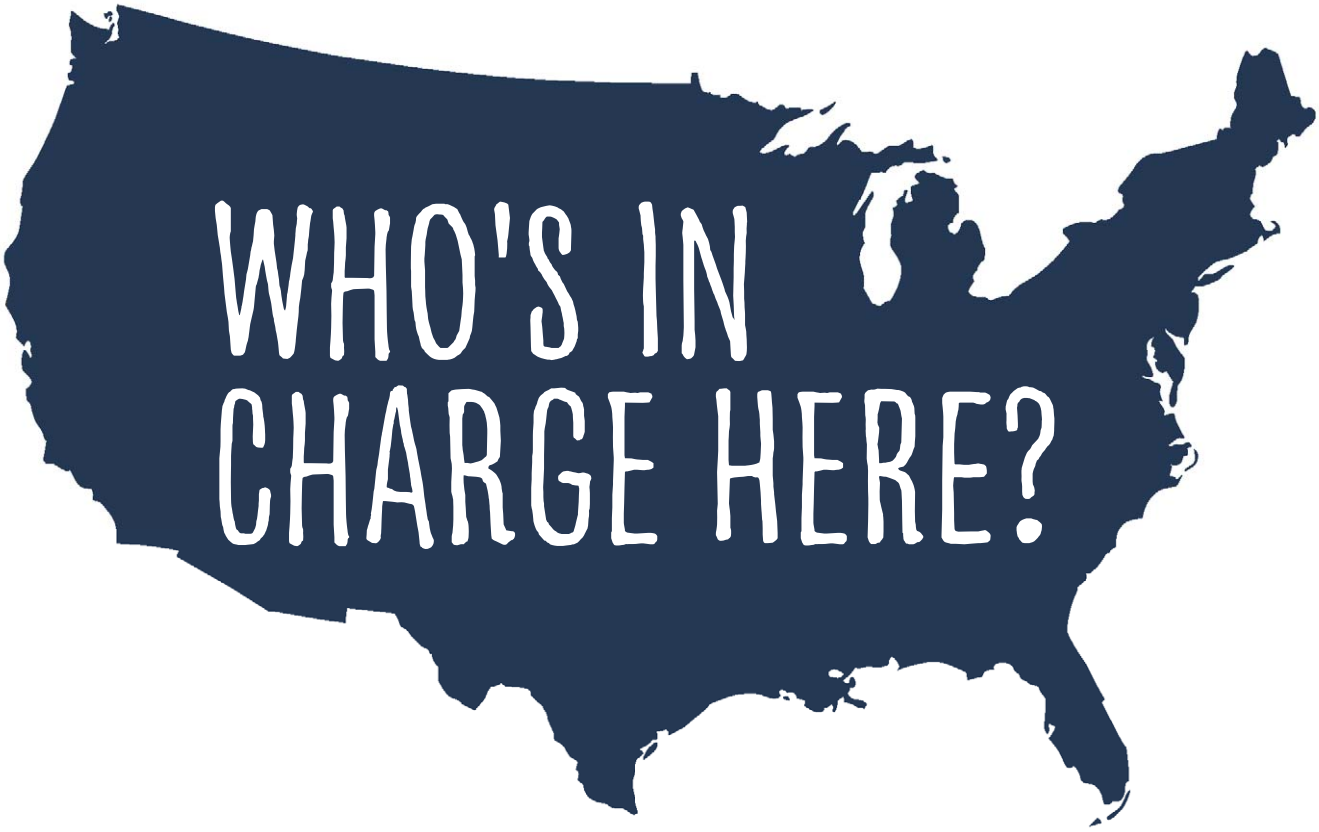
Summary

The examples stated here are not theoretical; the technology exists onshore and is used similarly in other industries such as shipping, retail and medicine.

Because the vast majority of pipelines and platforms were designed and built before the age of the internet and cloud-based computing, the benefits that technology can have on an existing asset tend to be disregarded. However, RFID technology has proven to be economical and simple to implement, with significant advantages to the asset's operations from both a safety and cost optimisation standpoint.

The oil and gas industry is changing, and even those who say 'we've always done it this way' are now open to accepting new technologies which are easy and economical to implement.

RFIDs, combined with GPS technology and cloud computing, can be seamlessly used in parallel with the current paper-based processes to manage inspections, maintenance, and personnel activities. Once a digital version has been sufficiently validated, the operators can quickly transition and start leveraging the benefits of a real-time, accurate, and cost-effective system.



WHO'S IN CHARGE HERE?

John Tintera, President, Texas Alliance of Energy Producers, USA, evaluates the case for federal authority delegation to state governments when considering pipeline safety policy.

The US federal government is primarily responsible for developing, issuing, and enforcing safety regulations for pipelines, underground natural gas storage, and liquefied natural gas (LNG) facilities. The pipeline safety statutes empowering the Pipeline and Hazardous Materials Safety Administration (PHMSA) allow State assumption, or delegation, of the intrastate regulatory, inspection, and enforcement responsibilities.

Numerous federal and state regulatory programmes see federal delegation of authority to state government as an important tool for good government.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There are a number of reasons why. Some benefits are obvious, even to the average citizen who does not work in the industry. These would include accountability at the ballot box of locally elected state lawmakers and officials, instead of Washington D.C. bureaucrats. In addition, delegation should provide easier access and interaction with state officials and local inspectors for hearings or administrative purposes in nearby regional offices.

Other advantages are not as obvious to the casual observer but are just as important, such as streamlining permitting processes for industry by removing duplicative applications that must be approved by both state and federal entities. Another advantage is improved regulator performance, with local inspectors frequently located near the areas of concern, providing for quicker response to complaints or concerns.

These types of benefits are why the midstream pipeline industry in almost every US state has some level of the federal pipeline delegation authority.

How does delegation occur?

Federal delegation begins with the federal statute. Delegation must be authorised as part of the statute. If the statute does not allow delegation, there can be none. Fortunately, the federal pipeline safety statutes provide for state assumption of the intrastate regulatory, inspection, and enforcement responsibilities.

The state must then seek the delegation. This typically begins at the gubernatorial level and works down the political chain of command to the regulator's agencies, who prepare and submit the detailed delegation documents.

To qualify for delegation and subsequent certification, a state must be prepared to adopt the federal regulations. They may also adopt additional or more stringent state regulations if they are not incompatible with the federal regulations.

This adoption extends to enforcement. A state must provide for enforcement sanctions substantially the same as those authorised by the pipeline safety statutes.

Finally, a state must be willing to undergo and pass an annual audit, or certification, conducted by the federal regulator (PHMSA), as part of the delegation authority. These audits are extensive, detailed, and available to the public for review.

Recent renewed state interest

Interest in federal delegation is increasing. Under the current federal administration, important new philosophies have emerged. One high profile example is 'co-operative federalism'. To state government, these new policy statements have indicated a willingness of federal regulators to work closely with their state counterparts.

Some states have recognised and reacted to this. Taking Texas as an example, here the legislative leadership recognised the wisdom and the opportunity of federal authority delegations and asked for more. In 2017, the 85th Texas Legislature passed Senate Concurrent Resolution 26, which was subsequently signed into law by the Texas Governor. It states, in part: "Resolved, That the 85th Legislature of the State of Texas hereby respectfully urge the executive branch and the Congress of the United States to work in conjunction with the State of Texas to identify federal regulations...and determine whether they should be revised, delegated to state agencies, or eliminated in order to ease the overly burdensome regulatory patchwork on the oil and gas industry in Texas."

In the national arena, there has also been progress. The Interstate Oil and Gas Compact Commission (IOGCC), an organisation representing the governors of 31 member and seven associate states, passed a similar resolution in 2018 at the urging of the Texas representative, Wayne Christian, current Chair of the Railroad Commission. IOGCC Resolution 18.054 is titled 'Pertaining to the Delegation of Federal Regulatory Authority to State Government Agencies' and states:

"Now, therefore, be it resolved that, the IOGCC urges the President of the United States and the Congress, in consultation with the IOGCC member States, in the spirit of co-operative federalism, identify those federal regulations, especially those promulgated under the authority of the United States Environmental Protection Agency, the United States Department of the Interior, the United States Department of Energy, and the United States Department of Transportation, and determine whether any additional regulatory authorities should be delegated to states in an effort to improve regulatory efficiency and effectiveness."

Scope and size

The cited resolutions express sincere and powerful political sentiments. But, how do these words translate into action in the real world? Many would point to Texas to illustrate.

Why? According to state regulators, Texas has the largest pipeline infrastructure in the nation, with 466 623 miles of pipeline representing approximately one-sixth of the total pipeline mileage of the entire US. Texas' pipelines are divided into the categories of: natural gas and LPG distribution lines (152 994 miles), hazardous liquid and natural gas transmission lines (69 104 miles), hazardous liquid and natural gas regulated gathering lines (6380 miles), intrastate production and gathering lines leaving a lease (177 706 miles), and interstate lines (60 439 miles).

The Railroad Commission of Texas has safety responsibility over all but interstate lines. That is a lot of lunch for a state regulator to say grace over. It requires adequate staffing.

Boots in the field

It is said 'all politics is local'. So are all field inspections. Regulators enforce these rules with a small army of state employees, including inspectors, permitting experts, auditors and other associated support staff. In Texas, there are hundreds of regulatory staff to serve the public. Some rove the field, inspecting pipelines to prevent incidents, verify permit requirements, or investigate and respond to incidents. Texas has created seven regional pipeline safety offices, including the headquarters in Austin, stretching from the panhandle to the Gulf Coast, and from the high plains of West Texas to the piney woods of East Texas. Field personnel can be located near the regions they serve, ensuring rapid response times. They have access to online data to make them efficient, and they are specially trained to oversee the midstream industry. It would be very difficult for a federal agency to compete with this network of expertise.

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Texas also relies on other divisions and additional state agencies to contribute their expertise. Railroad Commission Oil and Gas (RRC) inspectors respond to pipeline oil spills during emergencies. The Texas Commission of Environmental Quality (TCEQ) inspectors respond to spills of other pipeline products, such as refined products, for emergency and spill response. During major incidents or government declared disasters, pipeline incidents are woven into the escalating state response by the Texas Division of Emergency Management (DEM) – which has the authority to literally place the resources of the entire State at the disposal of the political leadership, to ensure safety and environmental protection.

Funding

None of this happens without funding. Successful state implementation of federal programmes will be at risk without a properly funded state regulator.

Funding comes from at least three primary sources. Federal delegation frequently provides funding, state government augments this funding with state appropriations, and regulators are provided authority to charge fees for permits – so industry almost always contributes a fair share to the funding mix.

In Texas, the state legislature truly puts its money where its mouth is. During this past legislative session, the state regulator sought and received significant state funding for more pipeline safety inspectors. The RRC will receive a total of US$254.7 million across the 2020 - 2021 biennium, which will allow for an additional 22 pipeline inspectors. A federal agency would be hard pressed to readily command an investment of the size Texas has made to increase state inspectors.

Enforcement and transparency

Enforcement is more than a financial deterrent, it is also a bridge of credibility to the public to demonstrate that the regulators are at work on their behalf. To see any pipeline safety enforcement data, the Railroad Commission of Texas website provides a store of Pipeline Safety Enforcement Cases, from 2011 to the current date, including the assessed fines. It is also possible to attend an enforcement hearing, since all hearings are posted as open meeting events where the public can watch the testimony unfold or review the archives of hearings as more become available over the internet. Furthermore, because the RRC Commissioners are statewide elected officials, voting is another way for your voice to be heard, whether you agree or disagree with the agency actions.

Information

In today's world, information means more than just a website, it also means the ease with which the public can access information. For example, there are 1387 operators of intrastate gathering, transmission, distribution, and master-metered systems in Texas alone. Information on any of these entities or pipelines can be retrieved from the RRC. This is a clear example of the transparency and the power of state oversight. Add to this the state Open Records laws in Texas, which provide the ability to retrieve virtually any state record from government, and information can be considered a powerful tool for the public good. This compares more than favourably with interactions with a federal bureaucracy.

Recent legislative trends in Texas

Texas has the most pipelines, and the state needs innovative and evolving legislative efforts to keep pace with this growth. Other states may want to evaluate the opportunities of some recent Texas legislative action to see if it is also applicable to their state.

On the civil front, no one can ignore the current inflamed politics of energy policy. This agitation has led to reckless actions by some to halt pipeline construction in order to serve their personal political will. This summer, Texas has signed into law HB 3557 relating to civil and criminal liability for engaging in certain conduct involving a critical infrastructure facility – creating a criminal offence. The bill raises the criminal penalty from a misdemeanour to a Class 3 felony for damaging, interfering or impacting energy infrastructure while trespassing in protest.

On the regulatory front, Texas permitting has a new opportunity to streamline. At some point in their operational life, pipelines will perform a hydrostatic test to verify safety. In this hydrostatic test, water must be safely disposed. Hundreds of these discharge applications are required every year in Texas. However, currently operators must request two permits, one from the state regulator and another from the federal regulator. Duplication is bad business, so HB 2771 by the 86th Texas Legislature will address this. The bill transfers the jurisdiction of permitting the discharge of this oil and gas waste from the RRC to TCEQ, where broad NPDES authority already resides. The TCEQ has also been instructed to request NPDES delegation from the EPA by 2021. While the RRC remains responsible for the regulation and cleaning of spills, industry and the public will no longer have to deal with multiple permits when this legislative vision is fully put into place.

The path forward

The pipeline industry frequently serves as a common denominator in solving energy problems. As such, common sense regulation of pipelines is critical to the economy's health and safety.

Federal delegation brings the states, with their special expertise and focused viewpoints, into the solution. However, federal delegation has been ignored in the past. An example is the Spill Prevention Containment and Countermeasures (SPCC) programme at the EPA. Currently the federal statute does not allow SPCC delegation. This results in federal plans competing with state plans, the possibility of duplicative state and federal requirements, and a larger federal government bureaucracy. All this while the states have the inspectors, their existing state plans, and their own regulatory framework to address the concerns that prompted SPCC legislation.

To conclude, it should be insisted that virtually every federal regulatory initiative include an opportunity for federal delegation. The Texas Alliance of Energy Producers considers it important that this delegation opportunity be clearly included in the statute and evaluated by interested states. More of this would be better for all of us.

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A RAM GOOD OPERATION

Anne Knour, TRACTO-TECHNIK, Germany, discusses a pipe installation project in Texas that utilised dynamic pipe ramming and HDD equipment.

With several large natural gas transmission pipeline projects underway, pipeline construction contractor Pumpco, Inc. from Giddings in Texas has been busy installing gas pipeline throughout the US. The multi-faceted pipe contractor is well versed in a wide range of pipeline installation methods, including the use of ramming technology.

Pneumatically driven pipe ramming machines are used for the dynamic installation of pipelines beneath roads, railway embankments and rivers. These machines, which provide thrust forces up to 40 000 kN (4000 t), enable the economic installation of open steel pipes as casing or product pipes up to 4000 mm diameter, over lengths up to 80 m, in soil classes 1 - 5 (partly even class 6, which is easily soluble rock) without the need for jacking abutments.

The machine technology is robust, load-resistant and reliable. It is a suitable technique for installing horizontal and helically welded pipes, seamless pipes, and pipes with insulation protection. It can be used for various applications in all kinds of soil types, with the exception of muddy areas, swamps and compact, non-displaceable soils.

The project

On a recent section of pipe in Southern Texas, near Big Bend State Park, the contractor employed dynamic pipe ramming

to install a section of 1.070 mm (42 in.) diameter pipe under a roadway, through extremely difficult soils.

The 65 m ramming project was part of a larger natural gas pipeline installation. This particular section of 42 in. steel product pipe proved to be very challenging. To install the pipe, Pumpco crews used an 800 mm diameter Grundoram Apollo pneumatic pipe rammer.

Rick Melvin, pipe ramming specialist with TRACTO-TECHNIK'S US sister company TT Technologies said, "This project was full of challenges, but the crew know what they're doing with their modified pipe ramming version of slick bore. Plus, having the most powerful pipe rammer in the world on the job helped as well."

Figure 1. The dummy pipe in the pit.

Slick boring

During the slick-bore process the product pipe is welded to the back end of an installed bore pipe. A winch is connected to the lead end of the bore pipe and is used to pull the casing out. As the bore pipe is removed the product pipe is pulled into place. In this scenario, the bore pipe is installed with a pneumatic pipe rammer. Once the product pipe is installed, the bore pipe can be used again for the next slick-bore. The bore pipe does all the difficult work and allows the product pipe to be installed as efficiently as possible.

On the job

Pumpco crews began by digging a 50 m trench leading up to the crossing to accommodate the new product pipe on the north side of the road. An oversized trench was completed on the south side of the road to facilitate pipe ramming operations. Once prep work was complete, crews welded a cutting shoe on the lead end of the first section of the dummy pipe.

Melvin said, "The cutting shoe really strengthens the leading edge of the pipe for maximum penetration through difficult soil and rocks. Because of its oversized cut, the shoe reduces both external and internal friction on the pipe. The cutting shoe also helps protect the pipe's coating or insulation. Now on the Pumpco project, they were not able to utilise bentonite, but in other configurations the cutting shoes also create a channel for the flow of a bentonite/polymer mixture. Their conical

Figure 2. The product pipe was cradled with side booms and straps during the ramming process.

Figure 3. Welding the cutting shoe on the dummy pipe.

internal surface reduces soil displacement and influences the bore's accuracy."

Ramming proceeded without incident for several casing sections until progress slowed dramatically. Pumpco Project Manager Hunter Hill said, "The entire crossing was approximately 65 m from entry to exit. We made it 45 m and ran into what I'd describe as a naturally occurring cobble concrete that completely halted the progress. We advanced 1 m one day and then maybe 30 cm the next day. So we decided to stop, figuring that the pipe might actually be collapsing, and try to dig it up and see what we encountered.

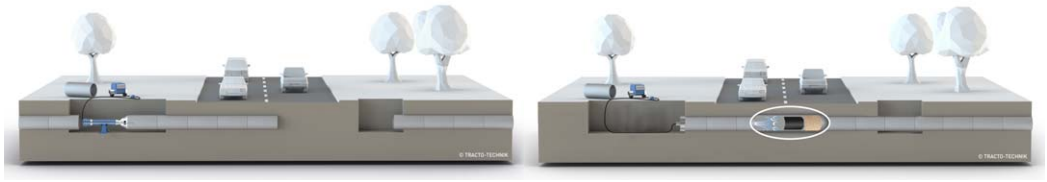

Figure 4. Schematic illustrations of the dynamic steel pipe ramming technique with GRUNDORAM (left) and removal of the soil that has gathered inside the steel pipe during ramming (right).

"We had to use a hammer hoe to break through the material and expose the pipe in the easement. If we didn't have that big hammer, we wouldn't have made it to the other side, we would have been stuck under the road." Once the pipe was free, Pumpco crews rammed another section of bore pipe in and cut off the now-deformed cutting shoe. After backfilling back to the road, crews began cleaning out the casing.

HDD rig used for pipe cleaning

Project Manager Hill said, "We used an HDD rig to clean the spoil out of the carrier pipe. First we used a mud motor, going in and out for the first 6 m or so. Then we ran some cross over subs and used a 24 in. (610 mm) OD rock motor backwards to clean out the rest. We yo-yoed through it, pulling out a little bit at a time until we only had a little bit of debris in the bottom. Then we pushed a pig through the pipe and that cleaned it right out."

After the spoil was clear, crews welded the new product pipe to the end of the installed casing and then moved the Grundoram to the north side of the road. There, crews welded a small section of wall casing, a sacrificial pipe, to the back of the product pipe to facilitate the rammer. With the spoil cleaned from the bore pipe, crews were able to ram the product pipe in slowly without incident. Pumpco crews simply cradled the product pipe during the process with side booms and straps until it was completely installed. Once the installation was complete, Hill's crew removed the bore pipe and the sacrificial pipe section, and turned the project over to another Pumpco division to continue tying the line into the rest of the pipeline.

The entire project took two weeks for set up and one week for ramming and welding. WP

Note

Some information included in this article was presented as part of a paper at the Pipeline Technology Conference, May 2017.

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STOP STEALING OUR CATHODIC PROTECTION!

Tim Bechtel, Dairyland Electrical Industries, USA, discusses the benefits of incorporating DC decoupling into a company's existing corrosion control programme.

When protecting pipelines with cathodic protection (CP), one of the issues that commonly occurs is that the CP is shorted out to the electric grounding grid or is absorbed by another unintended neighbouring structure. This can cause a technician to struggle with keeping the intended pipeline

in compliance as per PHMSA 192.463, Appendix D, pertaining to external corrosion control and CP levels. Usually, the initial attempt at a solution is to turn up the rectifier current output.

Problem

Recently, an example of this scenario was presented to Dairyland Electrical Industries by a pipeline operator. The operator had an electrical substation positioned between the pipeline station and the impressed current cathodic protection (ICCP) ground bed system protecting it. This included a fence in common between the two facilities (Figure 1).

The ICCP was intended to protect not only the station but also the pipeline from the north and south of the station. In an attempt to have the station and pipeline in compliance, the operator had the rectifier output at 55 A. Readings showed that 33 A were provided to the station, and of those, 28 A were protecting the electrical substation grounding grid. This reading was taken at the grounding connection at the fence that separated the two entities from one another, as can be seen in Figure 2. This value would shift to near zero when the rectifier was turned off, proving that it was not coming from another source. Readings for the pipeline from the north side were at 8 A and from the south side were 14 A. The remaining current was protecting the station grounding and some of the piping.

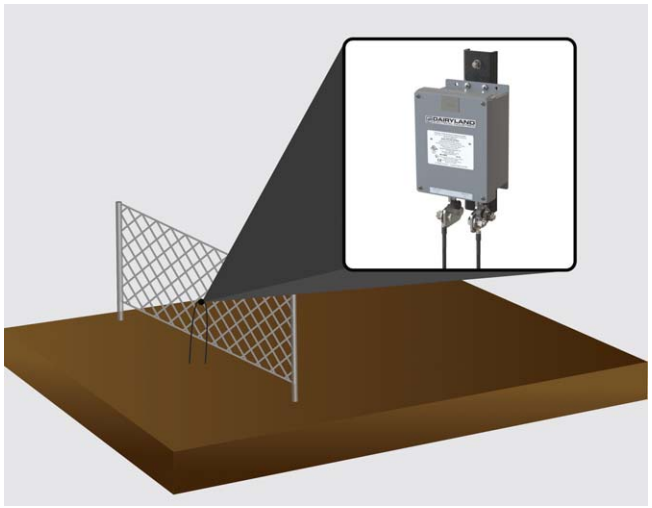

Figure 1. CP isolation point at the metering station's direct bond to the electrical substation grounding grid.

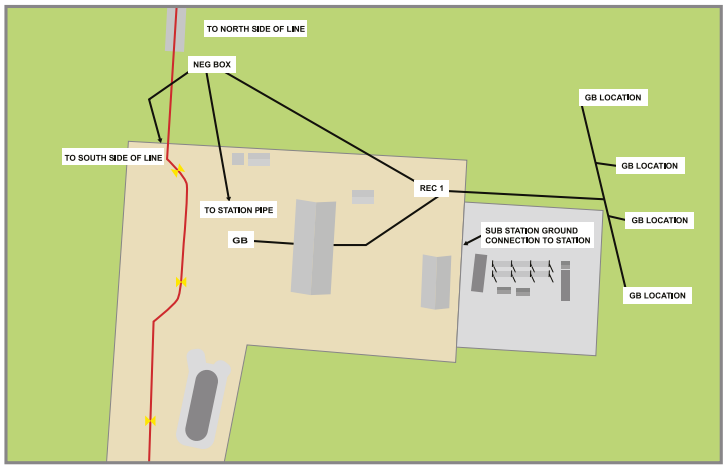

Figure 2. Pipeline metering station and electrical substation overview.

With a substantial amount of the ICCP current protecting the utility grounding grid, both pipelines to the north and south of the station did not have adequate CP. The south pipeline was out of compliance just a short distance away with only a -0.609 V reading to a reference cell – well below the -0.850 V industry criteria. The operator was faced with a decision to make in order to improve the CP readings on the pipeline to make it compliant with PHMSA regulations.

However, what happens when turning up the rectifier will simply not achieve the desired outcome in order to maintain compliance?

Solutions considered

The first option considered was to install an additional ground bed. This would be costly and would not address the issue of the existing ground bed shorting out and protecting the electrical grounding grid. Moreover, depending on the connections, the operator could be faced with the same issue as the existing ground bed and have a significant portion of the amperage displaced onto the electrical substation grounding grid.

A more desirable option is to decouple the facility from the offending substation. Doing so would isolate the DC current to the intended pipeline while still providing AC continuity for safety grounding purposes. Decoupling allowed the pipeline operator to eliminate the negative impact the substation was having on their CP system while retaining an effective ground path and electrical isolation from other underground metallic structures – a compliance requirement of CFR 192.467 (PHMSA).

When choosing to decouple, determining the location(s) to install a decoupler is critical in order to achieve sufficient DC isolation, to enable compliance to be achieved on all of the structures the ICCP system was designed to protect.

Decoupler selection

Critical to proper product selection, one of the first questions to ask when decoupling a complex facility is whether or not there is the possibility of AC being induced on to the system.

In this case, yes. Due to the fact that the structure which is absorbing the CP current is the electrical substation grounding grid, fed by adjacent high voltage power lines, there is the possibility of AC being induced on the piping.

Dairyland manufactures two rugged and reliable devices that are commonly used for this application; the Solid State Decoupler (SSD) and the Polarization Cell Replacement (PCR). These are solid state devices that require no maintenance, have an indefinite lifetime, and are designed to handle multiple fault current events and even lightning strikes. Due to the possible fault current available from the electrical substation, the operator needed to choose the PCR, as this has a higher fault current capacity than the SSD.

An additional challenge of having an unnecessarily large amount of CP current applied is the increased chance of interference with other structures. Foreign pipelines, for example, may be shifted to a more positive potential due to excess current interaction from the subject CP system. An opportunity to decrease that current output while still achieving CP criteria is desirable.

Installation considerations

There are multiple areas a decoupler could be installed in order to isolate DC current in this application from the facility electrical grounding system:

- Utility decoupling at the transformer.
- Station electrical panel between the neutral bus and the grounding bus.
- Motor operated valve (MOV) grounding conductor – one decoupler for each.
- Station grounding grid bonded to the electrical substation grounding grid – one decoupler for each point of connection.

To achieve the best possible result, the pipeline operator looked at each installation in order to determine the best long-term outcome.

Utility decoupling at the transformer

For example, by isolating at the utility transformer, the CP current will be isolated from reaching the utility substation. However, everything within the operator's station will receive CP. The decoupler would be installed by the utility company and would not be owned by the operator. With this installation, everything within the operator's station would receive CP, including piping, grounding grids, conduits, buildings, gradient control mats, etc.

Decoupling at the electrical panel

If installed at the operator's electrical panel, a similar result would occur. Everything within the station would be protected by the ICCP system. However, in this scenario, there is no utility involvement, and the operator can have an electrician install the decoupler. With this installation, everything within the station would receive CP, including piping, grounding grids, conduits, buildings, gradient control mats, etc.

Decoupling at the MOV

An MOV with AC power has a grounding conductor that bonds the cathodically protected pipeline to the operator's grounding grid. Placing a certified Dairyland decoupler in series in the grounding conductor blocks CP current but meets all electrical safety grounding codes. For this scenario, one decoupler would be needed for each MOV in the station.

Next, possible bypasses of the decoupler would need to be mitigated. These include metallic conduit, communication cabling, and measurement tubing as possible sources that could bypass the decoupler. The bond between the operator's grounding grid and the electrical substation would need an additional decoupler installed in series at that connection to further optimise CP performance. By performing this installation, the only structures that receive CP current should be the intended structures. The station grounding system and the electrical substation grounding grid would no longer receive CP current.

Decoupling the grounding grid

Installing a decoupler between the operator's grounding grid and the electrical substation grounding grid would require a decoupler installed in series in each connection. This would only address this connection and may require further decoupling of the MOVs or other bonds that could be potential bypasses.

In each of these situations, there would have still been an issue with the grounding grid connection that is located at the fence. Even though these solutions would have prevented the CP current from flowing to the utility grounding grid and typically would have been a good solution for this scenario, this would not have addressed the direct connection at the fence. This connection would have bypassed the previous options and would have thwarted any attempt to isolate the DC current.

In this case, the operator installed a decoupler in series in the bare copper wires that bonded the electrical grounding grids of the two facilities, located at the fence that separated them. A Dairyland decoupler can be installed at this location due to the fact that the device is UL listed as an effective ground fault path – as defined in NEC 250.4(A) (5). With this installation, the connection between the two facilities' grounding grids are still AC continuous, providing the necessary safety grounding to protect personnel and equipment; however, the DC current is isolated at that point of connection.

Table 1. The readings that were taken before and after the installation of the decoupler

Location/test point	Without decoupler	With decoupler
Rectifier output	55 A	58 A
Northside of line	8 A	34.6 A
Southside of line	4 A	24.5 A
Substation	26 A	1.2 A
Pump inlet	-1.168 V	-1.415 V
North of station	-2.365 V	-2.732 V
1 mile north of station	-1.340 V	-1.412 V
ROW south of station	-0.609 V	-1.412 V

Note: The 'With decoupler' readings were taken after the rectifier had been off for an unknown period of time due to a blown fuse. These readings were taken shortly after replacing the fuse and will most likely improve as the pipeline polarises further.

Results

The result of installing the decoupler at this location was that the CP current was now effectively blocked from flowing to the electrical substation grounding grid. CP current remained on the operator's station and piping as it was originally intended to do.

As is evidenced in the readings in Table 1, there was a significant change in the CP potential readings and distribution of current before and after the Dairyland decoupler was installed. After installing the decoupler, the section of pipeline located in the ROW just south of the station improved in electro-negative value from -0.609 V to -1.412 V, bringing it back into compliance. All other test points improved in value, meaning that the operator could now turn the rectifier down to compensate for these improved values and efficiencies gained through installing a Dairyland decoupler. The CP current was shifted to the intended structure – the pipeline – as compared to the electrical grounding grid. By turning down the rectifier output, the monthly costs to operate it will be reduced, while simultaneously increasing the life of the ground bed itself.

As for the small amount of amperage that was still going to the electric substation, this was not found to be flowing through the decoupler but had bypassed the device and was flowing to the electrical substation grounding grid through another path. The operator did not believe this to be a significant amount of current to warrant further investigation at this time and was pleased with the results that were currently being achieved.

The biggest take-away from this case is that the operator could cancel the plans for a deep well ICCP system – which was the intended plan B if the decoupler did not fix the issue. This ended up saving the company US$80 000 of installing a second ground bed, along with the additional annual costs associated with monitoring and maintenance of the bed. Even though the installation of a second ground bed would have brought the CP readings to an acceptable level, that would not have fixed the problem of the operator losing CP current onto the neighbouring structure. This solution would have been the same as having a house with a broken window in the middle of winter, which would create the need for the furnace to be turned up in order to compensate for this source of leakage. In this scenario, would you choose to fix the window to keep the heat from escaping, or not fix the window and place a second heater in that room in an effort to bring the temperature back up? When put in these terms, it makes it much easier to understand the importance of addressing the issue of CP current being drained by an unintended structure.

Conclusion

If an operator is experiencing similar issues with their CP current flowing onto unintended structures, installing more CP is not the optimal solution. Instead, these structures should be decoupled at the bonds that connect them. This will keep a pipeline in compliance with PHMSA 192.467 and increases the ability to achieve the criteria required in PHMSA 192.463. By incorporating the decoupling of unintended structures into an existing corrosion prevention programme, an improved CP system, reduction in maintenance costs, and a life extension of both the intended structure and the CP system itself, can all be achieved.

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IT'S A CASE OF PRESERVATION

Mark Zazulak, MESA, and Chuntao Deng, Keyera Corp., Canada, outline a case study of the performance of corrosion inhibiting filler in cased pipeline crossings.

Pipelines have long needed to coexist with civil infrastructure such as roadways, railways, and other structures. Activity and conditions associated with proximity to civil infrastructure make it desirable to provide additional protection from mechanical loading to the pipe.

Placing the pipeline within a larger diameter pipe segment – called a casing – to isolate it from the mechanical load and facilitate future pipe replacement, was a popular solution which has enjoyed widespread usage for multiple years. Many thousands of cased crossings have been constructed and are operating across North America. The use of a casing is not without its disadvantages, however.

The environment within a casing is unique and different from the conditions the carrier pipe is subjected to elsewhere. If a casing is performing as intended, and the humidity is low, then the main corrosion threat is general atmospheric corrosion at holidays.

However, when water and mud enter the casing – which can occur when the casing itself loses integrity as a result of full thickness pitting corrosion or the failure of a seal – other corrosion accelerating mechanisms become available.

Some examples include:

- Immersion of a coating pinhole in a water electrolyte.
- Bacteria growth raising the possibility of microbially influenced corrosion (MIC).
- Condensation coupled with high oxygen concentration, enabled by casing vents, can accelerate corrosion at coating holidays.

In addition, the casing itself can become an impediment to the use of cathodic protection (CP), which is the means by which corrosion at coating holidays is prevented. If the casing and/or pipeline physically shifts, it may result in direct contact with the pipeline and casing, resulting in an electrical short that reduces the level of CP applied to the pipeline. A study by Southwest Research Institute has identified shorted casings to be at elevated risk of corrosion.[1]

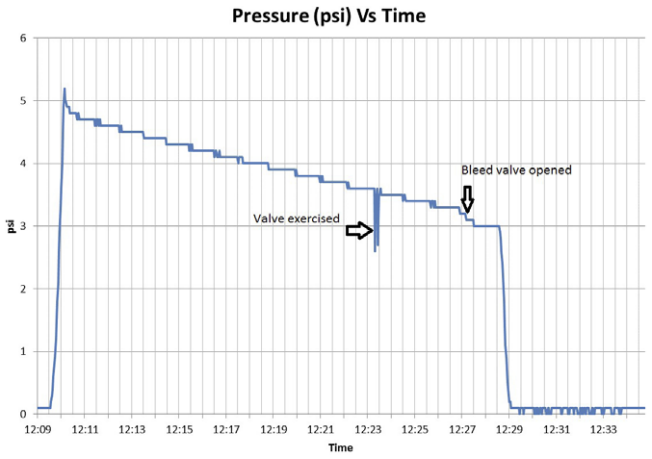

Figure 1. Air pressure test result.

Figure 2. Cosasco remote data collector installed on casing vent.

Another difficulty created by casings is their limiting effect on the investigative and assessment techniques that can be used to assess the condition of the pipeline and coating. This is especially important because the coating may be the only corrosion protection the carrier has within a humid casing.

For these reasons, the use of casings at crossings has fallen out of favour in new construction as modern design, coatings, and horizontal directional drilling (HDD) have enabled long-term maintenance-free crossings to be built.[2]

However, large numbers of ageing legacy casings are in place and represent a market for assessment, repair, and replacement services.

Repair and replace

Crossing replacement projects are very expensive in proportion to the level of safety, lifespan, and reliability improvements they yield, which results in a low priority being frequently assigned to the projects. A more practical and lower cost option to a crossing replacement has been sought after.

Historically, waxes and other dielectric fillers have been the lower cost option. Limiting dielectric products is the need to fully encapsulate the carrier pipeline in the dielectric material to provide complete protection. Some products must be hot applied with specialty tanker trucks, adding a logistical cost.

In recent years, technologies based on organic corrosion inhibitors have begun displacing dielectric products as a low-cost preservation method; the use of vapour phase corrosion inhibiting (VpCI) filler in place of a casing replacement can result in cost savings in the order of 95% or greater. Compared to ballpark cost estimates of crossing replacement by HDD, VpCI filler is in the order of approximately 2% of the cost.

Vapour phase corrosion inhibitors have a number of advantages over dielectric fills as a protection method:

- A corrosion protective effect within all surfaces of the cavity that are accessible by liquid or gas phase diffusion.
- An enhancing synergistic protective effect when combined with CP.
- The ability to monitor the corrosion inhibitor effectiveness within the casing over time by use of electronic resistance (ER) probes.

Some descriptions of the corrosion protective performance of Corrologic® VpCI casing filler are described in the literature; one major pipeline operator reported less than 1 mpy of observed corrosion on all of seven test casings which were tracked for 1 - 1.5 years.[3] Another paper describes the combined remote monitoring of ER probes and CP over a two month period.[4]

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Case study

Through an ILI inspection, Keyera identified an active corrosion feature on a cased crossing at a relatively remote location in west-central Alberta.

The casing is 12.75 in. OD and 110 ft in length, with an 8.625 in. OD carrier pipeline. The information available indicates that the casing was installed at the time of the original construction of the pipeline in 1969. MESA was contacted to provide a mitigation proposal.

A questionnaire was completed and indicated that the casing has two vents, was somewhat inclined, and not electrically shorted to the carrier.

MESA made an initial site visit to assess the casing candidacy for installation of Corrologic filler. At the initial visit, air was blown through the vents showing the casing to be dry, then one vent was capped and air was used to pressurise the casing to 5 psi. The air flow was then stopped and the pressure loss was observed for some time. Minor leakage of compressed air was noted, but the integrity was deemed to be more than adequate by comparing the leakage rate to data collected from other successful casing fills. A perfectly sealed casing is not required, as the filler is designed to thicken and remain within the casing despite minor integrity issues observed under pressure testing (Figure 1).

Corrologic casing filler is water-based with a proprietary amine carboxylate VpCI active ingredient. It is prepared on-site by adding an organic polymer gelling agent to the liquid stream immediately prior to injecting into the casing where it thickens.

The casing fill was completed the following month after the initial visit, and an ER probe with a battery powered remote data collector was installed.

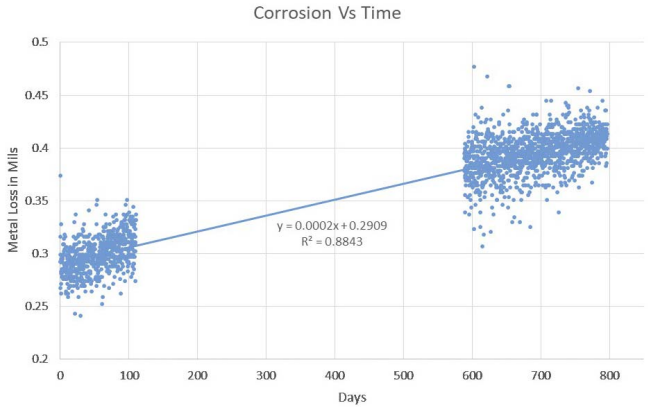

Figure 3. Less than 0.15 mils of total metal loss.

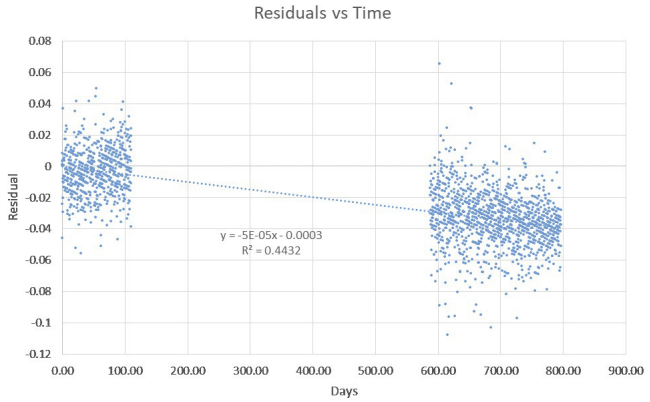

Figure 4. Small negative slope of residuals plot shows no degradation in VpCI protectiveness.

Corrosion monitoring

While the filler is designed to be a permanent long-term preservation solution, verifying inhibition performance over time is of interest.

Additionally, long-term corrosion monitoring of ER probe measurements is desirable as a strategy to identify casings that experience an adverse change.

In this installation, a Cosasco remote data collector (RDC) was used in conjunction with a 10 mil type D cylindrical ER probe, which was placed down the casing vent and immersed in casing filler.

The RDC was set to store a reading every four hours, which was then periodically downloaded. Data spanning 797 days was collected, with a long period of 478 days without data where the battery was not changed.

A plot of measured probe metal loss vs time clearly shows that the corrosion rate is very small (0.07 mpy) and can best be described as linear (Figure 3).

To test the validity of the linear corrosion rate assumption, a residuals plot was made by testing for a change in error between the observed values and the values predicted by the linear equation of best fit. The residual plot indicates a trend towards increasingly negative residuals over time. This can be interpreted as an indication that an extrapolation of the linear corrosion rate will result in a slight overestimation of corrosion, and a confirmation that there has not been a slight degradation in the protective effect of the filler since it was installed.

The corrosion rate found in this case study is approximately seven times the published laboratory rate found by other investigators using electrochemical methods.[5] However, in this case study, the composition of the casing filler was adjusted by adding 10% of propylene glycol in place of a portion of water in the mixing process. The propylene glycol addition was made as a non-toxic way to improve the low temperature freezing performance of the filler in cold climates.

The measured corrosion rate is still 14× lower than the rate of 1 mpy described by NACE as a common benchmark for effective corrosion control.[6]

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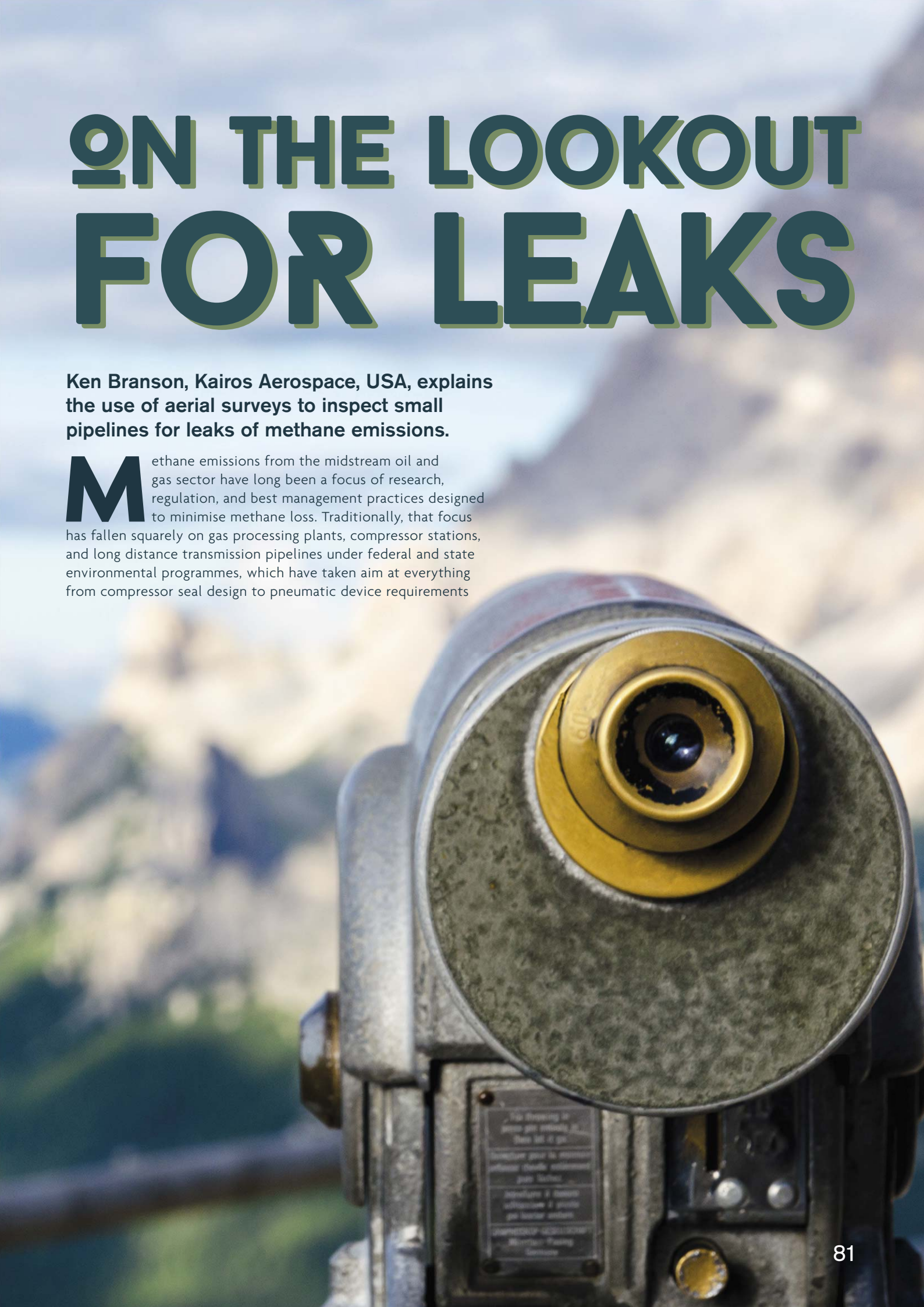
ON THE LOOKOUT FOR LEAKS

Ken Branson, Kairos Aerospace, USA, explains the use of aerial surveys to inspect small pipelines for leaks of methane emissions.

Methane emissions from the midstream oil and gas sector have long been a focus of research, regulation, and best management practices designed to minimise methane loss. Traditionally, that focus has fallen squarely on gas processing plants, compressor stations, and long distance transmission pipelines under federal and state environmental programmes, which have taken aim at everything from compressor seal design to pneumatic device requirements



and fugitive emissions monitoring programmes. Due to technical and economic limitations, less attention has been given to the thousands of miles of smaller gathering pipelines that link well sites to that larger infrastructure. New data taken in the Permian Basin by Kairos Aerospace reveals that the approach of focusing on surface facilities and large-scale transmission lines may be missing an important piece of the methane puzzle. The surprising finding from this new data is that methane emissions from pipelines account for more than twice as much methane product loss as from surface facilities, such as compressor stations.

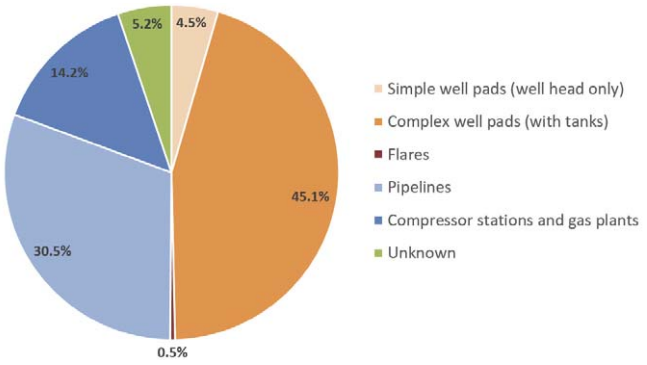


Figure 1. Methane emissions by type of source (percentages by volume) for all emissions detected by Kairos Aerospace's Permian Basin aerial methane survey, 2018 - 2019.

Figure 2. Aerial imagery of a methane plume from an underground gas gathering pipeline.

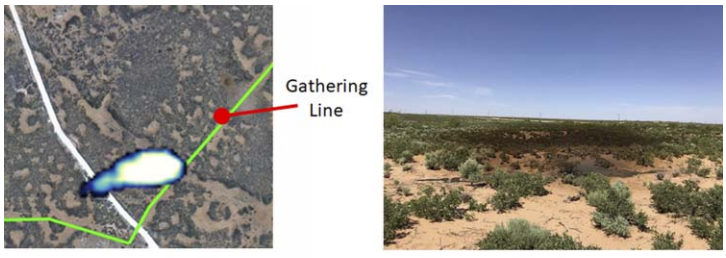


Figure 3. (A) Aerial imagery of a methane plume near a known gas gathering pipeline (marked in green on the map). (B) Photo taken of the site by the ground inspection team – darker shade caused by hydrocarbon liquids on the ground and nearby vegetation.

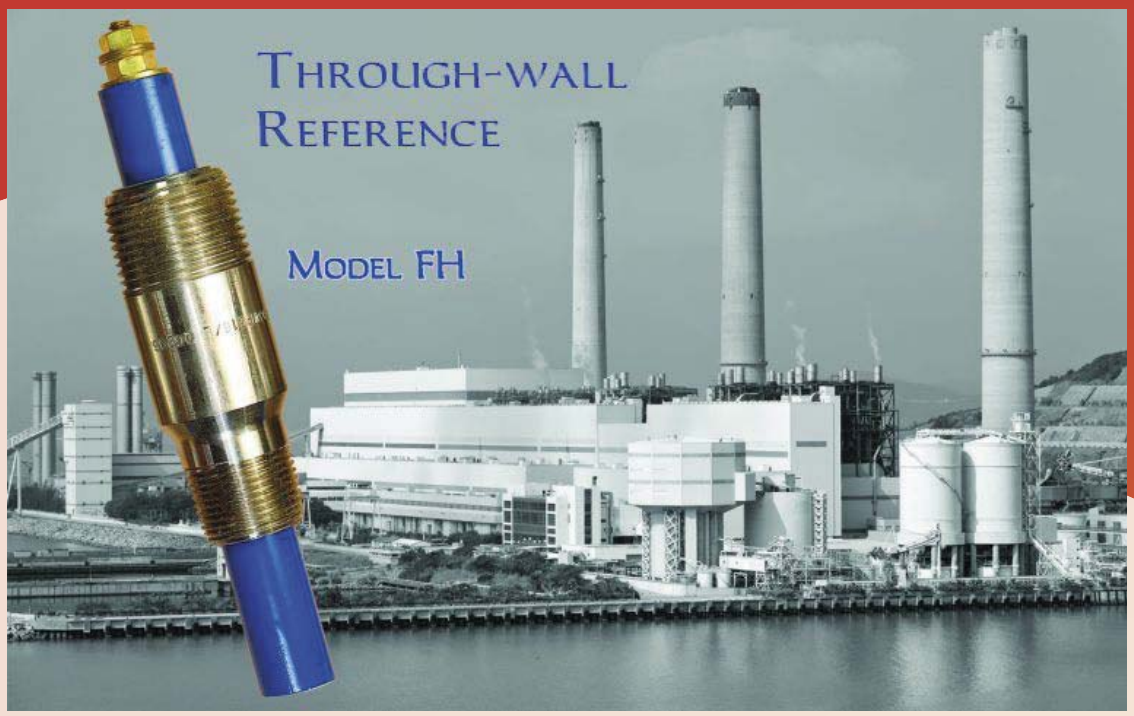
Aerial surveys

Since November 2018, Kairos has been conducting aerial surveys of production regions in south-eastern New Mexico and the Midland Basin in Texas, as part of what will eventually be a full survey of the entire Permian Basin. Kairos uses sensors mounted on light aircraft flying at 3000 ft above the ground to measure excess methane concentrations between the plane and the ground. The collected data is analysed to create maps of methane covering the entire production region, highlighting locations with plumes of high methane concentration and quantifying the emission rate for each of those plumes.

As of May 2019, the survey has inspected more than 16 000 surface facilities and more than 5000 miles of natural gas pipelines. This is already the largest and most comprehensive methane emissions survey undertaken for any oil producing region in the world. The survey has identified hundreds of locations with large methane plumes, including upstream facilities and compressor stations, as would be expected. The big surprise, however, was identifying more than 150 emission locations that are far from any surface facilities and instead are associated with underground gas gathering pipelines. Methane emissions associated with pipelines represent 31% of all emissions (by volume) measured during the survey (Figure 1) and 68% of emissions from midstream assets.

Shedding light on underground gathering lines

Perhaps it should not be a surprise that the industry has been less aware of emissions from pipelines than from surface facilities. According to data from IHS Markit, there are approximately 132 000 miles of natural gas pipelines in the Permian Basin. The vast majority are small, class 1, rural gathering lines that do not have the same leak detection requirements as larger lines or those located in more densely populated areas. Most methane emissions research has focused on surface facilities, probably because those are easier to identify and visit. Large, interstate transmission lines are typically instrumented to detect anomalies and are regularly inspected per regulatory requirements, while the smaller gathering lines have received much less attention from everyone: operators, regulators, and researchers. However, it is these smaller but numerous pipelines that seem to be the source of most of the emissions. Of the limited cases where Kairos collected detailed information from ground inspections of the identified sites, all of the leaks identified were from smaller pipes, ranging from 3 - 8 in. in diameter. Problems ranged from holes in old, corroded pipes to branch lines that had been improperly capped off, and to joints that were literally popped apart from excess line pressure – a



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persistent problem in the Permian Basin, where the current shortage in gas pipeline capacity leads to lines running at higher and higher pressures.

It is an enormous challenge to monitor all of these pipelines, especially if it would require walking the lines (or riding an ATV) with a handheld methane detector. In many cases, Kairos finds that operators do not have very accurate data about where all of their smaller lines are even located. The methane emissions are often found in places far from any roads and are unlikely to be noticed through normal operations for long periods of time. As an example of this, Figure 2 shows a methane plume originating from a gas gathering line at a location far from any road or surface facility. The plume extends downwind for hundreds of meters before crossing a major road and coming near a surface facility, where it might be detected if the wind is blowing in the right direction. Fortunately, new technology using aircraft is making this problem more tractable by providing inexpensive ways to collect emissions data for entire areas, rather than needing to follow individual pipelines. Even better, field-scale surveys also identify methane from the surface facilities more commonly studied as emission sources.

Filling in the information gaps

Pipeline operators have tried to monitor these gathering networks using mass balance techniques. They monitor for situations where there is too large a discrepancy between gas in and gas out measurements to be accounted for by expected meter inaccuracies. There are two limitations of this approach. First, only very large leaks, on the order of 1 - 2% of total pipeline volume, result in a large enough discrepancy to be detected by this technique. Kairos routinely identifies pipeline leaks of hundreds of thousands of ft^3/d that operators had not detected, even though they were consistently monitoring mass balance measurements on their pipeline networks. Second, once a problem is suspected, you still need to find the problem, typically by walking the lines. Figure 4 shows one case where Kairos flew a pipeline network for a client who suspected a problem existed based on mass balance monitoring – and Kairos found not one, but two leaks. If the operator had walked the line, they would have probably stopped as soon as the first problem was found, shut in the line, fixed the problem, and opened it back up. At that point, one of two things would have happened, neither good. Maybe the second leak would have been big enough for them to realise that they still had a problem, and then they would have had to repeat the inspection and repair process. Worse, maybe they would not have realised that they still had a problem on that line and the leaking would have gone on far longer, resulting in much greater emissions and product loss over time.

Finding the problems sooner is key to controlling costs. Pipeline leaks that can be detected from aircraft are almost always large enough to be cost-effective to repair, based purely on the value of lost product. However, reducing the cost of site remediation is another large benefit. Because these leaks typically occur in very remote, rarely visited areas, it is not uncommon to learn of the problem only when a rancher complains of dead vegetation or oil seeping up out of the ground. That only happens after a leak has been occurring for a long time. By that time, the cost of remediating contaminated soil can be very high, and operators may be required to install and maintain monitoring wells for years if there is a concern about groundwater contamination. Fortunately, the gas escaping can be detected long before the problems have become that bad. Figure 3 shows an example where hydrocarbon liquid droplets were misting up from an underground pipeline leak. The location is far enough from any roads that it would probably have gone undetected for months. However, aerial detection of the methane plume allowed the operator to address the problem quickly. Despite the liquids, the vegetation was still alive, indicating that the leak had not been going on very long, and the soil remediation costs were lower than expected for this type of problem.

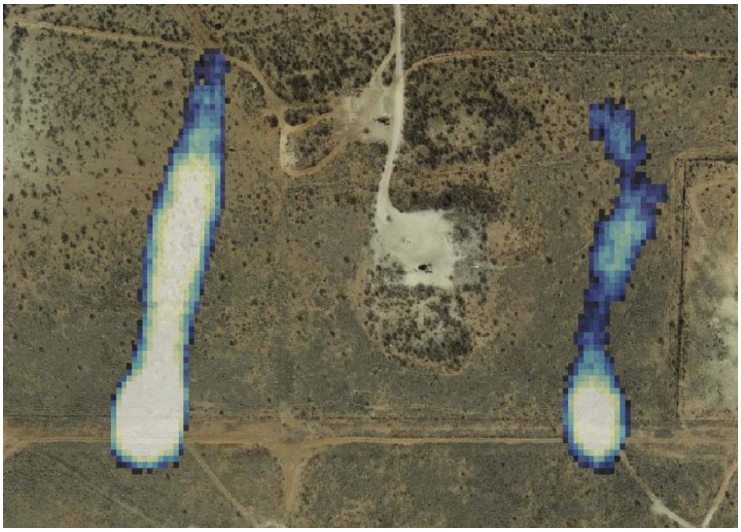

Figure 4. Methane emissions from two distinct locations along a gas gathering pipeline.

Conclusion

This new data from the Permian Basin is giving us a better understanding of the importance of methane emissions from gas gathering lines. Industry has made progress in reducing fugitive methane emissions from compressors, to the point where Kairos' data suggests that these are no longer the most important source of midstream emissions. Addressing pipeline leaks, especially from gathering lines, is the largest area of opportunity for reducing methane emissions. While the challenge of inspecting thousands of miles of small pipelines in remote locations is large, new remote sensing techniques give operators an efficient way to understand the condition of these assets and drive down product loss and remediation costs.

Figure 1. Operators performing an inspection on the high-temperature emulsion pipeline.

INSPECT THE UNINSPECTED

Michael Sirois and his team at Eddyfi Technologies, Canada, explore developments at the forefront of pipeline inspection in the digital age.

In the US alone, in 2018, there were 634 pipeline incidents, eight fatalities and 90 injuries, for a total cost of over US$1 billion. In 2019, there have already been 297 pipeline incidents, three fatalities and three injuries, with costs exceeding US$100 million.[1] In North America, cracking is among the top three causes of pipeline failures.[2]

As a first assessment of the health of their pipeline network, owners are required to rely on inline inspection (ILI) tools to get a preliminary diagnostic. This data acquisition sets the outline for targeted areas that need further investigation where direct examination must be executed. As such, the stakeholders must stay up to date on the new advances in pipeline inspection. This article sheds light on a technology for the pipeline industry that is capable of changing the way inspections are performed on these assets, reducing the human factor, and making way for reliable and repeatable inspection data.

Emulsion pipeline case study

Emulsion pipelines essentially carry a mixture of bitumen, hot water and steam. Unfortunately, these critical assets are subject to various damage mechanisms, among which cracking – including stress corrosion cracking (SCC), an environmentally assisted cracking mechanism that can induce rapid failure when initiated – is one of the most prevalent and is known to be one

of the main causes of pipeline incidents. To properly mitigate risks, an emulsion pipeline asset owner would require a long line to be inspected as part of an extensive inspection campaign. After considering performing magnetic particle inspection (MPI) – the de facto method for pipeline direct examination – the asset owners opted for an alternative, digital method for several reasons.

First and foremost, the total area to be inspected was far too large. Inspecting a 24 in. (60 cm) diameter pipeline over a 20 mile (32 km) stretch, is akin to scrutinising 12 football pitches for minute details. Furthermore, there was no room for errors such as having a crack undetected, and the non-destructive testing (NDT) examination needed to be extremely reliable from beginning to end, while remaining safe for both the operator and the environment. To make the inspection of this asset even more difficult, the pipeline surface was hot (150°C), which points at dry MPI as a first NDT technique. However, MPI has several limitations. Indeed, dry MPI is a long inspection process, so inspecting 20 miles with this technique would have taken a vast amount of time. It would also have required extensive surface preparation, including exhaustive sandblasting and careful painting, as proper contrast is key with this technique. Moreover, it is a method that is invariably impacted by the weather, environmental conditions and outside temperature.

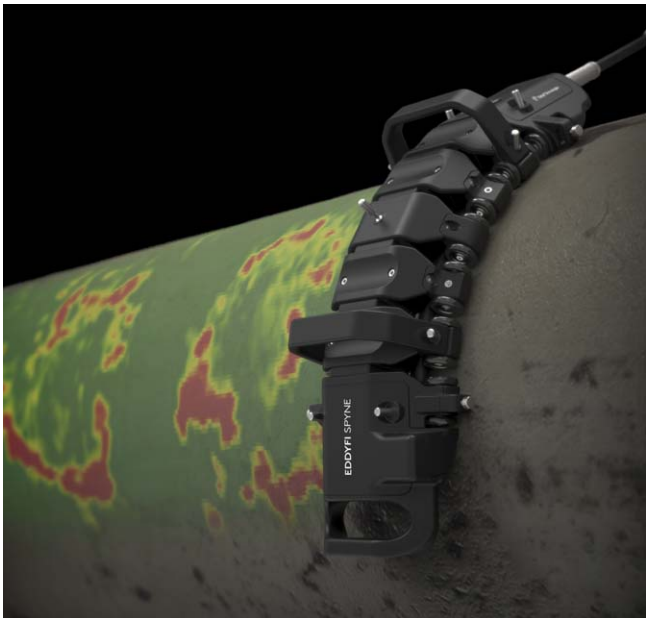

Figure 2. A representation of real Spyne data scan overlaying a pipe.

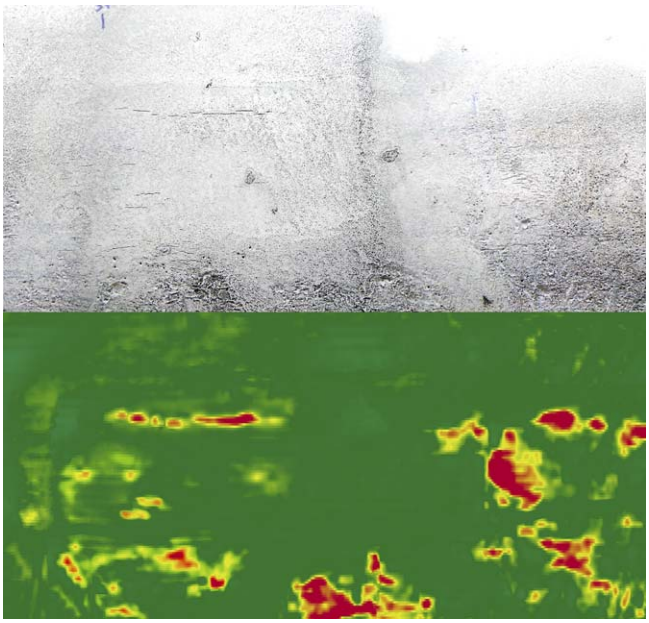

Figure 3. Example of data collected using MPI, and data obtained with inspection using advanced ECA.

Virtually all steps of an MPI inspection procedure also heavily rely on the operator, including surface preparation, magnetisation, interpretation and reporting. Although extremely useful in a wide variety of contexts, MPI is subject to the human factor, which can impact the repeatability of results. A striking example is when trying to detect a very small crack under a pipeline after hours of manipulating a yoke in an inhospitable environment. Indeed, after having considered dry MPI, it became obvious to the decision makers that this technique would require too much time and too many technicians, and would offer limited confidence in the inspection results. Being able to collect data, map results, and archive digital records were also key features that only a digital inspection method could provide.

As an alternative to dry MPI, the pipeline owner and inspection company decided to choose eddy current array (ECA) – a digital, electromagnetic NDT technique that allows the efficient detection of surface cracking, even in the presence of paint or coating. Flexible advanced ECA probes are the ideal embodiment of this technique when it comes to long emulsion pipelines, and were the best fit for this inspection campaign. With a coverage of 8 in. (200 mm) and a scanning speed that can reach 24 in./sec., the solution provided fast results and was suited to detecting isolated cracks as small as 3 mm in length and 1 mm in depth, in addition to typical SCC clusters encountered during direct assessment work.

The tool's high sensitivity, the ease with which it is used, and its tolerance to elevated surface temperature were the key factors that led the decision makers to adopt the NDT inspection technique. When partnered with a portable ECA instrument, Spyne, Eddyfi's

Figure 4. An operator performing an in-ditch inspection with Spyne.

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ECA probe specifically intended for pipeline integrity, delivered colour-coded maps (C-scans) on the instrument's large multi-touch display. Additionally, the advanced ECA probe features an encoder. All data is recorded with spatial referencing, so cracks appearing on the screen can be accurately located on the actual pipeline. With the assisted detection capabilities of the partnered instrument, all crack-like indications were highlighted by the software so that technicians could confidently discriminate a crack from a spurious signal in order to undertake the most suitable action. Finally, this method also allowed for on-the-spot reporting, mostly due to an integrated, archivable screening report feature.

Numerous blind tests and field trials have shown that Spyne compares favourably against MPI when it comes to detection of SCC on pipelines. The tool is less operator-dependent and reduces the burden on the technicians, especially when facing non-ideal surface preparation, adverse weather conditions, or physically inaccessible spaces. The ECA solution systematically led to the discovery of more SCC than MPI, in less time, with no increase in false positives, all the while providing complete digital records of the inspection. The probability of detection offered, along with the repeatability aspect of the technique and the full digital records (including archiving) are advantages over MPI. In terms of inspection speed, the fact that ECA does not require extensive surface preparation is a significant time saver. Adding into the equation the large coverage of the probe and the scanning speed it tolerates means that an ECA inspection such as this one is typically 2 - 5 times faster than MPI, while offering a greater data density.

A solution for various pipeline integrity applications

Considering the cost of excavation and trenching for gas pipelines, ECA technology is confirmed to be a valuable method of inspection for assets. The technology presented in this article has also proven to be effective on various other applications specific to the pipeline industry, such as buried pipelines, in-ditch direct assessment work or during direct examination digs.

Conclusion

The imaging, reporting and archiving of inspection results have understandably become the standard of expected outcomes in inspection campaigns. When these elements are combined with non-negligible features, such as improved probability of detection, time saving, repeatability, and mitigation of the human-induced factors inherent to inspections, new technology and methods of inspection for pipelines are on the way to becoming the go-to instruments for inspectors because they contribute to the confidence in the data obtained. They allow for safe, quick, and accurate assessment of conditions, and lead to better decision making. In short, they play an important role in diminishing the risks that could have great impact on the environment and local communities, all the while benefitting both the asset owner and the service companies. WP

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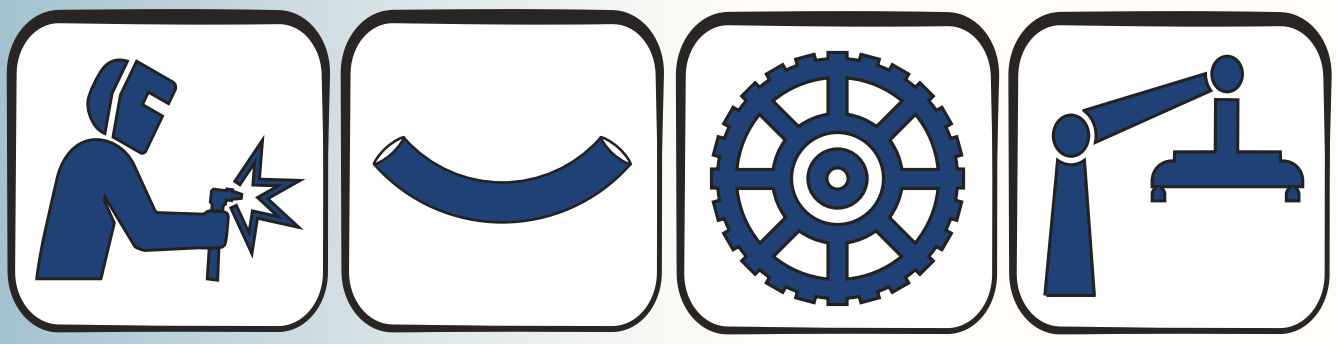

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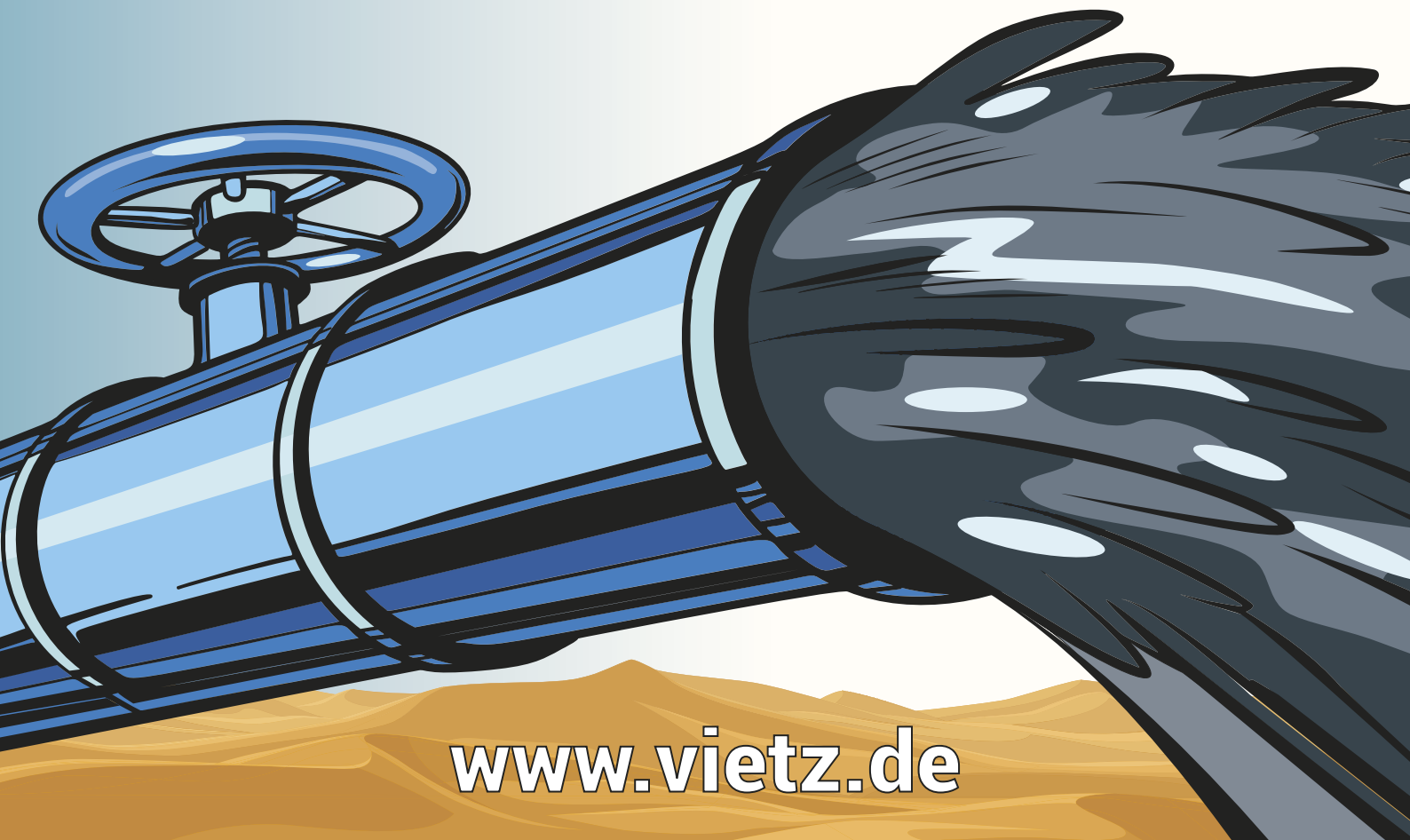

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